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**The development of a discursive psychology approach to investigate the participation of students with English as an additional language (EAL) in writing and solving arithmetic word problems with peers**

**The development of a discursive psychology approach to investigate the participation of students with English as an additional language (EAL) in writing and solving arithmetic word problems with peers**

A dissertation submitted to the University of Bristol in accordance with the requirements of the degree of Doctor of Philosophy in the Faculty of Social Sciences.

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# Abstract

There has been very little research examining how students learning English as an additional language (EAL) participate in mathematics classroom interaction. This dissertation addresses two broad substantive questions: How do EAL students use language to think about mathematics? How do EAL students make sense of mathematics classroom talk? Previous research in this area has largely failed to problematise issues relating to the diverse backgrounds of EAL students. This dissertation also addresses the methodological question: How can mathematics classroom interaction involving EAL students be investigated?

The dissertation gives an account of the development of a methodological approach to the investigation of mathematical interaction. This approach draws on ideas from conversation analysis and discursive psychology. A focus of analysis is the identification of patterns in students' attention. By then examining moments where attention is shifted from one area to another, it is possible to examine how attention is used by students as part of the social activity of thinking. This methodological approach was used to analyse interaction involving EAL students as they worked with peers on the mathematics classroom task of writing arithmetic word problems.

Analysis led to the identification and description of four interwoven patterns of attention. These patterns were of attention to the word problem genre, to narrative experience, to mathematical structure and to written form. Further analysis highlights how attention to these different aspects of the task was used by the participants to make sense together and manage social relationships. This analysis shows how EAL students are able to draw on a range of different forms of experience in working on mathematical word problems. These findings suggest that EAL students benefit from opportunities to work with other students to negotiate shared sense in the classroom. They also demonstrate the efficacy of the methodological approach developed in this study.

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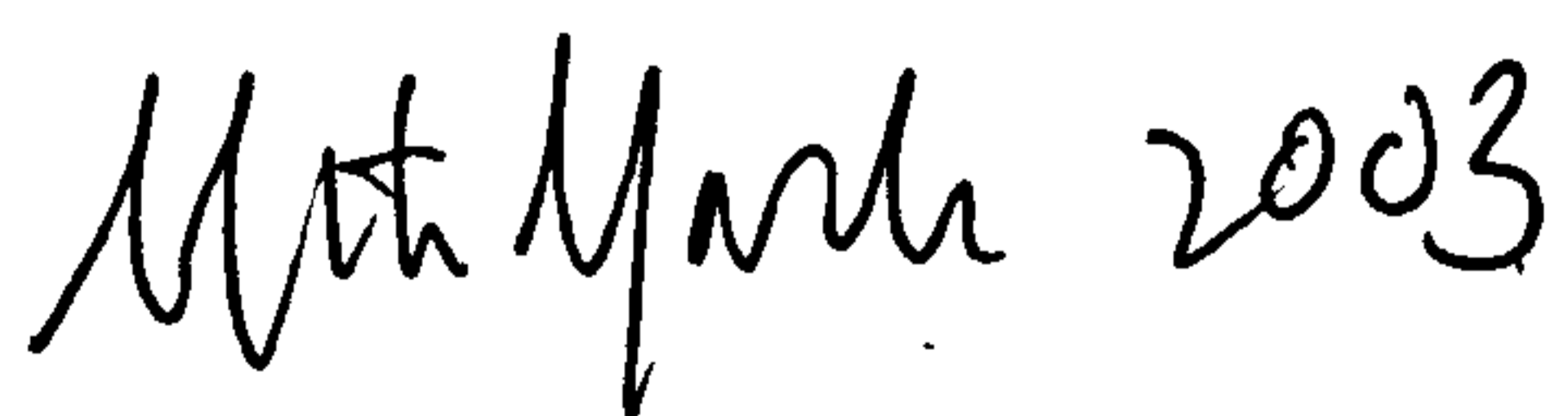
Et finalement un grand merci à Josée Beauregard pour un soutien sans réserve.

### **Author's declaration**

I certify that, except where otherwise stated, the work contained in this dissertation is entirely my own and has not been submitted for the award of any other degree at this or any other university. Any views expressed are entirely my own and in no way represent those of the University of Bristol

A handwritten signature in black ink, appearing to read 'Barwell', with a long horizontal flourish extending to the right.

Richard Barwell

A handwritten date in black ink, '11th March 2003', written in a cursive style.

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## **PART ONE**

## Chapter 1

### A place to begin

In 1995, I found myself in the mountains of northern Pakistan, working with the students and teachers of a small community school. There were around 270 children of all ages from 5 to 14. They spoke Burushaski first, Urdu second. Some also learned Arabic and Persian and sometimes other languages as well. Their school had been created by the local community to provide education through the medium of English. My challenge, therefore, was to teach mathematics, in English, to students for whom English was at best a third language, and a language which they were still very much in the process of learning. I worked hard to meet this challenge and thought about it throughout the three years that I spent in Pakistan (see Barwell, 1997, 1998, 2000a). My work raised many questions. One that I frequently returned to was: how do they learn? How do my students, working in a language they are still struggling to speak, manage to learn any mathematics? That they did so amazed and impressed me and provoked my curiosity. I thought about the relationship between different languages and mathematics teaching and learning. I thought about the influence of the prevailing culture of education that I encountered. I puzzled over why my students did and said certain things in mathematics. On occasions, it seemed clear to me that the ways in which my students thought about mathematics was caused by the languages they spoke. On other occasions it seemed obvious that this could not be the case, that the language they spoke could have no influence on the abstract ideas of mathematics. I found no resolution to these opposing thoughts but continued to work at my teaching both with children and teachers. Through my work, I became aware that in some ways I would never resolve this issue, since I could never know what it was like to be a student or one of the other teachers in my school. Increasingly, I realised that I could

never think like my students and colleagues, or rather, I could never know what it was like to think like them, since their world was different from mine.

My need to make sense of these experiences led me on my return to the UK to study for a master's degree in education. I was particularly interested in the *process* of teaching and learning mathematics involving students who were learners of English, the ways in which students made sense of their mathematics, given that the classroom language was one they were still acquiring. Much of the research I read about focused more on students' performance in tests, either as an end in itself or as a means to answering other questions about language and mathematics. Such research offered little insight into how students engaged with mathematics in the classroom. Other work appeared to explore students' language development or broader cultural factors. I could find almost nothing which focused on the processes of learning mathematics in a multilingual context. I therefore began to think about how such an investigation could be conducted.

During the year of master's study I visited an urban secondary school which has many students who are learning English, known in the UK as having English as an additional language, or EAL [1]. As well as observing many mathematics lessons, I conducted two small scale exploratory studies which involved a small number of year 7 (aged 11-12 years) EAL students. I recorded these students working in pairs on mathematics tasks and analysed their interaction. Through these studies, I explored some of the issues that arose for me in Pakistan. The notion of discourses, or ways of talking, emerged as being relevant and important. I became interested in how the students' use of language during the mathematics tasks was related to conventional ways of talking in mathematics classrooms, or in other environments, such as the home or playground. My work raised many questions, some of which I set out at the end of the dissertation:

How are learners' meanings related to the different discourses in which they occur?  
How are learners cued into these different discourses? What is the relationship between discourse, context and meaning? How do EAL learners develop a sensitivity to different discourses? Monolingual learners have a lifetime to become sensitive to the subtleties of meaning, connotation and the different discourses in which they occur. EAL learners...must take time to develop this sensitivity, yet they do learn. My question then, remains: how do they do this? (Barwell, 1999, p. 62).

These questions form one starting point for the work set out in this doctoral dissertation. The nature of these questions, which derive from my interest in classroom processes rather than outcomes, suggests a more qualitative approach. The broad aims of this work include an investigation of the interaction of students who have English as an additional language as they are engaged in mathematics tasks in their classroom. The focus will be on interaction between students as they work together in order to gain insights into processes of thinking and learning.

There is, however, a second point of departure for this research, which concerns the issue of meaning. This concern, already alluded to above, dates back to my work in Pakistan where my experience of working with students and teachers led to an awareness that although we were using the same words, the same English language, what we meant by those words was different. This was particularly apparent in my work with teachers. During my earlier training workshops, I would initiate discussions about various aspects of teaching mathematics. I hoped, for example, to broaden the range of mathematical experiences of students, who were used to learning algorithms by rote. In the workshops, therefore, the teachers and I might discuss the possible uses of different kinds of classroom activities, such as games or practical work. These discussions were lively and interesting but seemed to have little effect on teachers' classroom practice. I slowly realised that whilst we could talk about games or discussions, what the teachers meant by these words was not the same as what I meant by them. On reflection, this was hardly surprising. Our experiences of teaching and learning mathematics or any other subject were quite different, so that what a 'game' or a 'discussion' might entail were also different. Indeed, our wider cultural, linguistic and social experiences were also implicated, since the cultural or social meanings of games and the typical ways of talking in or about different games were also different.

Meaning, then, for me is linked to experience. When I use a word or phrase, what I mean is related to my experience of acting in the world, including my experience of language. Since no two individuals share the same experience, what they mean by what they say will always be different. Furthermore, it is not possible somehow to know what someone else means: any attempt to do this is an interpretation, filtered by the interpreter's own experience. Indeed even the implication that meaning is some kind of tangible, knowable object is problematic. This rather strong position, which

derives from my own experience in Pakistan, raises serious issues for my research. How can I investigate the participation of students with English as an additional language in mathematics teaching and learning, if I have little experience of their cultural, linguistic, social and educational backgrounds? If I cannot say what students mean, can I say anything? These questions form a central methodological concern of this study.

The experiences I have described which led to the above methodological questions also have implications for the notion of *methodology* itself. Since the term is used in a variety of ways, before proceeding I should briefly clarify what methodology entails for me. For many researchers the term 'methodology' denotes what Cohen & Manion (1994) gloss as the "critical description and analysis of methods" (p. 38), a view which concerns the process of conducting research (p. 39). My interpretation of how they discuss methodology suggests that their position does not address the issue of interpretation which my experiences in Pakistan raised for me. Analogously with my work with teachers, any method of data collection I may use will be interpreted by the participants in the research. The questions in an interview or in a questionnaire, for example, will be interpreted by the participants according to their experience. I will then interpret their responses according to mine. For me, therefore, methodology must include an account of how I come to make my interpretations, what Webb (2000, p. 36) calls "my research story". This story includes not just a final set of methods, but the experiences of selecting, developing and deploying those methods, since these experiences are part of how I make sense of my data. Clearly such accounts can never fully describe the on-going interaction between me, the conduct of my research and the development of my ideas. By giving a fuller account of these processes, however, I hope to make them more accountable, as well as more open to scrutiny and challenge.

### **How the dissertation is organised**

In this chapter, I have outlined two points of departure for this dissertation, one substantive, the other methodological. The former concerns questions of how EAL students think and learn mathematics. The latter focuses on how such questions may



be investigated. Although both substantive and methodological concerns are addressed throughout, the dissertation falls into two parts. The first, comprising Chapters 1 – 6 focuses on the development of a methodology which addresses the issue of meaning raised above. The second part, comprising Chapters 7 – 11 is more concerned with the analysis of the data I have collected in order to address more substantive issues. I will briefly outline these two parts in more detail before adding a note on the use of data throughout this dissertation.

## **Part 1**

As I observed above, there has been some research interest in bilingual or multilingual learners of mathematics and their classrooms. In Chapter 2, I return to this literature to look more closely at what research has been conducted as well as how researchers have dealt with the issue of meaning in the multilingual, multicultural environments in which they have worked. Chapters 3 – 6 concern the development of a methodological approach to investigating my questions, including the collection and analysis of data. Chapter 3 introduces the school in which I conducted almost two years' of fieldwork. Chapters 4 and 5 develop a language for the description and analysis of students' interaction drawing on ideas from conversation analysis (e.g. Sacks, 1992) and discursive psychology (e.g. Edwards, 1997). In particular, I elaborate the notion of *orientation* as a pattern in students' talk. Chapter 6 then describes the process of data collection and the nature of the resulting data.

## **Part 2**

The second part of the dissertation is largely devoted to the analysis of the corpus of tape-recorded interaction collected for this study. Chapter 7 sets out the identification and description of four orientations, or patterns, in students' talk as they work on a mathematics classroom task. Chapters 8, 9 and 10 take three of these patterns and examine the role each plays in students' thinking through talk. Chapter 11 concludes the dissertation by summarising findings and considering some of their implications for teaching and research.

## **A note on the use of data**

My work over the past three years has seen the development of my thinking in several parallel but interwoven strands. These strands include the choice of methods used, the development of a methodological approach, my on-going exploration of the literature and the continuing analysis of my data. In particular, in conducting my research, whether in reading the work of others or carrying out my own investigations, I have sought to make sense of what I am doing in terms of the experience of the students and teachers who became the focus of my emerging ideas. Thus, whilst each chapter focuses on specific aspects of the research process, the ideas are illustrated with relevant information and extracts from transcripts of recordings I have made. The inclusion of some of my data throughout the dissertation in this way serves to contextualise the process I describe and brings out many issues which may otherwise appear rather abstract. Where such data is introduced, I give brief indications of when and where the recordings were made or the information obtained. A full account of data collection procedures and the status of the different forms of data obtained during the course of this study are set out in detail in Chapters 3 and 6. Notes about symbols used in transcripts, the system used to label the data, use of names and other matters can be found in Appendix I (pp. 217-221). The next chapter, which concerns the literature on the participation of EAL students in the teaching and learning of mathematics, is illustrated with part of a transcript featuring a student I have called Farida.

## Chapter 2

# Teaching and learning mathematics and English as an additional language

To begin this chapter, I want to introduce Farida. When I met Farida, she was 9 years old and had attended her urban primary school since she joined the nursery class. Her family, which is from Pakistan, live near to the school and her parents work long hours in the shop they run. At home, Farida speaks both of her languages at different times. She usually speaks English with her five sisters and Punjabi, a Pakistani language, with her parents, although both languages are always present. Her teachers have expressed some concern about her progress, which has not matched that of her peers. Her parents are also a little concerned about her progress and would like to arrange a private tutor to provide extra support, particularly in literacy. What is not clear is how Farida's bilingualism is a factor in her progress [2].

One morning in the summer term of 2000, I invited Farida and another Pakistani student, Parveen, to do some work away from their class for a few minutes. I audio-recorded the two girls as they worked. It was the first time I had recorded either student in this way. The purpose and practicalities of making this recording are discussed in more detail in Chapter 6. The extract below shows the first few minutes of the session, just after the two students have sat down, in which Farida offers some unprompted thoughts (see Appendix I, pp. 217-221, for an explanation of the transcription system used in this and other extracts in this dissertation). What mathematics can I see in what Farida says? What language issues might arise for her teacher? How much does talk like this tell me or her teacher about Farida?

## Extract 2.1

12 RB [ b-  
13 F (exhales)[ we/ we/ we're learning about um/ factor and divide and/  
14 division/ and take away add yeah/ and like/ miss gives us a test miss T/  
15 she gives us a test every test/ and she gives us/ three times test/ like/  
16 times/ she gives us divide/ she gives us take away/ she like mixed it up/  
17 like she give/ um/ take aways and add together/ and she gives like divide  
18 and/ take and/ (tuts) what's those (grid) called/  
19 RB (...)  
20 P multiply  
21 F yeah multiply/ and plus she/ she likes/ when we when she  
22 explai=explained it yeah/ we/ put it in our maths books?/ and she tells us  
23 to do something/ and she puts something on the board like some  
24 numbers/ and we do it in our maths books?/ and then when we've  
25 finished/ l-l-/ nearly lunchtime/ and we stop and tidy up and (bring) the  
26 books and then/ she like/ um//  
27 P circle/ when  
28 F oh yeah/ circle/ and shapes and she talks about three Ds and two Ds like/  
29 but one face and hexadas she like says [ six sides  
30 P [ multiply then/ multiply  
31 F yeah and/ and/ miss T like/ choose hepsadas/ you have six sides/ yeah?/  
32 and pentagon has eight sides/ um/ and ummm/ ummm/ and I think  
33 RB okay/ thank you for telling me about your/ about your maths/  
1A/2F&P: 20/6/00

I am not sure why Farida offered me these thoughts, but perhaps she is saying what she thinks I am interested in hearing. What she says is certainly interesting. She talks about her school mathematics, first about arithmetic tests, then about a lesson and finally, after an intervention from Parveen, about geometry. She uses a lot of mathematical vocabulary, words like 'divide', 'add together', 'factor', 'three-D', 'face' and 'pentagon'. She uses a couple of mathematical facts, including a hexagon having six sides and a pentagon having eight (conventionally, pentagons have five sides). It is difficult to say how familiar she is with the words she uses. She appears to make two approximations of the word 'hexagon', for example, 'hexada' and 'hepsada' but I cannot say if she has just forgotten the correct word or has not heard it correctly in class or is just playing with the sounds of the word or words. Similarly, I cannot say if she knows how many sides a pentagon has, only that on this occasion she does not use the word 'pentagon' in a standard way. Perhaps she meant to say 'octagon' and the wrong word came out. I cannot say from this extract. Equally, although she talks about tests, and her words conjure up images and feelings for me, these images and feelings are not the same as Farida's. Her experience of mathematics tests and of learning mathematics is different from mine. So

when she talks about multiplying what she means is informed by the many times she has used or seen multiplying, whether in the mathematics classroom, in her parents' shop or anywhere else. The mathematics that students like Farida encounter at home and in their community may be very different from the mathematics of the classroom. More broadly, Farida's experience of education and of mathematics is, in part, related to her social and cultural background. As researchers such as Gregory & Williams (2000, pp. 158-179; see also Heath, 1986, pp. 190-262) have shown, different communities may attach significance to different forms and aspects of education. Farida, for example, attends a mosque school, where a much more formal teaching approach is used. These experiences inform Farida's interpretations of what she encounters in school (and vice versa) and are expressed in the words she uses.

If I can never be party to all Farida's experiences and so can never fully be party to what Farida means by what she says, what can I say about Farida's mathematical thinking or learning or that of EAL students like her? Clearly, I need more evidence than this brief snippet provides, but what kind of evidence? In this chapter, I want to explore what researchers have done to try to understand the relationship between bilingualism or multilingualism in students and mathematics teaching and learning. I am particularly interested in research relevant to the UK context. Thus, I will discuss research conducted in the context of teaching and learning which takes place mostly or entirely in English. The research considered will in some way be concerned with school students for whom English is an additional language. Relevant research will examine aspects of classroom learning, teaching or interaction or issues relating to the curriculum or to assessment. I will not refer to studies which compare the mathematical thinking of different linguistic groups (e.g. Han & Ginsberg, 2001; Miura, Kim, Chang & Okamoto, 1988; Towse & Saxton, 1998; Zepp, Monin & Lei, 1987), as such studies do not concern bilingual students. Nor will I consider studies such as those which investigate the different mathematical activities which students encounter outside school (e.g. Jones, 1996; Nunes, Schliemann & Carraher, 1993; Tomlin, Baker & Street, 2002) or different cultural perspectives of mathematics (D'Ambrosio, 1985; Gerdes, 1997). My interest is in how EAL students like Farida participate in the learning and teaching of *school* mathematics. Whilst Farida and her peers are likely to bring their out-of-school experiences of

mathematics to bear on their classroom work, I am not in a position to detail even a little of that experience, let alone be able to say what it means for them. Furthermore, using the findings of such research risks my making unjustified generalisations on the basis of students' cultural backgrounds.

So how have researchers investigated the teaching and learning of mathematics involving students for whom English is an additional language? How have they dealt with the complexity of this issue? How have they dealt with the diverse backgrounds of EAL learners and what this means for meaning? What conclusions have they drawn? How robust are their findings? And what implications are there for the classroom? Perhaps the most fundamental question asked by teachers, policy makers and researchers alike is 'does it make any difference'? Does learning English as an additional language have any effect on mathematical attainment? Do EAL students do better or worse or just the same as their monolingual peers in mathematics? Do EAL students need specific kinds of support in learning mathematics [3]?

### **Does it make any difference?**

There are few large-scale surveys of mathematics attainment that investigate bilingualism as a factor. This is perhaps because 'bilingualism' is not a homogenous state with the same impact on all students in all classrooms. Variations in linguistic proficiency, language structure and background social and cultural conditions make it difficult to attribute any difference in performance in mathematics tests even partly to bilingual factors. There have been studies seeking differences between ethnic groups both in the UK and in the US. Although far from conclusive, such studies lead to a concern that students from some ethnic backgrounds tend to underachieve in mathematics (Cocking & Chipman, 1988, p. 21; Collier, 1987, p. 637; Gilborne & Gipps, 1996, pp. 10-11, 13-14, 26; Hargreaves, 1998, p. 410; Phillips & Birrell, 1994, p. 60). In the UK, for example, Phillips & Birrell (1994), compared 82 8-year-old EAL students from South Asian backgrounds with 98 monolingual students on mathematical and literacy measures. They found that the EAL students attained less highly than the monolingual students in

mathematics and that they made less progress in mathematics over a year. These findings were in contrast to the EAL students' performance in literacy tests, where they did as well as their monolingual counterparts. Even where differences in attainment like these are found, however, it is not clear whether they are as a result of linguistic, cultural, social or economic conditions or some combination of these and other factors (Secada, 1992, pp. 639-641). An additional complication is the fact that the tests used to measure attainment are written in English, so that students' proficiency in English, particularly mathematical English (see Pimm, 1987) obscures their attainment in mathematics (Prins & Ulijn, 1998, pp. 155-156).

A further issue in reporting the attainment of students from minority communities is that such studies implicitly take the majority perspective when considering what counts as attainment, downgrading other forms of mathematical achievement as less valuable. Farida may be able to do arithmetic in Punjabi, for example, but this will never be tested in school and given a national curriculum level. She may be familiar with mathematical practices from her parents' shop, but these practices may not be recognised or considered in her mathematics lessons. The only attainment that counts is that measured by national tests. Where teachers use more informal ways of measuring students' progress, it is still progress in relation to the UK's National Numeracy Strategy (NNS) or National Curriculum (NC) that is being measured. Methodologically, then, research of the kind discussed above tends to assume that all students interpret tests as an activity as well as the particular content of mathematics tests in the same way. For students from diverse social, cultural and linguistic backgrounds, this assumption needs revisiting.

Clearly, the impact of learning English as an additional language on mathematics attainment is far from straightforward and the role played by language in the mathematics classroom is complex. A number of different researchers have attempted to reduce this complexity by focusing on a single aspect of the additional language situation. The most frequent approach has been to investigate the relationship between *language proficiency* and mathematical attainment. Proficiency is a logical factor to consider. Language is unlikely to be an issue for a student who is fluent in English (although there may be related issues of a cultural and social nature). For a student who is new to English, on the

other hand, there are clearly challenges in participating in and learning mathematics. Between these two positions lie the majority of EAL students. In Farida's case, I can speculate that some aspects of learning mathematics may be problematic. Her attempts to say the word 'hexagon' or to find whatever the word was that goes with 'grid' suggest that for her mathematical discussion may be more convoluted and involve more attention to the language and so less to the mathematics than for her monolingual peers. Does linguistic proficiency have any effect on mathematical attainment? If Farida's proficiency in English is under-developed, will this affect her learning of mathematics? Does her level of proficiency in Urdu or Punjabi make any difference to how well she learns mathematics?

Investigations of questions like these form one of the most widely researched aspects of multilingualism in mathematics education, though the overall quantity of research remains low. Researchers have been influenced by the work of Cummins (e.g. 2000, 2001), especially his 'threshold hypothesis'. The threshold hypothesis states that for bilingual students:

- low levels of proficiency in both their languages leads to cognitive disadvantage (compared with monolingual students);
- native-like proficiency in only one language offers neither cognitive advantage nor disadvantage;
- high levels of proficiency in both languages leads to cognitive advantages (see Cummins, 2001, pp. 71-75, for a more thorough account).

A number of studies have been based on the assumption that any cognitive advantage or disadvantage will show up in students' levels of mathematics achievement. A key early study was conducted by Dawe (1983) in the UK in which he investigated the threshold hypothesis by testing groups of around 50 students aged 11 - 14 from four different language backgrounds, Punjabi, Mirpuri, Jamaican Creole and Italian. As measures of linguistic proficiency, he used tests of English reading comprehension and tests of competence in the students 'first' language or L1 [4]. For mathematical performance, Dawe used a test of deductive reasoning or logical thinking set in English and a test of logical connectives, that is problems involving words like 'if...then', 'either...or' and 'but'. By comparing scores on the linguistic tests with those on the mathematical tests,



Dawe did find evidence to support Cummins' thresholds, particularly the lower threshold. Students who did not score highly on either English or their L1 did not generally score highly in the mathematics tests. He also found some evidence to support the upper threshold. Interestingly, this was strongest in the Mirpuri group, despite the relatively low social status of Mirpuri as a dialect of Punjabi.

Since Dawe's (1983) work, a number of other studies have provided further evidence that linguistic proficiency is related to mathematical attainment, in line with Cummins' ideas. Clarkson, for example, has conducted several studies in Australia and Papua New Guinea over the past 10 years involving bilingual students aged 9-12 years (e.g. Clarkson, 1991a, 1991b, 1992; Clarkson & Dawe, 1997; Clarkson & Galbraith, 1992). His approach (Clarkson, 1992, is a good example) involved testing students' linguistic proficiency in English and in L1 [5] as well as on different aspects of mathematics, including mathematical word problems (for an example of a word problem, see p. 15 below). He used the scores from the linguistic proficiency tests to divide the students into three groups. The low-low (LL) group consisted of students with low scores in two languages and the high-high (HH) group consisted of students with high scores in two languages. In line with Cummins (e.g. 2001, pp. 71-75), the third group consisted of students with a high score in one language only, which he called 'one dominant'. Clarkson (1992) then looked at the mathematics scores of the three groups of students. The LL groups recorded significantly lower scores than the other two groups on at least some aspects of mathematics in each study, supporting the idea of a lower threshold. Clarkson's results also provide some evidence to support the upper threshold, although the link is much less strong than that for the lower threshold.

Overall, Clarkson's and Dawe's (Clarkson, 1991a, 1991b, 1992; Clarkson & Dawe, 1997; Clarkson & Galbraith, 1992; Dawe, 1983) work seems to show that students' proficiency in both (or all) of their languages does make a difference to their performance in some mathematical tasks. It should be noted, however, that the number of studies is still relatively small and narrowly focused, with a limited range of mathematical tasks being used. Furthermore, little work of this sort has been carried out in the UK since Dawe's (1983) early study.

There are some weaknesses in the way the work was carried out. One problem is a somewhat simplistic treatment by mathematics education researchers of Cummins' (e.g. 1979, 1988; Cummins & Swain, 1986; see also summaries in Cummins, 2000, 2001) work and of the notion of bilingualism more generally. An important element of Cummins treatment of bilingualism, for example, is a distinction between conversational proficiency and academic proficiency. EAL students generally become conversationally proficient much more quickly than they achieve academic proficiency, which can take several years longer (Collier, 1987, p. 638; Cummins, 2000, p. 76; Thomas & Collier, 1997, pp. 32-39). A second weakness is the implicit privileging of the English language and western school mathematics. This can be seen in the way English language proficiency is tested more rigorously than L1 proficiency and in the way mathematics is generally tested in English. On occasion, researchers (e.g. Clarkson & Dawe, 1997, p. 154) have sought to avoid this last problem by using symbolic reasoning tests which have no explicit linguistic component at all. The use of such tests neglects the cultural nature of both mathematics and formal testing. It may be, for example, that more proficient bilingual students have also had more access to western forms of school mathematics and so interpret the test questions more appropriately (from the researcher's perspective) than students who are less proficient in English. I make these points not to undermine the results of the above studies, but to highlight their limitations. It cannot be claimed that students who are less proficient in two languages are less good at mathematics than their more proficient peers; only that they score less highly in certain kinds of test. As with the testing of attainment, then, there are methodological weaknesses in research investigating the relationship between mathematical attainment and linguistic proficiency, notably the implicit use of English as a linguistic standard.

Farida, for example, achieves low scores in mathematics tests, such as the Year 5 optional national test paper [6] which her class took towards the end of the school year. If the level of Farida's academic language proficiency lies beneath some lower threshold, this may, in part, explain her low score in the tests, but I cannot say why this is. The following is a question from one of the tests:

There is 60g of rice in one portion. How many portions are there in a 3kg bag of rice? (QCA, 1998, p. 25)

Farida's response was to write "100kg". What does this response tell me? What does it *not* tell me? Clearly the research discussed so far does not tell me anything about how Farida might have answered this question. The above problem is an example of a *word problem*, a form of mathematics question used in schools throughout the world. The word problem is also the mathematics task most investigated by researchers interested in EAL or bilingual students (e.g. Adetula, 1989, 1990; Bernardo, 1999; Clarkson, 1983, 1991b, 1992; Clarkson & Galbraith, 1992; Mestre, 1986, 1988; Secada, 1991). This interest perhaps reflects the position of word problems at the intersection of linguistic and mathematical thinking, requiring students simultaneously to make sense of a highly specific linguistic genre, draw on their social and cultural experience to understand the scenario portrayed in the problem and recognise and solve an implied mathematical problem. In the above question, for example, there is linguistic complexity in the way the problem creates a situation that does not really exist. The question first states that there is a certain amount of rice in one portion though I was not previously aware that there was any rice. I am then asked to think about how many of these portions there are in a bag of rice, which I also did not know anything about until it was referred to. There are social and cultural assumptions about rice that comes in bags, about portions, especially the implied idea of *equal* portions, and about using weight as a means of apportioning, rather than a cup or a handful, say. I am also expected to realise what the question actually requires me to do is not to think about rice, but to perform a division calculation and write down the outcome (see Cooper, 1994, pp. 150-151). Not surprisingly, word problems have the potential to be particularly difficult for EAL students.

In his study in the US, Mestre (1986) compared groups of monolingual and bilingual Hispanic university engineering students. He tested them in reading in English, algebra and on a set of word problems. He found that the Hispanic students worked more slowly on the reading tests than the monolingual students. There was little difference between the two groups on the algebra test, but on the word problem test the Hispanic students were both slower and less accurate than the monolingual students. The results of the algebra test suggest that this difference is not necessarily due to Hispanic students being

less proficient at mathematics. Furthermore, the level of vocabulary in the word problem questions was suitable for the bilingual students' level of English proficiency. This suggests that there are other interpretative demands on students apart from vocabulary. Mestre concludes, "knowing the vocabulary in a word problem is no guarantee that the mathematical relationships...will be appropriately interpreted [by non-native speakers]" (*ibid.*, p. 399). Certainly being able to read a problem is not the same as making sense of it in the way the writer of the question intended. Lower scores than those achieved by monolinguals students may be due to the reading and interpretative demands of the tests, rather than students' proficiency in mathematics. Indeed, linguistic factors could explain many of the research results discussed so far in this chapter. They could explain Farida's relatively poor performance in mathematics tests including her difficulty with the above question. Farida is quite capable of reading the test question shown above. She can also make sense of it in some way; it is meaningful to her. What is required by the examiner, however, is that Farida works out what she is *meant* to do, what sense she is *supposed* to make.

Unfortunately, the generally quantitative approach used in the research discussed so far in this chapter offers few insights into how students make sense of word problems or other mathematical questions or situations. Indeed, such studies tell us very little about what happens in the mathematics classrooms in which students participate in such mathematical activities. What happens in mathematics classrooms where there are EAL students? How do such students participate in doing and thinking about mathematics? How do teachers work with such students? Is it possible to identify features of mathematics classroom talk that are related to the presence of students like Farida? Do EAL students make a difference for teachers?

These issues have been investigated in a number of classroom ethnographies mostly conducted in mathematics classrooms in North America (Campbell, 1986; Goldstein, 1997; Khisty, 1995; Khisty, McLeod & Bertilson, 1990; Moschkovich, 1996, 1999). The studies I shall discuss here are all set in classrooms in which the teacher is bilingual and shares both languages with at least some of the class. Although this situation is less common in the UK, the research nevertheless raises issues of relevance to teachers of

EAL students in British mathematics classrooms. In her study in the US, Khisty (1995) looked at three second-grade and two fifth-grade mathematics classes containing some Spanish-speaking EAL students. The class teachers were all English-Spanish bilingual to some degree. Khisty observed and video-recorded several lessons in each class and analysed, amongst other things, the use of the mathematics register or mathematical language, and the use of English and Spanish. She found differences in how teachers attended to the mathematics register, particularly where potential ambiguities arose in *either* language. Teachers who seemed to be more effective paid more attention to the language of mathematics as well as to the mathematics itself. Perhaps surprisingly, however, she found that the teachers in the study rarely used Spanish in mathematical contexts. Instead, teachers used Spanish for instrumental purposes, such as giving instructions and organising the class, as well as to show 'solidarity' with the students, when motivating or encouraging them, for example (see also Setati, 1998, 2002).

This social aspect of classroom discourse was also apparent in Goldstein's (1997) study of a Canadian high school mathematics classroom consisting of 11 Cantonese-speaking students from Hong Kong and 14 other students from seven different countries. The teacher was a Cantonese speaker and sought to use her familiarity with this language to support her students. Goldstein describes how a group of nine Cantonese-speaking students used their first language to maintain friendships within the group. The students within this friendship group, who rarely used English amongst themselves, also supported each other with their mathematics, explaining concepts and ideas to each other in Cantonese. They also used Cantonese to gain access to the teacher for support, but did not seek assistance from non-Cantonese speakers. These patterns of interaction led to tension in the class, since the relative success in mathematics of the Cantonese speakers was seen by the rest of the class as due to the advantageous position they had in terms of access to the teacher.

In the study already discussed above, Khisty (1995) compares the mathematics culture of two different bilingual classrooms. In one, the teacher controls discussion, through the use of repetition and chanted or choral responses in a way that Khisty sees as depersonalising mathematics for the students. In the other, mathematics was negotiated

through discussion, challenge and debate. This environment frequently required students to explain their ideas and to draw on previous experience to make sense of new situations. For Khisty, the culture of this second classroom led to students making mathematical meaning for themselves through interacting with both the teacher and other students. Her observations lead her to conclude that the 'myth' of mathematics somehow transcending language is detrimental to the interests of EAL students. These studies of classroom language highlight the multifunctional nature of talk. Teaching mathematics to EAL students involves more than getting the language right. How classes talk together is part of the development and maintenance of the many relationships within that class, relationships that can have implications for students' learning. These issues have implications for teachers' practice. What strategies do teachers use when teaching mathematics to EAL students?

Moschkovich (1999) explored the question of what teachers can do to facilitate bilingual student participation in mathematical discussions. She studied a third-grade class of 33 Spanish-speaking EAL students who were taught by a bilingual teacher. She noticed several strategies used by the teacher to support her students' involvement in whole class discussion. The teacher sought clarification from students, accepted and built on their responses and frequently recast what students said in more mathematical language. A key element in how the teacher managed the discussion was to ensure that the focus stayed on the mathematics, particularly by listening to the mathematical content, however it was expressed. As Moschkovich points out (p. 18), the teacher's approach went beyond simple attention to mathematical vocabulary and its correct usage. This observation leads her to be critical of some 'advice' for teachers which she argues focuses excessively on mathematical vocabulary and the use of real or 'concrete' objects to support students' learning. I can see the force of this position in the case of Farida. As I discussed in the opening extract, she has acquired a great deal of reasonably accurate vocabulary, but is perhaps still working on how to use some of it.

A further weakness of an overly simplistic approach to mathematical language is highlighted by Monaghan (1999a, 1999b) who, from his perspective as an EAL teacher, examined the mathematical language found in a British mathematics scheme (Secondary

Mathematics Individualised Learning Experience, SMILE). He found, amongst other things, that the way in which mathematical vocabulary was used was not constant across the scheme, but changed according to the age of the student. Words like 'diagonal' were used quite differently at different stages of the scheme. Thus, for students like Farida, it is not only a question of becoming familiar with how new vocabulary is used. Her familiarity must also evolve as she progresses through school. Thus, even the notion of mathematical vocabulary is far from straightforward. Despite criticism of an overly simplistic approach to mathematical language in teaching EAL students, however, there is a difficult balance to be struck between attention to mathematics and attention to mathematical language, where the latter does include vocabulary but also broader aspects of language such as mathematical ways of talking, of arguing and explaining.

Striking this balance emerged as a key issue for teachers participating in research conducted by Adler (1995, 1997, 1998, 1999, 2001), a teacher educator in South Africa. Adler worked with 6 teachers from different school backgrounds in South Africa, a country where multilingual classrooms [7] are the norm. She observed and recorded the teachers' mathematics lessons and interviewed the teachers. She also discussed extracts from their recordings with each of the teachers concerned. Through this work Adler develops what she calls a "language of teaching dilemmas" which emerge for her teachers in their multilingual classroom environments (e.g. Adler, 2001, pp. 57-134). One of the *teaching dilemmas* elaborated by Adler, that of 'transparency' (pp. 115-134), relates to the preceding discussion of mathematical language. In this context, transparency concerns the visibility of, or explicitness of attention to, mathematical language. The issue is raised by one of the teachers participating in the study, who reflects on an incident when a student was giving an explanation to the rest of the class:

[she] put forward what she thinks is going on in relation to that issue and it is a question of even though her language is not clear is there understanding amongst the rest of the students and it seems like the rest of the students do understand even though she is using incorrect language (Adler, 2001, p. 130).

Here, there is a tension for the teacher between teaching 'correct' language, and her students learning mathematics. By intervening, the teacher could shift the attention of the students from the mathematics they are grappling with to the language used to explain

that mathematics. Intervening could allow the student giving the explanation to do so using more mathematical language, but the resulting explanation will not necessarily be the explanation she would have given for herself. In some ways, intervention would disempower her student. On the other hand, offering a language for students can empower them to develop their thinking. I can see how these dilemmas may impinge on Farida's learning of mathematics. Consider, for example, the moment when she says "hexadas she like says six sides...miss T like/ choose hepsadas/ you have six sides/ yeah?/ and pentagon has eight sides" (p. 8, Extract 2.1, lines 29 and 31). How, as a teacher, could I respond? Do I correct her 'hexadas' and 'hepsadas' to the word 'hexagons'? Or do I focus on her assertion that 'pentagon has eight sides'. And if so, am I addressing the fact that pentagons have five sides, not eight. Or that octagons have eight sides, not pentagons. Am I responding to mathematics here or to language? And perhaps more importantly, how else could I respond?

These last questions are important and deserve further work. They are however, like the ethnographic studies discussed above, striking in their focus on the teacher. By taking the teacher's perspective, they do not address issues of how EAL students participate in classroom mathematics, of how they think and learn mathematics or of how they make sense of the mathematical activities in which they take part. How does Farida make sense of mathematical situations? How did she make sense of the word problem shown above (p. 14)? For me, such questions are a better place to work from than questions about why children like Farida get word problems 'wrong' (at least according to the mark scheme). Exploring how Farida thinks about such problems assumes that her responses make sense to her, even if they do not to anyone else.

### **Where next? Some conclusions and considerations for a way forward**

The learning and teaching of EAL students in mathematics has many dimensions of complexity. Researchers have dealt with this complexity in different ways. Some have used tests to look for relationships between students' performance on different aspects of linguistic and mathematical proficiency. While this approach simplifies the complexity of



these different proficiencies, it does nothing to address the complex socio-linguistic background of different students. Studies of this kind have been conducted in several countries around the world, involving students from different ethnic, cultural and linguistic groups, indigenous and immigrant, small and large communities, rich and poor and many other dimensions besides. Given the rather modest quantity of research on EAL students' mathematical attainment and its underlying factors, I can draw few if any general conclusions. The one pattern that does seem to emerge from these studies is that proficiency in English is related to success in mathematics tests, and that the relationship between the two is broadly in line with Cummins' (e.g. 2001, pp. 71-75) threshold hypothesis. It is not clear, however, if lower performance is due to lower levels of progress in mathematics, or due to the language and format of the tests.

A second group of researchers have addressed the complexity of EAL students' learning of mathematics by adopting a more qualitative, in-depth approach based on many hours of classroom observation, recordings and interviews. Again, it is not possible to draw simplistic generalisations from such studies, due to the small number of students and teachers involved. To seek to do so, however, is to misunderstand the nature and purpose of the research. Their work identifies issues that arise for both teachers and students from the ongoing daily life of classrooms. An important theme which emerges from this body of work is the multifunctional role played by classroom language. Language is used to organise classroom activity, develop and maintain relationships and conduct social business as well as for teaching and learning. Language is implicated in talking about mathematics, and talking about mathematical language, leading to several possible courses of action at every turn of a discussion. A second theme is a regular critique of a simplistic attention to vocabulary and the more visible aspects of mathematical language.

Very little of the work reviewed in this chapter deals adequately with the methodological issue of meaning and interpretation raised in Chapter 1 (pp. 3-4). There is a frequent assumption that interpreting the words students speak or write is unproblematic, that meanings can somehow be 'read off' from what students say and do. Given the immense variety of experience brought by EAL students to our classrooms, this crucial issue deserves more attention. The resulting weakness of much research in this field is perhaps

related to two widespread focuses: *students attainment* and *teachers' practice*.

Investigations of EAL *students' attainment* based on their performance on tests gives little insight into how students make sense, think and learn in the classroom. For students from minority backgrounds, moreover, there is a danger in this approach that they are constantly measured against the criteria of the majority. A focus on how language is used in classrooms from the perspective of *teachers' practice* means that there is much less attention on students like Farida. How does *she* use language to think about mathematics? What 'dilemmas' does *she* face? How does *she* make sense of mathematical talk?

A concern with the role of language in processes of thinking and learning points towards a qualitative mode of inquiry. If I accept that what Farida says is meaningful to her, any attempt to investigate her participation in school mathematics must find a way to avoid imposing unjustified interpretations on what she says and does. In exploring Farida's mathematics, and that of her peers, therefore, I seek an approach which does not make assumptions about what she means by what she says. This issue is addressed in the chapters which follow.

This review has raised a number of considerations for the development of my own research, of which I shall mention two. Firstly, I am interested in EAL students' rather than teachers' perspectives, since these have been neglected in the past. Secondly, I am interested in EAL students' participation in school mathematics, in how they use language to think about mathematics and make sense of the language of the mathematics classroom. These two considerations suggest an approach to research which involves examining students' participation in school mathematics, focusing on their language use. This implies that the primary data should consist of some record of students' interaction as they work on mathematics activities. The next chapter sets out how I located a suitable site and developed appropriate methods for the collection of such data.

## Chapter 3

### A mathematics classroom

In this chapter, I will briefly set out the principles which guided my initial approach to the collection of appropriate data and my prototype research design. These principles arise from the issues discussed in the previous chapter. It will be helpful for me to discuss this early work at this stage, since I will refer to some aspects in succeeding chapters. In particular, I will use extracts from my early data in discussing the development of a more thorough theoretical and methodological position.

#### First principles for data collection

The review of research presented in Chapter 2 led to a number of substantive questions. Two, in particular, are key:

- How do EAL students use language to think about mathematics?
- How do EAL students make sense of mathematical talk?

Part of my task over the next few chapters is to explore the notions of ‘using language’, ‘thinking’ and ‘making sense’, guided by the strong methodological position I have already begun to elaborate. As part of this process, it is helpful and productive to have access to a site of potential data collection, in order to consider the above issues in the light of practical experience. I am interested in students’ mathematical talk, that is talk relating to tasks set in mathematics lessons. I am also interested in EAL students. My primary data should therefore consist of some record of interaction involving EAL students engaged in some form of mathematical activity. I use *interaction* to include any

situation in which two or more humans do something together. Language is the chief medium through which we interact and would therefore form the main, though not exclusive, focus of data collection. More precisely, I am interested in the students' perspective, as this has been largely neglected in existing research, as I observed in Chapter 2 (p. 20). This position in turn suggests that I should focus on interaction between students, rather than on whole class interaction, say, in which much of the pattern of talk is likely to be influenced by the teacher (see, for example, Edwards & Westgate, 1987, p. 41; Edwards & Mercer, 1987; Sinclair & Coulthard, 1975). In Chapter 1 (pp. 2-3), I raised the issue of the need to avoid making assumptions about what students mean by what they say, since such meanings are informed by participants' experiences. My own participation in any activity designed to collect records of interaction will introduce my own experiences, including those of thinking and learning mathematics. While this is unavoidable, I should avoid more direct participation in activity being recorded or observed as primary data. I should not, for example, act as a participant myself.

Methods of recording students' interaction could include field notes or audio or video recordings. As students' use of language is a key interest, however, a comprehensive record using suitable equipment is preferable. Opportunities to record interaction during mathematical activity could arise in mathematics lessons or in specially designed situations. Since, however, I am particularly interested in how EAL students take part and make sense of school mathematics, I should avoid artificially created situations, since the interaction which arises in such situations may be different from that found in students' everyday experience of school mathematics. This suggests that I record students' talk during their mathematics lessons. I am not arguing here that I should seek some idealised 'normal' classroom talk. By observing any interaction, whether directly or through the use of recording equipment, I will necessarily be a participant in that situation and the interaction which takes place within it. My point is simply that I should aim to record situations that are closer to students' everyday experience than not. My previous experience of using video to record individual students suggests that video cameras and tripods are potentially more intrusive and off-putting than audio equipment (Barwell, 1999, p. 64), reducing the naturalistic status of any recordings. In line with the previous

point, therefore, I should use audio recording as the primary method of capturing interaction. These recordings can then be transcribed. The degree of detail of transcription can be adjusted as the methodological approach to data analysis develops.

I have set out a preliminary position regarding the general approach to data collection. In order to explore the feasibility of this approach, and begin a process of development and refinement, I needed access to a mathematics classroom. In the rest of this chapter, I describe how I selected a suitable research site.

### **First steps: finding a mathematics classroom**

The research I conducted for my master's dissertation (Barwell, 1999) looked at EAL students in Year 7 (aged 11-12 years). That work raised some practical issues which I took into account in locating a classroom in which to collect recordings of interaction. In particular, many of the EAL students present in Year 7 had been in the UK for several years. Consequently, there was little outward sign that their language status affected their participation in classroom discussion. This is not to say that there was no effect, only that any effect was likely to have become increasingly subtle as students became more proficient in English. It makes sense, therefore, to seek to work with slightly younger EAL students, where for some, at least, the level of English proficiency will be lower, and any effects therefore more visible. At the same time, I am concerned that the mathematics curriculum of the participating students should be reasonably well developed. The mathematics curriculum studied in the youngest years of school is of a basic level and it is therefore less likely that I will be able to identify issues which relate distinctively to mathematics. A second reason to look at slightly younger students is that this will entail working in a primary school. In primary schools in the UK, students work for most of the week with the same teacher. The teacher is therefore more familiar with each student and their learning and there is a degree of continuity across different subject areas which is not present in secondary schooling. Thus working in a primary classroom in effect eliminates one possible source of variation in students' interaction.

Based on the above considerations, I contacted a number of schools with significant populations of EAL students in a city in the South of England, seeking a class in Year 3, 4 or 5 (ages 7-8, 8-9 and 9-10). As a result I identified one school, with a Year 5 teacher who was prepared to participate. Clearly the school is self-selected. I have made no attempt to identify a school which is in any way representative of schools in the UK, the city in question, or of schools serving minority ethnic communities. My only criteria were the presence of EAL students of the preferred age and a teacher willing to take part. This self-selection is not seen as a problem, however. As my review of relevant work shows, there is little previous research which explores the EAL student's perspective (see Chapter 2, p. 20). At this stage in my research, I am interested in how *any* EAL students I may gain access to, participate in the normal, everyday, mathematics lessons they are offered, whatever that may be. The representativeness of the school is not therefore an important factor in this study.

The next section provides some background information about the school and the Year 5 class whose teacher agreed to participate in this research. I also briefly outline the support offered to EAL students in the school and give some background to the mathematics curriculum taught in Year 5.

### **A school**

The school which agreed to take part in this study is a small primary school situated in a multi-ethnic inner-city area. Approximately 150 students attend the school, which has one class in each year-group, from reception (aged 4-5) to Year 6 (aged 10-11). The school also operates a pre-school nursery on the same site. Students attending the school come from a range of cultural and ethnic backgrounds, including African-Caribbean, Chinese, Pakistani, Somali and White, with many students identifying with more than one of these cultural and linguistic backgrounds. As a result of this diversity, there is an equally wide range of languages spoken by students. These languages include, Cantonese, Caribbean Creoles, English, Mandarin, Somali, Punjabi and Urdu. Many students use two or three different languages outside school. Approximately 25% of students are recognised by the school as EAL, which provides a range of support, outlined in the next section. Amongst

these students are those who have grown up and attended school entirely in the UK, though some may have been on extended family visits overseas of up to six months. There are also students who have arrived since the start of formal schooling, including immigrant children and refugees. Of these recent arrivals, some have attended school in a previous country, which may include their home country or a third country. Others may not have attended school before they arrived in the UK. Clearly, the term EAL applies to students with a wide range of cultural, linguistic and educational experiences.

### **Support for EAL students**

Support for EAL students in the participating school is organised by a dedicated EAL co-ordinator. There are two aspects to this support: the identification and assessment of EAL students; and the provision of additional teaching and learning opportunities. EAL students at the school are initially identified through their parents when the student arrives in the school. A standard interview is conducted with the parents by the EAL co-ordinator, which seeks information about which languages are used in the home and to what extent they are used. Parents are also asked which members of the family, including the student, use which languages and to what extent. This information provides a general background for staff and a basis for assessing the student's experience of different languages.

EAL students' English proficiency is also assessed by the EAL co-ordinator, using a proficiency scale, which extends from 1 to 4, summarised by the co-ordinator as follows:

- stage 1: making a start in English*
- stage 2: becoming familiar with English*
- stage 3: becoming a more confident user of English*
- stage 4: not needing support in English*

It is important to note that these stages are used to describe students' proficiency in English. They do not describe students' proficiency in any other language, nor do they directly relate to students position in relation to Cummins' (2001, pp. 71-75) thresholds [8]. I will use the school's assessment of students' proficiency as descriptive information about any students involved in this study. The assessment for the stages, which students

progress through from stage 1 to stage 4, is based on a set of criteria relating to both spoken language and literacy. EAL students are reassessed at least once a year with suitable support identified. Language support includes the use of dual language books (reading books in which each page is written in two languages), cassettes of stories recorded in the home language and opportunities to work with younger students from the same language background. Specialist staff who speak Mandarin, Punjabi, Somali and Urdu work with students who speak these languages for short periods each week. Support relating to the curriculum includes some extraction classes, in which a language support teacher works with a small group of EAL and monolingual students. Such classes may, for example, involve working on the language of a science or mathematics topic in advance of meeting the topic in the mainstream class. Alternatively, language support teachers may work in mainstream classrooms alongside the class teacher to support EAL students.

## **Year 5**

When I first met the teacher who agreed to take part in this research in January 2000, she had been at the school for 6 years. In that time, she had taught several different age groups, including a younger version of the class she was then teaching as Year 5. Within the class were 5 students recognised by the school as EAL, of which 2 were from a Pakistani background, 1 was from a Somali background and 2 were from an Hong-Kong Chinese/ Vietnamese background. The general structure of the school day in Year 5, was to spend the first morning session working on English, based on the government sponsored *National Literacy Strategy* (DfEE, 1998). This session ended with a class or school assembly and a break. The second session, from around 11 a.m. until 12 noon, was devoted to mathematics. Again, the teacher followed a government sponsored scheme, the *National Numeracy Strategy* (DfEE, 1999b), described below. The afternoon session was used to teach the rest of the curriculum, including science, humanities, art and music, as well as personal and social education. The teacher felt that this last area, however, was an important aspect of her work throughout the day. She felt that many of her students had poor social skills, particularly with each other. She reported that many students had



difficulty working with their peers and some could be rude or antagonistic towards their fellow students. Thus, even in a mathematics lesson, the teacher felt that much of her work was designed to address these social aspects of her students' education.

### **The National Numeracy Strategy**

The Year 5 teacher, in common with the other teachers in the school, used the UK government's National Numeracy Strategy (NNS) (implemented in England and Wales) as the basis for her teaching in mathematics (DfEE, 1999). The strategy provides a 'framework' for mathematics teaching in all primary school year-groups [9]. The framework operates at several different levels.

- At the level of *a school year*, the NNS offers a week by week plan designed to cover all areas of the mathematics curriculum for that year-group (DfEE, 1999, Section 3). This plan includes some 'spare' weeks to allow for some flexibility. These spare weeks can be used for revision, for example. Like all aspects of the NNS, the year plan is advisory. The Year 5 teacher generally followed the content and suggested timings of the plan, although she altered the order in which topics were covered.
- At the level of *content*, the NNS provides a detailed summary of the mathematics to be covered in each topic, as well as a comprehensive set of example questions and problems (DfEE, 1999, Sections 5-6). The Year 5 teacher made use of many of these questions and problems in her teaching.
- At the level of *each day's work*, the NNS sets out a recommended format for a typical lesson (DfEE, 1999, Section 1, pp. 11-16). The format suggests that each lesson should be made up of three parts. The first part consists of 10 minutes of 'warm-up' activities, particularly focused on mental arithmetic. The second part, forming the main body of the lesson, begins with an introduction to the topic for the day by the teacher working with the whole class. The class then work in smaller groups, with the teacher working intensively with one group each day. The final part of the lesson consists of a plenary discussion led by the teacher, in which aspects of the group work might be discussed and taken forward.

The NNS is designed to fit in with other national educational structures, including the National Curriculum (NC) (DfES, 2002) and the national tests administered in England by the Qualifications and Curriculum Authority (QCA) [5]. The NC in mathematics, for example, is set out as a sequence of eight levels of increasing difficulty from level 1 to

level 8, through which students progress from ages 5 to 16. Students are expected to attain level 4 by the age of 11. The Year 5 teacher assessed her students' progress against the mathematics National Curriculum in part by using a set of test papers prepared by QCA.

Having found a teacher willing to participate in my research, I began to visit her mathematics lessons. The next section describes my initial observations of these lessons, as well as my first explorations of the recording process.

### **Into the classroom**

At first, I visited once a week to observe the Year 5 mathematics lessons. I wanted to become familiar with the class and with what happened in mathematics lessons. I also wanted to observe the EAL students to become familiar with how they fitted into the class. In this respect, I noted that the students were accustomed to working in groups and that these groups were not rigid. The teacher would rearrange the groups for some purposes or move students from one group to another. Groups were loosely based on attainment, with no EAL students in the small group of highest-attaining students. EAL students were distributed throughout all other groups, however. On some occasions, groups were reconstituted, so that EAL students did sometimes work with students normally found in the high-attaining group. I noted that the standard groups used in mathematics were not the same as those used in English lessons. I also observed that, occasionally, the teacher would organise a group containing all 5 EAL students plus some monolingual students and work intensively with them. The presence of monolingual students in this kind of group was designed to ensure that EAL students had access to native speakers, even when working in a targeted group.

In terms of the NNS, I observed that the teacher followed the three-part lesson quite closely, although the first part sometimes extended to 15 or 20 minutes, meaning that any group work did not take place until 30 minutes after the start of the session. The third part of the lesson was frequently curtailed or omitted. I also noticed that the teacher used some of the language of the NNS document with the students. She introduced most

lessons, for example, by telling the class what the day's "objectives" were (DfEE, 1999, Section 3, p. 3).

### **Explorations with a tape recorder**

After several weeks' observations, I began to explore the possibilities of audio-recording classroom interaction. I used a small portable tape-recorder with a separate desk-top microphone attached by a long lead. The microphone was in the form of a 10 cm x 10 cm black metal plate and was therefore reasonably unobtrusive. I used this equipment to record both whole-class sections of lessons, as well as to record groups of students during the second part of lessons. The resulting recordings were disappointing. Recordings of whole-class sections rendered a clear reproduction of the teacher's contribution. Much of what students said was inaudible, however. Recordings of groups were less satisfactory, mainly due to the level of background noise, made worse by the acoustics of the classroom. A problem with all the recordings was the difficulty of identifying who was speaking. To counter these problems, I arranged with the teacher to ask two students to work together in a quieter part of the classroom at a table on their own. Although the resulting recordings were an improvement, in that I was better able to identify who was speaking, there was still a level of background noise sufficient to render much of the recordings unsuitable for research purposes.

The logical next step, after moving two students to a quieter part of the classroom, was to remove a pair of students from the classroom altogether and record them working together in a quiet location. This move compromises my preference for everyday classroom interaction, trading it off against the need for usable data. I could take some steps, however, to mitigate the effects of withdrawal from the classroom. I could select students who worked together in class and ask them to work on a task taken from the work that they did in class. Thus, although the situation would be somewhat artificial in terms of its location, the work the students were doing would be based on whatever mathematics was going on in their classroom, as would the choice of students.

With this approach in mind, I used classroom observations to select two students, Cynthia and Helena (I have changed their names; see Appendix I, pp. 217-221). Cynthia was selected as she was one of the EAL students in the class. Helena was chosen as she had occasionally worked with Cynthia during mathematics lessons. Cynthia comes from a Cantonese-speaking background and had recently come to the UK from Hong Kong where she previously went to school. She had been in the school for about 18 months and in that time had learnt virtually all her English. Her proficiency in English in Year 5 was assessed as stage 2 ('becoming familiar with English'), bordering on stage 3 ('becoming a more confident user of English'). The Year 5 mathematics test taken by Cynthia indicated that she was working at level 3 of the National Curriculum. Helena is an English-speaking student whose Year 5 mathematics test indicated work at NC level 4 (see p. 30).

Based on my classroom observations I also selected a task, that of writing mathematical word problems, which Cynthia and Helena had worked on together. Word problems make up a substantial part of the NNS, and many examples are provided (e.g. DfEE, 1999, Section 6, pp. 82-83). For example:

To cook rice, you need 5 cups of water for every cup of rice.  
You cook 3 cups of rice.  
How many cups of water do you need?  
(DfEE, 1999, Section 6, p. 83)

Having identified a pair of students and a task, I arranged with the teacher to record them working in a similar way. I withdrew the two students from a mathematics lesson to a quiet area outside the classroom. I waited until after the first warm-up part of the lesson and the teacher's introduction to the day's work before withdrawing them, so that they would have some familiarity with what was going on in the lesson on their return. I explained to the two students that I wanted them to work together to write word problems about addition. After some discussion they seemed clear about their task and I moved away so that they could work undisturbed. I should add here that I was not concerned with how they interpreted their task. I did not have a 'correct' response in mind. Rather, I was interested in how they went about the task, whatever it meant to them. I sat some distance behind the two students, out of their line of sight, so that they were supervised,

but less directly influenced by my presence than would perhaps occur if I were sat at their table. Cynthia and Helena worked together for about 25 minutes. In that time, they wrote 5 word problems. I subsequently transcribed the tape, using a format based on that of Mercer (e.g. 1995) which I employed in my master's dissertation (Barwell, 1999), adopted because it combines readability with a reasonable level of detail. The suitability of this format will be reconsidered in the light of the process of developing my methodological approach (described in Chapter 6).

Having obtained my first usable transcript (see Appendix II, pp. 222-230), I come to the issue of analysis. What does it tell me about Cynthia and Helena's use of language? What can I say about their thinking, without making assumptions about what is going on in their heads? The development of my analytic approach, using the transcription of Cynthia and Helena's work as a sample of data, forms the subject of the next two chapters.

## Chapter 4

### Patterns of attention in talk

The ideas discussed in the first three chapters of this dissertation informed the exploration of methods for recording students' interaction described in the previous chapter. This exploration led to the recording of two students, Cynthia (EAL, stage 2) [11], and Helena (non-EAL) as they worked together to write mathematical word problems. Having obtained my first usable data, I now needed to develop an approach to the analysis of such data, an approach, moreover, which did not rely on assumptions about what the students mean by what they say. In this chapter and the next, I set out the development of this approach. The purpose of this chapter is to seek a general position on the nature of talk, as well as methodological tools with which to analyse any instances of talk I may collect. In particular, I will develop the notion of *patterns of attention*, which I will then illustrate using the transcript of Cynthia and Helena working together.

As a preface to my discussion about the nature of talk, let me begin by looking at the following extract from the transcript, in which Cynthia and Helena begin work on their first word problem. I will draw on this extract to illustrate the points I wish to make:

#### Extract 4.1

45	H	alright/ [ adding adding ones	
46	C	[ yeah you first/ you first	
47	H	okay then/ I'll show you// give me a name	
48	C	name/ um// (...)	
49	H	no	
50	C	Gemma then any	
51	H	Daniel then	<i>Daniel is in</i>
52	C	yeah brilliant	<i>their class</i>
53	H	^don't tell Daniel though/ [ cause he'll get really mad (with) me^	

54 C [ 'kay  
55 ? (...)  
56 H Daniel um *writes*  
57 C Daniel um  
58 H went to the shop  
59 C n-no can/ umm/ um write that/ Daniel work/ n-no/ Daniel/ w=um/  
60 Daniel/ well if he work/ (...) he have/ he have/ hundred pound/ and how  
61 many/ in/ the month/ (for example) like easy one  
62 H but you've got to use it in addin'/ addin'/ addition/  
63 C oh yeah  
64 H so you say Daniel/ yeah it's kind of like a addition thing isn't it/ because/  
65 Daniel went to work/ he had hundred pound/ a month?  
66 C um/ a week  
67 H oh that's ^(okay then)^ a hundred pounds a week/ how many/ how many  
68 um/ how ma=how much money do he have in a month  
69 C yep  
1A/OC&H: 21/5/00

There are many ways in which I could approach an analysis of interaction like that shown in this extract. A common approach is to look for patterns (e.g. Brown & Yule, 1983, p. 26; Edwards & Westgate, 1987, p. 105; Hammersley & Atkinson, 1995, p. 210), but what kind of patterns? Helena refers to 'addition' on several occasions; is that a pattern? The two students take turns to speak; is that a pattern? Helena seems to say more than Cynthia; is that a pattern? Arguably, all three examples are patterns, and there are many more I could have mentioned. The issue I need to address, therefore, is: which patterns are relevant to my investigation of the thinking and sense-making of EAL students in mathematics? I also need a reliable way of identifying such patterns. I cannot tackle these issues without a clear position on what *talk* is and how it works. As I stated above, the purpose of this chapter and the next is to discuss the nature of talk. More precisely, I will consider how examining talk can allow me to say something about how students use language to think about mathematics and make sense of mathematical talk. Through this discussion, I will develop an approach to the analysis of my data.

In this chapter, I will discuss the work of Sacks (1987, 1992; Sacks, Schegloff and Jefferson, 1974) whose ideas led to the development of conversation analysis, a field of research concerned with the organisation of talk and the relationship between the organisation of talk and that of the social world. I will begin my discussion with a general account of Sacks' (1987, 1992; Sacks *et al.*, 1974) theoretical and methodological perspective, before outlining some specific aspects of his work. I should emphasise that

although Sacks' work forms the basis for conversation analysis, I am not proposing to take a strongly conversation analytic approach to my work. The main reason for this is that conversation analysis is designed to investigate the organisation of talk itself, whereas I am interested in how talk is used to do things like thinking. I will not therefore provide a thorough review of the field of conversation analysis, or even of Sacks' work.

## Background to Sacks

Sacks' (1987, 1992; Sacks *et al.*, 1974) work is intellectually located broadly within sociology, although outside the mainstream of that field. He was particularly influenced by the ethnomethodological approach developed by Garfinkel (1967), with whom he collaborated. The contributions of their respective work is concisely summarised by Antaki & Widdicombe:

*Garfinkel:* [the] notion that social life is a continuous display of people's local understandings of what is going on (Antaki & Widdicombe, 1998a, p. 1).

*Sacks:* [the] insight that people accomplish such local understanding by elegantly exploiting the features of ordinary talk (Antaki & Widdicombe, 1998a, p. 1).

Garfinkel (1967) argued for a move away from the then-prevailing approach to sociological inquiry in which the researcher constructs a theory to explain the data they have available. The key issue here is that it is the researcher who constructs the theory, drawing on previously developed theoretical categories and concepts, such as power, identity or class, for example. Garfinkel contended that the outcome of such work was in essence the researcher's understanding of a situation and that the resulting theories and explanations had little to do with the understanding of the participants in that situation. Garfinkel observed that people generally make sense of the social situations in which they participate. Furthermore, he argued that for social interaction to proceed in some kind of meaningful, orderly manner, the participants show, through their actions, how they are interpreting relevant aspects of the situation as they go along.

Let me offer an example. I am observing a local football match. There is a pitch marked on the grass. On the pitch, two teams of players compete to score goals. Around the edge



of the pitch a small number of spectators watch the match. The players display their understanding of what is going on by behaving in footballer-like ways, within the confines of the pitch. Equally, the spectators show what they are by watching the game, shouting, cheering and staying on the edge of the pitch. If a spectator were to run onto the pitch and start chasing and kicking the ball, the players would display their interpretation of this new situation, probably by stopping the game, getting the ball back and generally remonstrating with the intruder. If, however, the spectator who runs onto the pitch, is a substitute player, those on the pitch will display a different interpretation, by welcoming the player and removing another from the pitch for the substitute to replace. The participants in this social situation make clear aspects of their interpretation of what is going on through their behaviour. Garfinkel essentially suggested that rather than using a football rule-book to describe and explain what is seen at a football match, what the participants do can be studied, in order to explore how the participants themselves both create and make sense of what they are doing. From this perspective, sense-making is seen in a constructive light as something participants actively and publicly do, prompting Sharrock & Anderson (1986) to use the alternative expression 'sense-giving' (p. 56).

Sacks' was interested in talk, which he saw as a social activity, that is; talking is a part of the action conducted by individuals in social situations. His rather distinctive view of this topic was informed by Garfinkel's ideas and involved making a similar move towards looking at participants' local, on-going sense of what is happening. Sacks observed that talk, the everyday interaction that takes place between people, is highly complex in nature. He also observed that most people have little difficulty in participating meaningfully in talk. He therefore set out to make sense of how people did this, and of how the organisation of talk makes this possible. In thinking about organisation, Sacks was not interested in constructing a theoretical model of interaction, analogous to a football rule-book. Instead, Sacks sought to understand the organisation of talk as used by the participants. In the same way that people at a football match show their interpretation of the situation through their behaviour, Sacks saw that participants in a conversation also display their on-going interpretations through what they do, and particularly in the case of conversation, through what they say.

In displaying interpretations, participants make use of their experience of what talk is like. In the football match, for example, rather than observing the activity with a preconceived set of roles in mind, such as player, referee, spectator, Sacks' approach entails looking at how participants apply such categories during the situation. Thus, if someone runs onto the pitch, as well as looking at how other participants behave with respect to the newcomer, I can also listen to what other participants say, since through what they say, they display interpretations or 'understandings' (Schegloff, 1984, pp. 100-101) of what is going on. I should emphasise that the terms 'interpretation', or Schegloff's 'understanding', does not refer to mental states on the part of the participants. These terms refer to the explicit, public sense that participants *give* to the activities they are engaged in, sense which in turn contributes to the construction of these activities.

In the football match, for example, the participants talk in ways which both interpret and construct their activity as playing football. They may not explicitly say 'we're playing football' but by jointly participating in 'football talk' they give a particular kind of sense to their activities. If a spectator runs onto the pitch, I can, for example, examine how the participants use different labels or categories to talk about to the newcomer and interpret the situation that their presence may bring about. The use of different possible categories, such as spectator, player or referee, to make a situation understandable relies on the participants' previous experience of talk, particularly talk at football matches. This, too, is evident in talk. Let us suppose one of the players was playing for the first time and had never seen a football match before. They may ask for further explanation of what a substitute is and how they work. As an analyst, I would be able to hear this explanation, and the construction of the new player as a novice to account for the need for that explanation. For Sacks, the use of different labels, or any other aspect of talk, contributes to how social situations are constituted. At the same time, what is said interprets that same situation. Following Garfinkel, therefore, Sacks contended that the on-going interpretations displayed in talk can be studied to see *how* participants carry out or accomplish their on-going interpretations of social situations, thereby also constituting the situations themselves (Schegloff, 1992).

The general perspective of Garfinkel and Sacks which I have outlined so far offers a way forward in my development of an approach to the collection and analysis of naturalistic interaction, such as that shown in the transcript of Cynthia and Helena. A concern which has emerged in earlier chapters is that it is not possible to say exactly what participants mean by what they say. I can, however, look at the patterns of interaction and behaviour which occur as they go about the business of a mathematics lesson. Sacks' perspective on talk complements this position. He rejects the application of *preconceived* categories (player, spectator) or structures (the rules of football) in favour of an interest in how situations are made understandable for participants, as discussed in the previous paragraph. He also shifts the focus of sociological inquiry from explaining the structure of society, to exploring *how* structure is brought about through talk. This position does not then rely on saying what participants mean, since it is based on the observation of behaviour, including talking, and relates those behaviours to observable patterns of action and interaction. I do not need to know what the person who runs onto the football pitch thinks he or she is doing, or what other participants think is happening. Instead, I can observe what happens, including what is said, in order to see how the actions of the newcomer are dealt with by the participants. This approach has the potential to provide a basis for my analysis of interaction. In particular, my concern should be with the understandings or interpretations which students themselves explicitly use as they work together.

I will now outline a number of more specific ideas from Sacks' work, which will serve as methodological and analytic tools, leading in particular to an elaboration of the notion of *attention*, leading to the possibility of describing *patterns of attention*. The selection and organisation of these ideas is my own and arises from my interpretation of Sacks' ideas. This interpretation has emerged from a process of dialogue between my reading of Sacks and my reading of my first transcript (shown in Appendix II, pp. 222-230).

## Aspects of the Sacksian approach

Sacks' work concerns the social organisation of talk. Examples of the ordered nature of talk include that in general, only one person speaks at a time, and therefore that participants must take turns to speak. Consequently, talk is in some sense sequential in nature, in that in taking turns, one turn must follow another. The task that Sacks set himself was not to identify this kind of order, which he acknowledged was apparent to anyone who took part in conversation and which appears to apply in any language (Silverman, 1998, pp. 51-52). Sacks set himself the task of explaining how this order comes about and how it makes talk possible. He devoted much thought, for example, to the issue of how turn-taking was organised and managed by participants in talk (see, for example, Sacks, 1992, pp. 624-632; also Sacks *et al.*, 1974; Silverman, 1998, pp. 101-103). The explanation of phenomena such as the organisation of turn-taking are not my immediate concern, however. I am more interested in the principles Sacks developed in order to conduct his analysis in accordance with the ethnomethodological position he adopted. I will develop two areas in particular, the first, relating to participants' *attention*, will allow me to elaborate the second, which concerns the notion of *patterns of attention*.

### Participants' attention

The sequentiality of talk acts as a resource for participants (Sacks *et al.*, 1974, p. 709). When a turn is taken in interaction, the speaker is not usually forming their utterance in self-contained isolation. Their words build on what has gone before. This is apparent in the following short clip from the transcript introduced earlier in this chapter:

#### Extract 4.2

47	H	okay then/ I'll show you// give me a name
48	C	name/ um// (...)
49	H	no
50	C	Gemma then any

51 H Daniel then  
52 C yeah brilliant  
53 H ^don't tell Daniel though/ [ cause he'll get really mad (with) me^  
*1A/OC&H: 21/5/00*

When Cynthia says “Gemma” (line 50), this does not make sense except in the light of the two students’ prior discussion. The immediately preceding few turns show that Cynthia is ‘giving’ Helena a name. Before these turns lies the opening discussion which established the task, and before that are the vast array of conversations and experiences in which the two students and I have participated which, as Bruner (e.g. 1990, p. 19), for example, observed, may be drawn on (for Cynthia and Helena) to contextualise and interpret what is happening in this clip. Bruner was referring to the interpretation of each individual, however. Each of us draws on the past to make sense of the present. In developing his theoretical ideas, Bruner was concerned with the process of interpretation as it takes place in our heads. Sacks (see Sacks *et al.*, 1974, pp. 728-729; Edwards, 1997, p. 101) observed that this sequential nature of talk provides an opportunity for analysis which does not entail seeing inside participants’ minds, since in each turn, the speaker publicly displays some degree of interpretation of the preceding turns. I can therefore examine each turn of participants’ interaction in relation to its predecessors and observe the explicit interpretation they have made available. Although this availability is one of the mechanisms by which interaction is intelligible to participants, it also offers information to analysts, since participants:

make available to the analyst a basis in the data for claiming what the co-participants’ understanding is of prior utterances, for as they display it to one another, we can see it too (Schegloff, 1984, p. 38; see also Edwards, 1997, pp. 100-101).

These interpretations (or ‘understandings’ as Schegloff has it) are of both the actions performed by the speaker through their utterance, and of the content of that utterance. The above clip provides a useful illustration of these ideas. Cynthia’s offering of names shows us that she has heard Helena’s words “give me a name” as an invitation to make such offerings. I cannot say if this is what Helena intended, only that this is how her words were heard by Cynthia. Thus the analyst can avoid attempting to say what participants intended to do by their words, by looking instead at how those words are

treated by the other participants. Equally, participants in interaction constantly display interpretations of the content of preceding interaction. Consider Helena's response to Cynthia's "Gemma" (line 50). Helena says "Daniel, then" (line 51), so displaying to Cynthia, but also to us, that she is rejecting Cynthia's suggestion. We cannot say why she is rejecting this suggestion, but we can see that she does so. Her rejection, itself a social action, evaluates the content of Cynthia's previous turn.

Sacks also develops the principle of analytic availability in a slightly different, though related direction. He observes that as well as displaying an interpretation of what has gone before, participants in talk highlight or point to that part of the preceding interaction that is relevant to their current actions. Indeed by *attending* to (in the sense of 'paying attention to') that which concerns them (Sacks *et al.*, 1974, pp. 728-729), the speaker *makes* that concern relevant to the present moment of talk. Again, this is a mechanism through which talk is intelligible to participants, but it also provides a means for the analyst to approach the data. In the above clip, for example, Helena (line 53) follows Cynthia's acceptance of the name 'Daniel' with an injunction not to tell Daniel "cause he'll get really mad". In so doing, Helena attends to some aspect of Daniel's likely response as she sees it, making it a relevant part of what she is saying. In this case, she constructs Daniel's response to account for her injunction not to tell him.

The idea that participants in talk attend to relevant aspects of preceding interaction or experience suggests a way into the messy business of analysing students' talk. I can examine interaction to look at where participants' attention is, turn by turn, to identify the concerns they make explicit. I should reiterate that in referring to attention, I mean attention as it is publicly made available. Participants may attend to many other aspects of their situation. All I can see, however, is the attention they make explicit in their interaction. In the clip shown above, for example (Extract 4.2), Helena attends to the name of a character for their word problem:

#### Extract 4.3

47 H okay then/ I'll show you// give me a name  
1A/OC&H: 21/5/00

In so doing, she also makes the presence of a name in such problems a relevant part of their discussion, although word problems do not necessarily have to have a named character (see, for instance, the example given in Chapter 2, p. 15). It is possible to see where Helena is explicitly attending without having to say how she conceives of word problems or whether she has a particular problem or name in mind. Participants' attention is therefore a potentially useful resource for developing an approach to the analysis of talk. In the next section, I develop this idea into the notion of patterns of attention.

### Patterns of attention

The notion of attention I have described above concerns the attention participants make explicit through each moment of interaction. In any sequence of interaction, participants are likely to attend to many different aspects of their situation. In Extract 4.2, above, for example, Cynthia and Helena attend to the idea of a name, to particular names such as Gemma and Daniel and to the effect of 'telling Daniel'. My interest is in aspects of interaction to which the two students regularly attend as they work on their task. I am, in effect, interested in *patterns of attention* in the two students' interaction. By looking for patterns, I can highlight areas of attention which play a recurring role in students' work together. Having identified such patterns, I can then explore what such attention does. In the extract from the transcript of Cynthia and Helena introduced at the start of this chapter, for example, at different points in their discussion the two students attend to a number of different aspects of their task as they see it. Helena, for example, as noted in the previous section, attends to the name of the (or a) character in their word problem. Following Helena's attention to the idea of a name, the two students jointly spend several turns attending to this issue:

#### Extract 4.4

47 H okay then/ I'll show you// give me a name  
48 C name/ um// (...)  
49 H no  
50 C Gemma then any  
51 H Daniel then  
52 C yeah brilliant  
1A/OC&H: 21/5/00

At this point in their discussion, therefore, Cynthia and Helena attend to a particular detail in their problem, that of a name. To describe this attention to names as a pattern, however, lacks a useful level of generality. The development of a useful level of pattern in Cynthia and Helena's talk requires working with the whole transcript, a task which is conducted in the next section. First, however, I will briefly address a further issue which arises from the idea of patterns of attention.

My interest in patterns of attention raises the issue of how such patterns may be recognised. At some level, the identification of participants' concerns in interaction relies on the analyst recognising those concerns and recognising the patterns that arise in them. For me to be able to describe attention to names in the previous extract, for example, I must recognise the 'Gemma' and 'Daniel' as names for myself. Analysis therefore involves the analyst using their own experience of interaction to see patterns in the explicit moment by moment concerns of the participants (Wetherell, 1998, pp. 402-404; Wetherell & Potter, 1993, p. 102) [12]. Edwards (1997, p. 101) argues, following Sacks *et al.* (1974), that it is precisely because it is at this fundamental level of interaction, working on the very patterns that make interaction intelligible, that analysis is possible. As social beings, we have vast experience of social interaction (much more than of formally analysing interaction), and so of making use of the patterns that are part of interaction. Analysts can draw on this experience to say something about the interaction of others. This position means that analysis is still interpretative. Interpretation is, however, closer to the shared aspect of interaction. Making interpretations at the level of interaction is therefore both more robust, and more open to scrutiny, since the interaction can be made available for others to examine (Silverman, 1998, p. 63).

I now want to put these ideas into practice by conducting a preliminary analysis of the transcript of Cynthia and Helena. Before doing so, however, I will return briefly to the status of transcribed recordings as a form of data. Sacks (1992) was interested in the detail of naturally occurring talk (vol. 1, p. 622), reflecting his aim of investigating the complex social organisation of conversation. Part of the task he set himself was "to see whether an order...exists" (*ibid.*, p. 622) for a stretch of talk. He is quite clear that this task does not entail him trying to order his data. Rather, he seeks what order there is in



that data. As Silverman observes, Sacks' (1992) approach is "driven by the data" (Silverman, 1998, p. 60). Given this interest, Sacks advocated the use of recorded talk, transcribed in some detail, as the preferred form of data. Among the reasons Sacks gives for using audio recording [13] are that it can be listened to more than once and that it provides a more accurate record of what took place than other methods, such as field-notes. Audio recording does not provide a record of *everything* that took place, but it does provide a reasonably accurate record of part of what took place (Sacks, 1984, p. 26; 1992, vol. 1, p. 622). Furthermore, the recording can be transcribed for the purposes of analysis, with the recording always available for improving the transcript through further listening and more detailed annotation. Finally, an advantage of transcripts over less detailed representations of talk, is that transcripts can be presented along with any analysis, so that the listener or reader may evaluate the analysis in the light of their own reading of the transcript (Silverman, 1998, p. 63). The conventions (see Appendix I, pp. 217-221) I adopted to transcribe my first recordings made in Cynthia and Helena's classroom (see Chapter 3, p. 31) allow a fairly detailed level of analysis, appropriate to Sacks' (1992) approach. Moreover, as I observed above, the level of detail of the transcripts can be increased according to the development of the analysis. Thus, the following preliminary examination of the transcript of Cynthia and Helena, as well as forming part of the development of analytic concepts, also forms part of the development of the practicalities of collecting and presenting data.

### **Patterns of attention in Cynthia and Helena's talk**

In this section, I will outline a preliminary analysis of part of the transcript of Cynthia and Helena writing word problems about addition (see Appendix II, pp. 222-230). The section under consideration shows the setting up of the task followed by the two students' work on their first two problems. In looking at their interaction, I am looking for patterns in their attention. In order to do this, I am drawing on my own experience of mathematics classroom talk, although I am not introducing my own categories to analyse the content of the two students' talk. Thus, for example, I am not analysing Cynthia's talk in order to ascribe any patterns I see to her status as a learner of English. I selected Cynthia for the

study because she is learning English as an additional language, but I cannot introduce this category (EAL) into my analysis *unless* it becomes relevant to the two students in some way. If their attention turns to Cynthia's status as a learner of English in some way, I can then explore any patterns that emerge around that attention [14].

In looking at attention, I am looking for patterns which are neither excessively localised nor too general. The patterns I am interested in should be visible to some degree throughout the transcript, though not to the extent that they are omnipresent. Attention to turn-taking, for example, although an example of a possible pattern of attention, does not specifically relate to the situation under examination, but is likely to occur in any interaction (Sacks *et al.*, 1974). My analysis reveals two patterns of attention which fit these criteria and which seem to be closely linked to the task of writing word problems. This is not to say there are not other patterns; rather that at this stage of methodological development and with my interest in how the students go about their task I can identify two patterns of attention which are potentially of interest. These are patterns of attention to what I will provisionally label as 'what a word problem is like' and 'mathematical structure'. I will illustrate each of these patterns with examples from the transcript. My purpose at this stage is to identify patterns which may be relevant to the two students' task. I am not yet in a position to address the possible significance of these patterns.

#### **Attention to 'what a word problem is like'**

Throughout their discussion, Cynthia and Helena attend to specific aspects of their word problems. They discuss possible names for characters in the problems, they discuss scenarios or stories for the problems, they discuss the wording of the question part of their problems and they discuss numerical details. These are all aspects of what makes a word problem a word problem (for Cynthia and Helena) and not some other kind of problem. This raises the question of what makes such problems distinctive, which I will return to in Chapter 7 (pp. 87-88). At this stage, it is sufficient to observe that the two students appear to have a rough idea of what kind of thing they are trying to produce. The evidence for this is the attention they devote to the various features of the problem, rather

than any explicit reference to these features. Hence in the following extract, Cynthia and Helena discuss names for characters:

#### Extract 4.5

47 H okay then/ I'll show you// give me a name  
48 C name/ um// (...)  
49 H no  
50 C Gemma then any  
51 H Daniel then  
52 C yeah brilliant  
*1A/OC&H: 21/5/00*

*Daniel is in  
their class*

Cynthia attends to Helena's turn (line 47) by attending to 'name' (line 48). She offers something inaudible, which Helena rejects (line 49). Cynthia then offers a name, which Helena responds to by suggesting a name herself. Thus, both students are attending to the choice of a name as a relevant aspect of the task of writing a word problem. A similar pattern can be observed in the following extract:

#### Extract 4.6

120 H in// okay// and you've got to do the next one right/ I'll tell you someone  
121 C yep  
122 H another name could be// Michael?  
123 C no/ um/ Sophie?  
124 H no/ not everybody in the class  
125 C ah/ Megan// [ (...)  
126 H [ could be  
*1A/OC&H: 21/5/00*

The two students also attend to scenarios for their problems:

#### Extract 4.7

56 H Daniel um  
57 C Daniel um  
58 H went to the shop  
59 C n-no can/ umm/ um write that/ Daniel work/ n-no/ Daniel/ w=um/  
60 Daniel/ well if he work/ (...) he have/ he have/ hundred pound/ and how  
61 many/ in/ the month/ (for example) like easy one  
*1A/OC&H: 21/5/00*

Helena treats the preceding “Daniel um” (lines 56 and 57) as an invitation to create a scenario, the outline of a story or situation as a setting for the word problem, offering “went to the shop” (line 58). Cynthia disagrees with the content of Helena’s offering (line 59), but not with its underlying purpose. Both students are attending to the scenario their word problem will have. The two students also attend to the wording of the questions which complete their problems. For example:

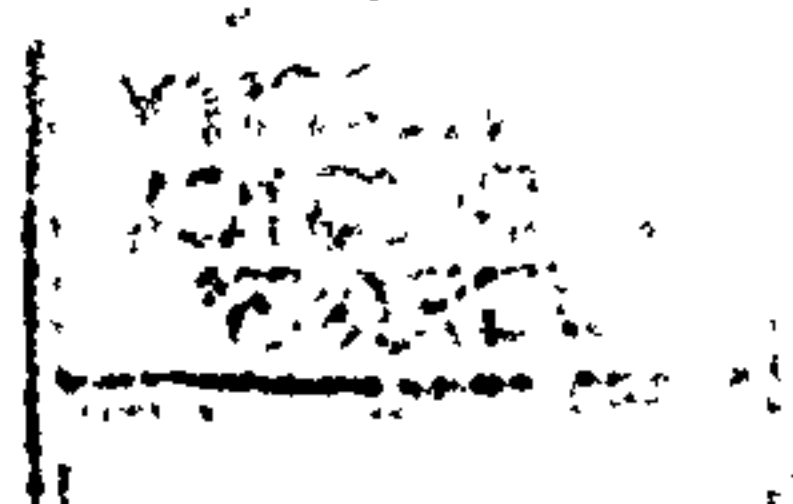
Extract 4.9

198 C how many together  
 199 H how much  
 200 C ‘s together/  
 201 H how much money does she spend/ um/  
 202 C together/ ah/ how much does she spend together  
 203 H how much did you spend in three weeks  
 204 C three weeks/ ‘kay/ no/ one month  
 205 H no  
 206 C yeah  
 207 H yeah alright [ (that’s not hard)/ it’s not hard actually/ just (...)  
 208 C [ that’s not hard (...)  
 209 H alright then just/ how much does she buy/ three weeks  
 1A/OC&H: 21/5/00

Again, although the two students debate the precise wording, both are attending to the question part of their word problem. Neither student contests the presence of this feature. As a final example of Cynthia and Helena’s attention to various aspects of ‘what a word problem is like’, the following extract shows them attending to numerical details:

Extract 4.10

80 C no/ [ have a job/ um no/ Daniel have a job/ one month he have err/ um/  
 81 umm/ four thousand three hundred and forty pound how many in a week  
 82  
 83 H tha’s that’s kind of hard for people though/ well not hard for most people  
 84 but  
 85 C it’s okay  
 86 H okay// Daniel/ [ Daniel has a job/ he gets paid *writes*  
 87 C [ has a job  
 88 he got/ uh he get/ he got/ four hundred and fifteen pound in a week  
 89 H what?  
 90 C four hundred and fifteen pound in a week  
 91 H paid/ how much?  
 92 C four hundred fifteen/ pound on a week/ no/ on a month  
 1A/OC&H: 21/5/00



Cynthia and Helena attend to both an amount for Daniel to receive as payment (lines 81, 88-92) and the period of time the payment should apply to (lines 80, 88-92), although there is no sign of them considering the mathematical relationship between these different quantities. They do attend to mathematical structure elsewhere in their discussions.

### **Attention to mathematical structure**

At several points during Cynthia and Helena's interaction, they turn their attention to the mathematical structure of the problem they are in the process of writing, often during moments of dispute. At this stage, I will characterise this pattern of attention as involving students' attention to the arithmetic operation or operations that will be required to solve their problem, or to arithmetic relationships between some of the quantities they are considering for the problem. These are illustrated in excerpts 4.11 and 4.12 respectively.

#### Extract 4.11

- 59 C n-no can/ umm/ um write that/ Daniel work/ n-no/ Daniel/ w=um/  
 60 Daniel/ well if he work/ (...) he have/ he have/ hundred pound/ and how  
 61 many/ in/ the month/ (for example) like easy one  
 62 H but you've got to use it in addin'/ addin'/ addition/  
 63 C oh yeah  
 64 H so you say Daniel/ yeah it's kind of like a addition thing isn't it/ because/  
 65 Daniel went to work/ he had hundred pound/ a month?  
 66 C um/ a week  
 67 H oh that's <sup>^(okay then)^</sup> a hundred pounds a week/ how many/ how many  
 68 um/ how ma=how much money do he have in a month  
*1A/OC&H: 21/5/00*

#### Extract 4.12

- 106 H no cause/ you said in a month/  
 107 C yeah/ no/ I said/ [ no/ I said/ Daniel has a job he gets paid four &  
 108 H [ how many  
 109 C hundred and fifteen pound in a month/ how many in a week  
 110 H how much he gets  
 111 C yeah/ how-how much he get/ on one week  
 112 H that's dividing innit  
 113 C oh yes that's divide/  
 114 H that's sort of like dividing cause there's four/ four weeks in a month so  
 115 that's four divided by (three) I mean four hundred and fifteen  
*1A/OC&H: 21/5/00*

In these two extracts, attention is turned to the arithmetic operation which may be required to solve the problem under construction. Thus, in Excerpt 4.11, Helena responds to Cynthia's proposed problem by stating the task: "you've got to use it in addin'" (line 62), thus evaluating Cynthia's suggestion (line 61) as not requiring addition. Similarly, in excerpt 4.12, the two students are debating whether to use a month or a week as the period for which Daniel gets paid. When Cynthia opts for a week, Helena attends to the operation required, which she states as 'dividing' (line 112) leading to further discussion. In the following extract, rather than considering the operation required, Helena makes an arithmetic link between two different elements of a problem which Helena first formulated as "Megan/ um/ goes to a shop five time/ no/ five times a week" (line 136):

#### Extract 4.13

209 H alright then just/ how much does she buy/ three weeks  
 210 C no months  
 211 H it's [ five times a week  
 212 C [ months  
 213 H 's like/ it's three weeks/ tha's fifteen days/  
 JA/OC&H: 21/5/00

Helena has suggested "three weeks" (line 209), which Cynthia has countered with "no months" (line 210). Helena then appears to give a reason for her suggestion of 'weeks' in preference to Cynthia's 'months', "it's five times a week" (line 211). She further justifies herself with the arithmetic relationship "it's three weeks/ tha's fifteen days" (line 213). Attention is thus turned to mathematical structure.

### **Summary**

In this chapter, I have used the ideas of Sacks (1987, 1992; Sacks *et al.*, 1974) to develop the notion of patterns of attention. This development has arisen through my reading of Sacks in conjunction with my work on the transcript of Cynthia and Helena. This emerging analysis provides some evidence for two patterns of attention in the talk between Cynthia and Helena as they write two word problems. These patterns are of potential relevance to my interest in how Cynthia uses language to think about her work

in mathematics, since one of them relates to the task taken from the students' mathematics lessons, and the other concerns mathematical structure. The patterns of attention to 'what a word problem is like' suggests that both students have had some experience of such problems in the past. Their regular attention to mathematical structure suggests that it is possible to see and say something about the mathematics participants are engaged in. These points indicate that identifying patterns of attention has the potential to be a powerful analytic tool in exploring how EAL students like Cynthia take part in school mathematics.

Having formed the general questions 'How do EAL students use language to think about mathematics?' and 'How do EAL students make sense of mathematical talk?', I stated in Chapter 3 (p. 23) that part of my task over Part 1 of this dissertation is to explore the notions of 'using language', 'thinking' and 'making sense'. This chapter has developed a theoretical and methodological perspective on 'using language'. Language is seen as a social activity, highly complex and yet intelligible to participants. This intelligibility arises from some of the features of talk discussed by Sacks (1987, 1992; Sacks *et al.*, 1974), in particular that participants make their interpretations explicit as part of doing interaction. Participants explicitly attend to what is relevant to their on-going discussion, publicly giving sense (Sharrock & Anderson, 1986, p. 56) to the activities in which they are taking part. This approach, moreover, does not rely on assumptions about what students mean, since it is based on publicly available features of their interaction, features which are publicly available in order to make that interaction intelligible. It is clear that at this stage, however, identifying and describing patterns of attention does not in itself address issues of how students use language to do 'thinking' or how they do 'making sense' as they work on mathematics tasks. To address these issues Sacks' ideas need further development, for which I turn in the next chapter to discursive psychology.

## Chapter 5

### Attention and discursive psychology

Through the ideas of Sacks (1987, 1992; Sacks *et al.*, 1974) I have developed the notion of patterns of attention as a tool for the analysis of students' interaction, as I set out in the previous chapter. I have not yet, however, shown how looking at patterns of attention is relevant to questions concerning how students think and make sense in mathematics. The interaction of Cynthia (EAL 2) and Helena (non-EAL) discussed in Chapter 4, for example, shows patterns of attention to 'what a word problem is like' and to 'mathematical structure'. What does this tell me about thinking? There could be a temptation at this point to revert to 'inside the head' arguments, by attempting to draw conclusions about Cynthia or Helena's thinking processes based on the patterns of attention that appear in their interaction. Given that I have ruled out this kind of approach, I must develop an alternative position which relates the patterns of attention in students' talk to issues of thinking and sense-making without making claims about what is going on inside their minds. This position also needs to include a clarification of how the notions 'thinking' and 'sense-making' are to be treated. That is the purpose of this chapter.

To carry out this task, I will draw particularly on the *discursive psychology* of Edwards and others (Edwards, 1997; Edwards and Potter, 1992; Potter and Wetherell, 1987; Wetherell and Potter, 1992), a body of work which extends the sociological treatment of interaction of Garfinkel (1967) and Sacks (1987, 1992; Sacks *et al.*, 1974) to deal with questions of a more psychological nature. I will not offer a comprehensive review of this work, which is beyond the scope of this dissertation. In this chapter, I will, however, provide a general overview of the discursive psychology approach, particularly as it



relates to my own concerns. The ideas developed in this discussion, together with those set out in the previous chapter will provide the basis for the analysis of data collected for the study described in this dissertation.

## **Discursive psychology**

The discursive psychology developed by Edwards (1997; Edwards & Potter, 1992) and others (Potter & Wetherell, 1987; Wetherell & Potter, 1993) builds on the principles developed in ethnomethodology and conversation analysis, particularly those of Sacks. Let me therefore recap those ideas: in different ways, Garfinkel and Sacks were interested in the *social* organisation of interaction. In particular, they were concerned with how participants in interaction organise and make sense of the interaction in which they are participating. Both writers examined the social actions conducted in interaction as a basis for their investigation of the organisation of that interaction. By examining how such actions are treated by participants, they avoided the need to say what interpretations participants have in their heads. They worked, instead, with the interpretations participants display through their participation. Thus, the ethnomethodological position addresses a fundamental psychological issue that arises from the impossibility of experiencing the mind of another. In addressing this issue, however, Garfinkel was solving a methodological problem in order to tackle questions of social organisation. His work did not focus on the kinds of questions typically encountered in the field of psychology. Ethnomethodology, however, is not a fixed set of rules on how to do sociological or any other kind of research. Rather, it offers a stance, an approach to research, which must be freshly developed and shaped according to each new area of inquiry (Sharrock & Anderson, 1986, p. 61). Discursive psychology, particularly as developed by Edwards (1997; Edwards & Potter, 1992) can be seen as a response to this position which seeks to develop the ethnomethodological stance, via the ideas of Sacks in psychological directions. Clearly such an approach is relevant to my own work, which can be seen as forming part of this development process. Having used the ideas of Sacks as a starting point for my analysis, discursive psychology offers a way to extend these

ideas to the issues of thinking and sense-making I am seeking to address in this dissertation.

To organise this discussion, I will address three key ideas in the discursive psychology approach. These are *social action*, *recipient design*, and *rhetoric*. I will begin, however, by addressing the notion of discourse itself.

## **Discourse**

In a broad sense, the term *discourse* refers to ways of using language in interaction associated with particular fields of activity, the patterned ways of talking and interacting which arise in doing different things (e.g. Clark, 1996, p. 29; Fairclough, 1989, pp. 22-23). Hence, I can postulate discourses relating to situations as diverse as football, educational research or school mathematics. As Sacks (1987, 1992; Sacks *et al.*, 1974), some linguists (notably Halliday, 1973, 1975, 1978), and many socio-cultural psychologists have argued (e.g. Bakhtin, 1986; Bruner, 1983, 1986, 1990; Vygotsky, 1978; Wertsch, 1991, 1998), it is these patterns which make meaningful interaction possible. Without such patterns, our speech and behaviour would be random noise and gesture. It is patterns, for example, which provide a link between words and the different contexts in which they are used. The project of conversation analysis can be seen as one of uncovering the complex patterns that make everyday talk apparently effortless for most participants. Conversation analysis, however, conceives of talk as a social activity. Reflecting this perspective, discursive psychology sees discourse as concerning action in social settings, as social practice (Edwards & Potter, 1992, p. 15). Thus, patterns of interaction can be seen as patterns of activity which take place in particular social situations. The discourse of school mathematics, for example, is part of the social activity of doing mathematics in school. For discursive psychology, it is discourse which becomes the focus of inquiry (*ibid.*, pp. 16-17), not in order to delineate an abstracted version of one discourse or another, but, in an ethnomethodological move, to explore how discourses bring about the activities they are part of. So, rather than attempting to describe the discourse of school mathematics, the task is to explore how discourse constitutes school mathematics for participants. This approach entails examining

instances of naturally occurring interaction, a position which rules out the use of interaction recorded in specially created situations as a way of investigating some other situation. Interviewing students about their mathematics lessons, for example, would provide data on the discourse of research interviews, but not on classroom mathematics (*ibid.*, p. 28). As with Garfinkel's (1967) move in sociology to examining the interpretations of social situations publicly displayed by participants, rather than as labelled and categorised by analysts, discursive psychology aims to explore how participants publicly interpret psychological aspects of such situations:

What we find in everyday talk is...a rich seam of concern about truth and error, mind and reality, memory and perception, knowledge and inference...people casually and routinely construct formulations of such things (perception, knowledge, inference and so on) as part of everyday discursive practices...(Edwards & Potter, 1992, p. 17).

Hence *thinking*, a term which encompasses all of the processes referred to by Edwards & Potter in the above quote, can be examined from the perspective of participants in interaction, rather than as underlying cognitive processes which can be used to explain what people do and say (Edwards, 1997, p. 60). As Edwards & Potter (1992, p. 17) acknowledge, this is not to say that people explicitly talk about these things. At some level analysts (including Edwards & Potter) must introduce some level of external categorising or labelling. It is not possible to remove analysts entirely from their analysis. Indeed the methodological issues raised in this dissertation are motivated by the need to recognise the role of the analyst, to include rather than exclude them. As a result of this position, therefore, as I argued in Chapter 4 (pp. 43-44), my interpretations are shifted to the level of public interaction, rather than of the inaccessible realm of the mind.

The treatment of psychological topics such as thinking or sense-making as being constituted through discourse, is a position Edwards (1997) calls 'methodological relativism' (p. 60; see also Sharrock & Watson, 1988, p. 59). Since one individual can never know what or how another thinks or knows, any consideration of such issues must take place through discourse, whether the discourse of cognitive psychology, everyday, commonsense psychology (what Bruner, 1996, pp. 45-46, refers to as 'folk psychology'), or other discourses of thinking or knowing. By turning his attention to these discourses, rather than to any underlying cognitive activity, Edwards (1997) avoids the issue of what

is going on inside people's heads. This is not to say that there is *nothing* going on, only that we cannot see whatever it is that is going on. Rather than attempting to make sense of how people think (in their heads), Edwards argues that we can examine how such issues are dealt with by the participants themselves. In so doing we uncover how such notions are dealt with as social practices in different contexts. It is this focus on action that lies at the heart of discursive psychology.

Before continuing this discussion, let me illustrate some of the ideas I have mentioned so far, for which purpose I will use the following extract from the beginning of the recording of Cynthia (EAL 2) and Helena (non-EAL) referred to in Chapter 3 and Chapter 4 (the transcript is given in Appendix II, pp. 222-230). I have asked the two students to write a word problem or story problem together and left them to work. After I left, the following exchange took place:

#### Extract 5.1

- 24 H d'you remember it?  
 25 C no  
 26 H it's/ a word problem is when you know miss writes on/ maths/ when she  
 27 writes/ a paragraph on the board/ or/ you copy the sentence on the board/  
 28 and and and it says/ um/ Mike had something or (Jane) had something  
 29 you know like that?  
 30 C no  
 31 H well that means/ right say like/ Natalie had/ Natalie went and bought  
 32 something/ and then/ you know? when miss says that?  
 33 C I can't remember/  
 34 H for instance// Natalie went to the shops/ she bought three things/ for fifty  
 35 p.  
 36 C oh I know now I remember/ the l-/ um/ the/ we=like/ th-the um um *v animated*  
 37 som'ing/ som'ing// um// I know what d'you mean but I can't explain  
 38 H yeah?  
 39 C yeah yeah yeah

1A/OC&H: 21/5/00

This extract exemplifies the 'rich seam' (Edwards & Potter, 1992, p. 17) of concern with matters psychological. At stake are issues of remembering, knowing and explaining (what a word problem is) and recounting and interpreting events (in previous mathematics lessons). Running throughout the extract is a concern with meaning, of words, of accounts and of explanations. In analysing this extract, my concern could be with what each student 'knows' about word problems or 'means' by what they say, about what they

are 'thinking'. I could then use these ideas to explain how Helena explains to Cynthia what a word problem is. From the perspective of discursive psychology (as well as the position already developed in this dissertation), this kind of concern is not admissible. I cannot say what Cynthia thinks a word problem is or whether she does or does not remember. Indeed, Edwards (1993) suggests that "it is not clear that they [students] 'really think' anything, at least not in the sense of carrying around in their heads ready-made explanations that merely await discursive opportunities to be revealed" (p. 219). Instead, I can examine how the two students do the activity of 'joint remembering' (Edwards & Middleton, 1986) through talk, how they deal with issues of knowing, remembering or sense-making by constructing thoughts or memories or accounts for particular occasions. In short, my concern is with action.

### **Social action**

Although the discussion between Cynthia and Helena concerns issues such as remembering and knowing, much, perhaps the greater part, of the patterning of their interaction is not directly related to these concerns. Their discussion is shaped by the systematic social organisation of talk investigated by Sacks (1987, 1992; Sacks *et al.*, 1974) and others. The two students take turns to speak, in this case through a sequence of question-answer pairs which leads to a negotiated expression of agreement (lines 36-39). As Sacks showed, these patterns of interaction arise through the social actions of the participants, actions which bring about the on-going organisation of their talk (see Sacks, 1987; Sacks *et al.*, 1974). For discursive psychology, the social action through which interaction is organised takes precedence over other aspects of interaction, so that:

...the psychological structures and functions of language have been shaped by language's primary social functions (Edwards, 1997, p. 84).

This assumption is based on the idea that since human language has evolved as a medium for social interaction, it is this function which shapes the patterns of language use [15]. Hence, although Cynthia and Helena's discussion clearly concerns psychological matters, we must see their interaction as primarily organised through the social actions their words perform. Edwards & Potter (1992) suggest that such actions might include "describing

and reporting interesting events, making plans and arrangements, coordinating actions, accounting for errors and absences, accusing, excusing and blaming, refusing invitations” (p. 17), all it should be noted, activities which must often be named as such by analysts. In the extract above, for example, we see (amongst other actions) a description of a classroom situation (lines 26-29), and an account from Cynthia of why she cannot demonstrate the knowledge she claims for herself, “I know what d’you mean but I can’t explain” (line 37). Indeed, the whole exchange can be seen as an act of remembering, where remembering is reconceived as a discursive activity. To show that interaction in which psychological concerns are at stake is patterned by the social nature of talk is a first step. In the search for a more developed theory and analysis of action in interaction, Edwards (1997) draws on Sacks’ (1992, vol. 2, p. 230) notion of recipient design and introduces the idea of the rhetorical organisation of talk.

### **Recipient design**

Sacks (1992, vol. 2, p. 230) observed that in interaction, what a speaker says is designed for the hearer, a phenomenon he called ‘recipient design’ (see also Sacks *et al.*, 1974, p. 727). Silverman (1998, p. 14) illustrates this with an example about people’s names. How we refer to another person is designed, in part, for the person we are talking to. As a teacher, for example, I refer to a colleague as ‘Mrs Jones’, if talking to a student, as ‘Anne Jones’, if talking to a colleague from another school who may know her, as ‘Anne’, if talking to another teacher in the same school, or as ‘my colleague Anne Jones’, if talking about her work to people who do not know her. The way I refer to Anne Jones is designed or selected to suit my audience. Sacks also illustrated the idea of recipient design on several occasions (e.g. Sacks, 1992, vol. 2, p. 230, 386-388, 543-546), including during his discussion of the following exchange:

A: Uh I am surprised he didn’t call you

B: Well’s alright

A: ((laugh)) Did he- he didn’t evidently

B: no

(Sacks, 1987, p. 64)

Sacks points out that in this short exchange, participant A gradually adjusts their utterances to achieve agreement with B, particularly in A's second turn, and concludes "...we have to see that the questioner is *designing the question* with an orientation to getting agreement" (Sacks, 1987, p. 63, my emphasis). Thus, A, whilst attending with B to agreement, designs their question for B. A's words are contingent on those of B *and* the surrounding circumstances of their discussion. It may be relevant, for example, that A and B are friends rather than say, work colleagues. Thus, a speaker is also designing their utterance for the moment and circumstances in which it is uttered. The actions of talk are *situated*, in that they are designed for particular circumstances (Edwards, 1997, p. 76). They are also *occasioned* (*ibid.*, p. 76; Garfinkel, 1967, p. 3), in the sense that they are designed for the unique moment of their occurrence.

Recipient design is a prevalent feature of interaction. The social actions which make up human talk can all be examined in terms of how they are designed for the hearer, including actions such as naming (Silverman, 1998), questions (Sacks, 1987), accounts (Edwards & Potter, 1992, p. 51-53) and descriptions and categorisations (Sacks, 1992, vol. 1, p. 169; Lepper, 2000). Recipient design is apparent in the exchange between Cynthia and Helena discussed above. Helena progressively redesigns what she says in order to reach a position in which Cynthia 'remembers' what a word problem is and the two students can get on with the task. I should point out at this point that the use of the word 'design' does not connote any attempt to claim to know what the speaker intends. For this reason, the choice of the word is perhaps inapposite. As I have already implied, *selected* is a good alternative, since what Helena is doing in the extract shown above, and what I am doing in the case of Anne Jones is selecting different possible things to say and ways in which to say them. Similarly, in the case of questions, accounts or descriptions, the speaker selects from a range of possible things to say and ways to say them according to whom they are addressing. Designing or selecting utterances, like other actions of talk, are part of the patterned ways of interacting in which we all participate. My interest is in what students can do with these patterns of interaction.

## Rhetoric

Recipient design has been taken further by research in discursive psychology, which introduces the notion of *rhetoric*, the idea that by saying things in different ways, different things are achieved. By designing an utterance in a particular way, speakers accomplish different outcomes, including the undermining of actual or potential alternative versions of what is being discussed (Edwards & Potter, 1992, p. 154; Edwards, 1997, p. 78). For me, rhetoric entails two related components: a selection of what to talk about; and a selection of how to talk about it. In examining how rhetoric works, the key question is ‘what does this do?’ What does a particular selection achieve that an alternative would not have achieved? What does a particular way of saying something achieve that another way would not? Consider the following cartoon from December 2001, when U.S. led military forces were searching caves in Afghanistan for the al-Qaida leader, Osama bin Laden:



"This is a grotto, not a cave..."

**Figure 5.1** Cartoon from *The New Statesman* (December, 2001)

The cartoon illustrates the nature of rhetoric: saying the same thing in different ways does different things. By describing his dwelling as a grotto, the Santa figure relates his somewhat unusual abode to the Santa fairytale, in which Santa Claus lives and works in cave-like place known as a grotto. In so doing, he seeks to undermine a version of the



situation the soldier may have, that the Santa figure is in fact Osama bin Laden, an allegedly dangerous bearded terrorist, widely believed at the time of the cartoon to be hiding in a 'cave' in Afghanistan. The Santa figure relies on an implicit association of the word 'grotto' with Santa Claus. The choice of this word is an example of a selection of *how* something is said or portrayed.

In the cartoon, the Santa figure's selection of what to talk about relates to another concern of rhetoric, that of *accountability*. Accountability concerns 'agency and responsibility' (Edwards & Potter, 1992, pp. 165-166). Speakers design what they say to account for why things happened and why people acted in the way that they did, so 'giving sense' to what is happening (Sharrock & Anderson, 1986, p. 56). Much of the time, this accounting entails accounting for their own actions, motivations or intentions (Edwards & Potter, pp. 166-167). In the cartoon, for example, in order to avoid being arrested or shot, the Santa figure must convincingly account for who he is and why he is there. By arguing that his cave is a grotto, the Santa figure establishes both who he is *and* what he is doing there, thus making his statement more accountable, and therefore less likely to be undermined. His accounting can be seen as a rhetorical action, specifically designed for the recipient and the situation.

The management of accountability is also a feature of the discussion between Cynthia and Helena. Consider, for example, how Helena manages the accountability of her efforts to sort out what a word problem is:

### Extract 5.2

- 24 H d'you remember it?  
 25 C no  
 26 H it's/ a word problem is when you know miss writes on/ maths/ when she  
 27 writes/ a paragraph on the board/ or/ you copy the sentence on the board/  
 28 and and and it says/ um/ Mike had something or (Jane) had something  
 29 you know like that?  
 30 C no  
 31 H well that means/ right say like/ Natalie had/ Natalie went and bought  
 32 something/ and then/ you know? when miss says that?  
 33 C I can't remember/  
 34 H for *instance*// Natalie went to the shops/ she bought three things/ for fifty  
 35 p.  
 36 C oh I know now I remember/ the l-/ um/ the/ we=like/ th-the um um *v animated*

37            som'ing/ som'ing// um// I know what d'you mean but I can't explain  
38    H        yeah?  
39    C        yeah yeah yeah  
1A/OC&H: 21/5/00

Helena could have dealt with Cynthia's apparent unfamiliarity with the term 'word problem' in several possible ways. She could have given an example or a definition of a word problem. She could have, in short, behaved more didactically. Such behaviour is often met with resistance, however, unless it is displayed by someone who is qualified in some sense to do so. Teachers can be didactic; students, generally, cannot. The pattern of discussion between Helena and Cynthia is of an almost Socratic question-answer form, with Helena 'revealing' what Cynthia already 'knew'. It appears that Helena is being didactic after all, though without any resistance from Cynthia. This accomplishment is related to the way Helena manages the accountability of what she is saying. Firstly, she constructs the task as one of Cynthia remembering, rather than one of Helena explaining; the agency lies with Cynthia, with Helena supporting her, rather than lying with Helena while Cynthia frustrates. To achieve this, Helena makes a selection of what to say: she talks about the task as remembering rather than anything else. She also comes up with a particular way of saying: she uses a question, as opposed to, say, telling Cynthia that she must remember, or stating that she (Helena) can remember. The use of a question puts the onus on Cynthia to respond (Sacks, 1992, vol. 1, p. 49), thus setting up the question-answer format, with Helena asking the questions.

Accountability is also managed over the three turns in which Helena constructs an explanation of what a word problem is as something *their teacher* does in class. From Cynthia's point of view, this device makes it hard to challenge or undermine what Helena is saying, since it is presented as something their teacher does, and therefore, since the business of teaching is to know about such things as word problems, something correct. Again, the agency of the explanation is shifted, this time from Helena to the teacher. By managing agency in this way, Helena's words also manage the responsibility for both the task of 'remembering' and for the veracity of her explanation. It is Cynthia's responsibility to remember, rather than Helena's to explain, and it is the teacher who is

responsible for the description of word problems, not Helena. Hence, accountability is carefully managed through the design of what Helena says.

In developing the notion of rhetoric in discursive psychology, Edwards & Potter (1992, pp. 160-163) highlight a number of devices which are used to manage accountability, particularly in terms of supporting the veracity of a speaker's or writer's (I will simply refer to 'speakers' in future) particular version of the world. These include what Edwards & Potter call: category entitlements, vivid description, narrative, rhetoric of argument and extreme case formulations, all of which work by either supporting the reliability of the speaker or by distancing the speaker from their account or version of the world, which can then be portrayed as 'objective'. I will briefly elaborate on each of these devices.

*Category entitlements* implicitly draw on particular identities, or membership categories (Sacks, 1992, vol. 1, p. 40; see also Antaki & Widdicombe, 1998b) which may be attributed to the speaker by a hearer and which are related to how reliable particular claims they make about the world may be taken to be. In the above extract (5.2), for example, Helena refers to what are constructed as the teachers words or actions. This account draws on the reliability of the teacher as someone who knows what a word problem is, someone who may be seen as more reliable in this respect than Helena. *Vivid description*, that is providing elaborate contextual detail, acts by displaying closely observed familiarity with a situation. Accounts constructed in this way have 'eye-witness' credibility, since they indicate that the speaker was personally present. Again, in Extract 5.2, Helena gives a precise sounding account of what the teacher does, using words like 'paragraph' and describing specific actions. This device supports Helena's account by drawing on the teacher's reliability as someone who has some expertise in word problem, so supporting the version of a word problem that Helena's words portray. *Narrative* works by creating a coherent scenario for a particular situation, which constructs the reported circumstances as expectable or even inevitable (see Edwards & Middleton, 1986). Helena's account of the teacher's actions takes the form of a short narrative, a narrative which Cynthia is implicitly part of, putting the onus on Cynthia to confirm the account. Use of the *rhetoric of argument* entails constructing claims in the form of logical argument or deduction. This device draws on the idea that logical

reasoning is objective and independent of the reasoner (see Edwards & Potter, 1992, p. 162). An example is shown in discussion of Extract 6.3 in the next section. Finally, *extreme case formulations* (Pomerantz, 1986) involve drawing on generalisations which are then portrayed as 'common knowledge', as able to be taken for granted. This device often draws on the language of 'everyone', 'all', 'never' and 'nobody', as in assertions which begin 'everyone knows that...'. These different rhetorical devices are not exhaustive (see Edwards & Potter, 1992, pp. 160-163 for others); nor are they mutually exclusive. Talk continually involves the use of many such devices, often in combination.

So far in this chapter, I have provided a selective overview of relevant principles of discursive psychology. These ideas build on ethnomethodology and conversation analysis to lead to a discursive approach to what are more usually treated as psychological phenomena, such as, for example, memory. These ideas can also be used to extend the analytic approach I developed in Chapter 4, a task which forms the subject of the next section.

### **The rhetoric of attention**

Before I develop the application of discursive psychology to participants' attention, let me briefly recap the main points of the approach to analysis set out in Chapter 5. The basis for analysis is participants' attention, which they make available so that talk is possible. Attention, here, does not refer to what participants are thinking, but to where they publicly attend. The identification of this attention is based on the principle that turns in talk display interpretations of what has gone before; talk is sequential. In responding to prior utterances, speakers attend to relevant aspects of what was said. This is not to say they ignore everything else, only that I can only examine what is public. By examining the attention of Cynthia and Helena as they write word problems together, patterns emerge in that attention.

Following discursive psychology, the investigation of attention entails exploring how attention is socially managed and organised in interaction. In particular, I propose, it is possible to consider a 'rhetoric of attention', the idea that attention is designed and

organised according to what is being done. By managing attention in different ways, different things can be achieved. Rhetoric (of words), I argued, consists of a selection both of what to say and of how to say it. Similarly, the rhetoric of attention, entails a selection of what is attended to, as well as the way in which this attention is brought about. Again, the key question is ‘what does this do?’ What does attending to one particular detail achieve that attending elsewhere would not? What does directing attention in a particular way achieve that another way would not? In examining attention from this perspective, I will still be looking at an important aspect of thinking, but where thinking too is considered in terms of how it features in discourse, rather than how it happens inside the mind.

In conducting such an analysis, conversation analysis and discursive psychology provide a number of tools. Firstly, I can, once again, make use of the sequential nature of interaction. As in the identification of attention, when considering what attention to a particular aspect of the situation achieves, I can look to see what happens next in the interaction. Participants in interaction display their interpretations and responses to what is happening, including their interpretations of where and how attention is directed. These interpretations are then available for me to examine. To illustrate this point, let me return to an extract from the recordings of Cynthia and Helena I first used in Chapter 4 (Extract 4.12, p. 49) as an example of attention to mathematical structure.

### Extract 5.3

106 H no cause/ you said in a month/  
 107 C yeah/ no/ I said/ [ no/ I said/ Daniel has a job he gets paid four &  
 108 H [ how many  
 109 C hundred and fifteen pound in a month/ how many in a week  
 110 H how much he gets  
 111 C yeah/ how-how much he get/ on one week  
 112 H that's **dividing** innit  
 113 C oh yes that's divide/  
 114 H that's sort of like dividing cause there's four/ four weeks in a month so  
 115 that's four divided by (three) I mean four hundred and fifteen  
*JA/OC&H: 21/5/00*

In this episode, following attention to certain details of the emerging problem (lines 106-111), Helena moves their attention to the mathematical structure of what has so far been

proposed (lines 112-115). What, then, does this shift in attention [16] achieve? In this case, it changes the terms of the discussion which it follows, from a rather arbitrary choice between 'month' and 'week' to a question of what kind of arithmetic operation their problem should have. How is this shift brought about? Helena makes a direct assessment of Cynthia's suggestion (line 112). When Cynthia expresses agreement, however, Helena follows this up by accounting for her assessment, interpreting Cynthia's ideas in terms of an arithmetic calculation, although she softens the directness of her initial criticism, however, "that's sort of like dividing" (line 114). The use of logical argument is a way of managing her accountability, since it presents her claim as based on an external, mathematical logic, rather than on her own opinion (Edwards & Potter, 1992, p. 162). This is not to argue for the truth or otherwise of what Helena says. My interest is in how she does what she does, in how she presents her 'thinking'.

Rhetorical analysis entails, in part, the consideration of what other possible versions of the world are undermined or pre-empted by what is said. This approach to some extent relies on the analysts familiarity with the language and situation under analysis or what Wetherell & Potter (1993) call the analyst's 'ethnographic understanding' (p.102; see also Edwards, 1997, p. 164). Discursive psychology to an extent addresses this issue through a consideration of the variation of talk (Edwards & Potter, 1992, p. 28; Potter & Wetherell, 1987). The assumption is that the ever-present variation in how people talk is rhetorically systematic, since as I have discussed above, saying things in different ways achieves different things. This systematic variation offers a 'lever' (Edwards & Potter, 1992, p. 28) for analysis, however, since different versions of accounts, descriptions stories or other discursive actions can be compared, in order to explore how the different ways they are constructed works in the situations in which they arise. By comparing, for example, the different ways in which Santa talks about his cave/grotto in different circumstances, it is possible to see how these different descriptions do different work according to when, where and to whom they are used. This approach can be applied to the analysis of attention. By considering the different ways in which attention is directed to mathematical structure, say, I can begin to see how these different ways relate (though not causally) to different outcomes.

An analysis of how attention is used in interaction along these lines is clearly of a different nature to the identification of patterns of attention. The latter involves looking at relatively long stretches of interaction. Analysing the management of attention requires closer, more detailed work on shorter episodes. How should such episodes be selected? Discussing the analysis of different accounts or descriptions, Edwards (1997) shows how a particularly fruitful approach involves comparing competing versions (p. 176). This form of comparison highlights the different rhetorical devices used and the rhetorical work these devices enable. In analysing attention, I can adopt a similar approach, by seeking episodes in which competing patterns of attention arise, as in Extract 5.3, above, in which attention to the details of the word problem and to its mathematical structure appear to compete. By finding and then comparing such situations, I can consider what is at stake between these competing areas of attention and can explore what such shifts in attention are designed to achieve.

## Summary

In this and the previous chapter, I have developed a theoretical and methodological conceptualisation of interaction which does not rest on the assumption that I can say what students mean by what they say. This approach sees interaction as primarily a form of social action and treats issues of thinking or sense-making as the discursive concerns of participants in interaction, rather than as *a priori* analytic categories or models. I have explored several aspects of interaction seen from this perspective, aspects relevant to the analysis of students' talk. These features arise from the rhetorical nature of interaction and include a range of rhetorical devices which work by managing the accountability and reliability of speakers' versions of the world. Using these ideas, I have developed an approach to analysis based on the notion of attention as social action. This approach entails the identification of patterns in students' attention. By comparing episodes in which competing areas of attention are visible, I can consider how attention is managed and used by students as they work together on tasks like writing word problems. In so doing I will be saying something about how students, including EAL students, think together as they work on this task, where both thinking and attention are seen as issues

dealt with by students in their on-going interaction. Similarly, my analysis will examine how the participating students, including EAL students make sense of mathematical language, since my approach entails examining the interpretations they make publicly available and exploring how those interpretations contribute to the on-going process of completing the task. Patterns of attention provide an analytic tool, a way of working with transcript data, which allows me to think about students' thinking and sense-making. By identifying and describing patterns of attention and then considering how these such attention is used by students in particular moments, particularly moments where attention is shifted from one pattern to another, I can obtain insights into how students use language to think about mathematics and how they make sense of mathematical language.

A consequence of the discursive position I have developed, is that although I have selected a student, Cynthia, whom the school treats as EAL, I cannot examine the interaction in which she participates and attribute specific aspects of it to her. Any interaction involving Cynthia is situated and occasioned, not least by the participation of other students. Although I cannot, therefore, point to particular utterances or actions and claim that they arise 'because Cynthia is EAL', I *can* examine interaction for occasions when aspects of being a learner of English become relevant *for the participants*.

To sum up, in order to address my key questions:

- how do EAL students use language to think about mathematics?
- how do EAL students make sense of mathematical language?

I collected and analysed data which tackles the following questions:

- What patterns of attention can I identify in EAL students' interaction as they write word problems together with their peers?
- How is attention used by EAL students and their peers in their work together?

The next chapter, which concludes Part 1 of this dissertation, sets out the nature of the data I collected.



## Chapter 6

### Recording students' talk

In Chapter 3, I described my initial explorations of a classroom situation which led to the recording of Cynthia and Helena working together on a word problem task. In Chapters 4 and 5, I developed a theoretical and methodological approach to the analysis of interaction like that of Cynthia and Helena's, leading to two specific questions:

- What patterns of attention can I identify in students' interaction as they write word problems together?
- How is attention used by students in their work together?

In this chapter, therefore, I set out the data I collected in order to address these questions. In particular, I describe what data I collected, the nature of the students who took part, how I recorded and transcribed students' interaction and a number of ethical issues which arose. First, however, I will clarify the notion of *data*, a notion which must be reconsidered in the light of the discursive position developed in the preceding chapters.

#### What is data?

The word *data* is commonly used to refer to whatever the researcher analyses, be it questionnaire responses, observations, documents, measurements or recordings. This 'data', however, is progressively transformed through the course of the research process. Responses are collated, observations coded and measurements statistically analysed. Furthermore, the nature of what is collected is related to the theoretical perspective of the researcher. Data cannot be 'raw'; it is brought into being by researchers and their

activities (see, for example, Edwards, 1997, pp. 53-61; Edwards & Potter, pp. 4-6; Latour & Woolgar, 1986). Even common-sense 'reality' can be seen as formulated as part of a theoretical position, constructed as part of a rhetorically designed-argument (Edwards, Ashmore & Potter, 1995; Edwards & Potter, 1992; Latour & Woolgar, 1986). Consider, for example, the transcripts used in this dissertation. To arrive at these transcripts, I first created a situation in which a tape recorder was used. The tape recorder recorded the interaction which took place. Or rather, the tape recorder recorded *some* of the interaction which took place. It did not record any of the gestures or facial expression or anything the students or I wrote down, for example. Neither did the machine record everything I or the students said. On occasions the students whispered or mumbled, walked around the room, covered over the machine and on at least one occasion, paused the recording for a few seconds. Sometimes, the machine recorded the two students but also various other sounds, such as a class in the next room on a warm sunny day when the windows were open, a class filing past to go to assembly, or one of the students tapping a pencil repeatedly on the desk. Having obtained a tape-recording, I proceeded to produce a transcript, a process which relies on the quality of tape-player and my own *interpretation* of what is on the tape. This interpretation is then represented on a page using written words, letters and other symbols. It is this typed transcript which I analyse. This outline of the process from students' work to transcript shows how my data is a construct, created for particular purposes and uses, one of which is inclusion in this dissertation. At various stages, I made choices and selections about what to include, what I heard, and what to write. I am not arguing that my data is somehow inaccurate or a poor record of students' interaction, only that *all* data is constructed by the researcher, although it is frequently presented as a transparent representation of reality. Although I cannot avoid constructing my data, I can avoid treating it as if it is transparent. In particular, I can be explicit about the uncertainties and difficulties in the collection and representation of my data and about why I made the choices I made [17].

## **What data did I collect?**

The exploratory work I conducted, described in Chapter 3, clarified a number of issues regarding the recording of students' interaction. In particular, it led to the decision to withdraw students from their lessons in order to record them in a quieter location. I also identified a suitable task for the students to work on, that of writing mathematical word problems, a task I observed the teacher set in class to pairs or small groups of students. Thus, although the recording situation would be somewhat artificial in terms of its location, the work the students were doing would be based on whatever mathematics was going on in their classroom. For similar reasons, I also decided as much as possible to select small groups of students whom I had observed working together in class. This was not a difficult condition to meet since the students were used to working in a range of groups and other arrangements. I did, however, modify the task slightly, in that I decided to ask students to solve their problems once they had written them, as this could give further insight into how they interpreted what they had written.

Given that the trial recording of Cynthia and Helena lasted for over 20 minutes, and given the detailed nature of the approach to analysis developed in Chapters 4 and 5, I did not seek to collect excessive numbers of recordings. I did, however, seek to involve several students with English as an additional language (EAL), in order to allow for some degree of comparison among them. For similar reasons, and since interaction is seen as a joint accomplishment of all participants, I recorded participants working in more than one combination of students, so that comparison would be possible among groupings. Similarly, I included various combinations of EAL and non-EAL students, including one pair of non-EAL students, in order to allow for comparison across combinations.

In the summer of 2000, the teacher and I identified a time when word problems would feature in Year 5's mathematics work, in this case in a week of work on solving money-related problems as part of a topic on using calculators. There were 6 students recognised by the school as learning English as an additional language in the Year 5 class of 1999-2000, 3 from Pakistani backgrounds, two from East Asian backgrounds and one from a Somali background. I arranged with the teacher to record six groups. I recorded 5 pairs

including the preliminary pairing of Cynthia and Helena, as well as one group of 3 in order to allow for comparison among the interaction in pairs and groups. Groupings were based on my observation of classroom interactions and were designed to include a range of situations. Groups included EAL students sharing the same or different language backgrounds, for example. I anticipated that the organisation of these groups would become more refined in future cycles in the light of my analysis of Cycle 1.

I recorded each group twice around the time of the calculator topic. The first recordings (later named Cycle 1A; see Appendix I, pp. 217-221) were made before the topic had been taught, the second round (Cycle 1B) took place after the topic. This aspect of organisation was largely for convenience, although again, it allowed for comparisons to be made in the two sets of recordings. The recording schedule is shown in Table 6.1, with EAL students indicated in bold type (all names have been changed; see p. 82).

<i>Summer term 2000 (Cycle 1A)</i>		<i>Summer term 2000 (Cycle 1B)</i>	
<b>Date</b>	<b>Participants</b>	<b>Date</b>	<b>Participants</b>
21/5/00	<b>Cynthia &amp; Helena</b>	11/7/00	<b>Safia &amp; Rahim</b>
19/6/00	<b>Safia &amp; Rahim</b>	11/7/00	<b>Cynthia &amp; Helena</b>
20/6/00	<b>Farida &amp; Parveen</b>	12/7/00	<b>Farida &amp; Parveen</b>
20/6/00	Eleanor & Vicky	12/7/00	Safia & Helena
21/6/00	<b>Cynthia, Daniel &amp; Joanne</b>	13/7/00	Eleanor & Vicky
21/6/00	<b>Safia &amp; Helena</b>	13/7/00	<b>Cynthia, Daniel &amp; Joanne</b>

**Table 6.1 Recording schedule summer 2000**

I returned to the school the following academic year, visiting the new Year 5 taught by the class teacher with whom I worked in the previous year. In this class, there were 7 students recognised as learning English as an additional language, 5 from Pakistani backgrounds, one from an East Asian background and one from a Somali background. I modified my approach to group organisation and recording in a number of respects. I only recorded students working in pairs, since the group of 3 students recorded in the previous year had proved difficult to transcribe. I involved each student in two pairings, since where this had happened in the previous year's work, the possibility of comparison

proved to be useful. I therefore recorded each EAL student working with one other EAL student, and with one non-EAL student. This meant that 4 EAL and 4 non-EAL students would result in 8 recordings. I therefore selected the 4 Pakistani-background students, as well as four non-EAL students with whom they sometimes worked. My focus on four students from the same language background was based on an observation in Cycle 1 that where students shared a home language, their common cultural experience sometimes became relevant during their discussions.

A second modification was that I dropped the before-and-after arrangement with respect to a class topic, since in terms of patterns of attention, comparisons in this dimension did not show any clear differences. I therefore negotiated to conduct two rounds of recordings, one in the autumn term (Cycle 2) and one in the summer term (Cycle 3). Each round followed an identified topic in which word problems arose. In the autumn term, the topic was division, and in the summer term, measures of length or distance, mass and capacity. Table 6.2 shows the recording schedule for these two rounds. Again, EAL students are shown in bold and all names have been changed.

<i>Autumn term 2000 (Cycle 2)</i>		<i>Summer term 2001 (Cycle 3)</i>	
<b>Date</b>	<b>Participants</b>	<b>Date</b>	<b>Participants</b>
30/11/00	<b>Zeb &amp; Afzal</b>	11/6/01	<b>Tahira &amp; Verity</b>
4/12/00	<b>Shaheen &amp; Benjamin</b>	11/6/01	<b>Shaheen &amp; Benjamin</b>
4/12/00	Courtney & Jackson	13/6/01	<b>Zeb &amp; Courtney</b>
5/12/00	<b>Tahira &amp; Verity</b>	18/6/01	Verity & Benjamin
5/12/00	<b>Afzal &amp; Jackson</b>	22/6/01	<b>Shaheen &amp; Tahira</b>
6/12/00	<b>Zeb &amp; Courtney</b>	22/6/01	<b>Afzal &amp; Jackson</b>
7/12/00	<b>Shaheen &amp; Tahira</b>	25/6/01	Courtney & Jackson
7/12/00	Verity & Benjamin	9/7/01	<b>Zeb &amp; Afzal</b>

**Table 6.2 Recording schedule 2000-2001**

### **Additional data**

My primary interest is in the social organisation of EAL students' interaction as they work with their peers on the task of writing mathematical word problems together.

Nevertheless, I collected several other forms of data, mostly to contextualise the primary

data by building up a background picture of mathematics classroom life in Year 5 and of the circumstances of the EAL students involved, including their educational and linguistic backgrounds.

In terms of classroom life, I collected two forms of data, both selective. Firstly, I video recorded three sets of lessons, each recording a topic around which my audio recordings were based. The purpose of these recordings, which were made using a fixed camera at the back of the classroom, was to provide a record of what took place. The camera was targeted at the front of the class and incorporated around two-thirds of the students within its field of view. This scope was sufficient to record any whole-class work led by the teacher from the blackboard or from a flip-chart, such as the opening mental-oral starter section. Although the camera continued to record during group activity, it only provides a general overview of the classroom; particular conversations cannot generally be distinguished from the hum of noise. The video record was supported by my own presence in these lessons, in which I particularly noted what was written on the blackboard, as this is not clear on a video record.

The second source of data relating to classroom life comes from the considerable amount of time I spent with both Year 5s. Over a period of almost two years, I visited the school on a total of 65 occasions, during which time I observed and participated in numeracy hour lessons as well as several other lessons, particularly literacy hours (English). Although I did not teach the class 'from the front', I participated in classroom activity in other ways, including working with particular groups at the request of the teacher, assisting students who needed help and occasionally joining in class discussions. I also worked with *ad hoc* groups of students outside of the classroom, working on mathematics with a small group of high attainers, or working with a number of students in the school's computer suite, for example. I was frequently invited by the teacher to take part in other aspects of school life, where I could offer an extra pair of eyes and ears. These occasions included the school's sports day, trips to a local museum and to a classical music concert. Through these various forms of participation I got to know the teacher and many of the students. I chatted often with the EAL students, my interest being not only professional, but personal, particularly in the case of students from Pakistani backgrounds. The

students responded warmly and appeared to appreciate my interest in them and their work. They sometimes volunteered information in the course of conversations, talking about going to school in Pakistan, for example. I also became familiar with the classroom culture of the Year 5s, and with their ups and downs as a class, their stresses and achievements. Throughout this period, I kept a journal of field notes and jottings, noting conversations of interest, classroom incidents, thoughts and reflections.

In order to build up a picture of the educational background of the students involved, I also collected a range of other data, including:

- copies of students' work during the video recorded lessons and other relevant lessons, such as when word problems arose;
- copies of students completed summer examination papers;
- audio-recorded interviews with the class teacher at the end of each year, concerning the students' progress during the year.

Regarding the students' linguistic background, I collected:

- records on the EAL students' language proficiency assessments and of the support they had received;
- audio-recorded interviews with the school's EAL co-ordinator about the students involved, providing information on patterns of language use and support in the students' homes based on interviews and visits she conducted as part of her work.

I did not visit students' homes myself: as I am not attempting to relate patterns of interaction in school with patterns from other contexts, further detail is unnecessary at this stage. Indeed, one of the issues my methodology is designed to address is the impossibility of using such background information to say what students mean by what they say. The EAL co-ordinator was able to provide sufficient background information to broadly describe the circumstances of the students.

As contextualising information, I will briefly outline some information about the EAL students who took part in the study, summarised Tables 6.3 and 6.4 (p. 76). The information comes from interviews with the class teacher, the EAL co-ordinator and school records.

Student	Language(s) used at home	English proficiency stage	Time in UK	Schooling	Mathematics NC level based on QCA test
<b>CYCLE 1</b>					
Cynthia	Cantonese	2	18 months	Hong Kong, UK	3
Daniel	Vietnamese	2	UK born		2
Safia	Somali	2/3	18 months	Somalia, Europe, UK	2
Rahim	Punjabi	2/3	UK born	UK	3
Parveen	Urdu, Punjabi	2	18 months	Pakistan, UK	2
Farida	Punjabi, English	2	UK born	UK	2
<b>CYCLE 2</b>					
Zeb	Urdu, Punjabi	2	UK born	UK, Pakistan during extended visits.	3
Afzal	Urdu, Punjabi	2	UK born	UK	4
Shaheen	Punjabi	2	UK born	UK, Pakistan during extended visits	2
Tahira	Urdu	2*	UK born	Pakistan, UK	2
* estimated level since students overseas at time of assessment.					

**Table 6.3 EAL students' backgrounds**

The non-EAL students achieved the following NC mathematics levels based on the QCA mathematics test:

Cycle 1		Cycle 2	
Helena	4	Benjamin	3
Joanne	3	Verity	3
Eleanor	3	Courtney	4
Vicky	2	Jackson	absent

**Table 6.4 Non-EAL students' mathematics attainment**



## **Recording students working**

The school is physically relatively small and crowded. Having decided to record students away from the classroom, I had to be flexible about the locations I used, depending on what was available at the time. Altogether I used 4 different locations. On some occasions, when some classes were away from the school on visits, I was able to use an empty classroom. Most of the recordings, however, took place in one of two small rooms. One, the topic resource room, was a kind of store room which doubled as a small teaching space. It had a window at one end, a door at the other, with the two sides lined with shelves which were filled with boxes of equipment, books and other paraphernalia. It also contained a desk and a few small chairs. The other venue I regularly used was the school's medical room which was slightly larger than the topic resource room, and contained two desks, a set of book shelves and a sink unit.

These details are relevant to the recordings in one respect. I was anxious not to sit in front of the students as they worked on their task, since they would be likely to behave as though I were monitoring their work and seek my assistance. Professional responsibility dictates, however, that the students should not be left unsupervised. My compromise was to introduce the task to the students and then to withdraw from their desk and sit out of their line of sight. I also affected to busy myself with some other task, some item of paperwork or reading, in order to encourage the students to work unsupported, although I was able to note occasional observations. In Cycles 2 and 3, I specifically observed which student was doing the writing, since in my transcription of Cycle 1 I discovered that I could not always be sure of this from the recording. This approach was easier to put into practice when we were working in a classroom since there was more space. The topic resource room, by contrast was rather a squash. Nevertheless, on the whole the students worked independently, sometimes calling on me for clarification of their task, rarely to assist them with the task itself.

Each recording session began with me inviting the relevant students to accompany me out of their lesson. Withdrawing the students was always by prior arrangement with the teacher and took place after the mental/oral start to the lesson and after the teacher had

introduced the group work or individual activity which followed, so that the students would be more easily able to return to their lesson after the recording. We agreed that I should only withdraw students during their mathematics lessons, so that although they were missing part of that lesson, they were still working on mathematics and were not missing part of some other curriculum area. It is for this reason that the recording schedules shown above (Tables 6.1 and 6.2) spread over several days.

Having withdrawn the students and taken them to the recording location for that day, I first introduced the tape recorder, a small 'reporter' type machine with built-in microphone, and explained that I wanted to record them while they worked. Students did not object to being recorded and some asked to listen to the recording after they had finished. Having switched on the recorder, I explained the task and provided the students with one sheet of plain paper and a pencil each. My introduction for Safia and Rahim in Cycle 1, for example was as follows:

#### Extract 6.1

1 RB right// okay/ next week/ the topic for maths is going to be about  
 2 calculators/ okay for year five for Miss T's class/ so/ what I thought I'd  
 3 ask you to do/ is try and make me errm/ two questions/ for using a  
 4 calculator with/ okay/ just to make it a bit easier/ I'd like them to be  
 5 questions about money/ about money/ okay?/ so what I'd like you to do  
 6 is make up two/ you know/ d'you know what a word problem is?/ or a  
 7 story problem?/  
 8 R yeah  
 9 RB yeah?/ yeah?/ okay/ could you could you/ write me/ between you  
 10 together/ on just on one piece of paper/ two/ story problems/ about  
 11 money/ to use next week/ in/ the topic about calculators/ [ does that  
 12 make sense? &  
 13 S [ I know  
 14 RB & yeah? okay I'll just/ I'll go and sit over there and um/ get on with  
 15 something else/ um but if you need me you can/ just ask/ okay? *RB withdraws*  
 IA/IS&R: 19/6/00

By only giving them a single sheet of paper, I hoped to encourage the students to work together, something I also emphasised in my explanation. For some of the recordings, I also provided relevant equipment. In the first year's recordings, which were related to a topic about calculators, I provided a calculator. In the final cycle of recording, which concerned measures, I provided a collection of measuring jugs and cylinders, although I

did not refer to them specifically, instead leaving them on the table for the students to use if they wanted to.

The decision to move to making recordings outside the classroom has implications for my analysis, since although task and groupings reflect those found in the students' lessons, the recording situation is clearly not the same. The very act of withdrawing the students sets up the recording as out of the ordinary. The environments in which the recordings were made were different from the classroom, in particular because they were quieter. The presence of a tape recorder was also different from classroom norms, and was sometimes made relevant by the students, some of whom treated the recording as a performance, chanting their completed word problem into the machine. Others left messages for me or commented that their words would be listened to by me or their teacher. Finally, the recordings were unusual in the amount of time the students were able to work undisturbed on their task, with some pairs spending up to 25 minutes working together without interruption from peers or from the teacher. In pointing out these differences between the recording situation and the students' classroom normality, I am not attempting to argue that these differences have little impact on the students' interaction or that this interaction is in some way comparable to that found in the classroom. Rather, I am acknowledging that there is a difference so that my analysis is seen in its proper context. From a discursive psychology perspective, all talk is situated in particular circumstances and activities (Edwards, 1997, p. 76). Rather than trying to avoid this situatedness, any data should be analysed in terms of what the situation is for participants. I do not see this position as a problem, since any insights that arise from my analysis will be for teachers, researchers or other readers to reflect on in the light of their own experience, rather than as a prescription for their practice (for examples of writing based on this position, see p. 216). Indeed, even if I had been able to record classroom talk between students, no two classrooms are identical, so that the same arguments would apply. My analysis will provide insights and questions rather than off-the-peg solutions.

## **Tapes and transcriptions**

Altogether I collected recordings of 28 sets of students including 26 pairs, of between 10 and 25 minutes each. Most of these recordings are of students audibly working on the word-problem task, though by no means all. In a number of cases, the students became side-tracked from their work for part of the time and discuss various matters ostensibly unrelated to their task. In a few recordings, the students interpret 'working together' as taking turns to make up a problem individually. While one writes, the other sits and waits or begins to amuse themselves with whatever they see around them. There were also occasional technical problems. In one case (Shaheen and Benjamin, Cycle 2, 4/12/00), the two students conducted most of their discussion in a whisper so that very little of their discussion was recorded. Less drastically, parts of some recordings were obscured by various kinds of background noise, some of it generated by the students, by, for example, repeatedly tapping their pencil on the table. Finally, on one occasion, the participants became interested in the workings of the tape recorder and briefly adjusted the speed control and the pause button, thus affecting what was recorded. Despite these various occurrences, I endeavoured to transcribe as much of the recordings as possible.

## **The transcription process**

As I indicated at the start of this chapter, transcription is an interpretative process. In transcribing my recordings, I interpreted the sounds of the tape being played back and represented those sounds in written form, itself a form of interpretation. Any reader of these transcripts must themselves also interpret what they see on the page. How a transcript is set out will influence that interpretation (Ochs, 1979). A key consideration in developing a transcription method is the approach to analysis which is to be used. An important issue is the degree of detail to be shown. By using audio recording, a great deal of visual detail, such as facial expression or direction of gaze, is already lost. Talking is nevertheless a complex process involving variation in sound, volume, intonation, accent, silence and other factors. The extent to which some of this variation is represented in my transcripts is the result of a process over a period of time. I first adopted a relatively simple form of transcription, based on that of Mercer (e.g. 1995) designed primarily to

show the content of talk. This approach, which was used to transcribe video data, uses a script-like layout and roughly indicates emphasis and pauses. An additional column is included for comments and observations of behaviour. It is relatively easy to read, since it uses few symbols and words are represented using standard spellings as much as possible. Although I modified the transcription conventions slightly, in the light of my work on the transcript of Cynthia and Helena, adding, for example, a marking for whispered speech, in general I found this approach showed sufficient detail for my present purposes. Since this dissertation records the first stages in the development of an approach to analysis, it may be that as this approach is taken forward in future, more detailed transcriptions will be necessary. At this, stage, however, the present system is sufficient (a full description of the conventions used is shown in Appendix I, pp. 217-221).

The process of transcribing is a time-consuming one. Being an interpretative process, transcribing is never complete and never perfect. My aim, therefore, was for consistency rather than perfection. My method was as follows. I first transcribed a single recording by hand, using pencil and paper. This slightly old-fashioned approach meant that I was able to concentrate on the words of the students without needing to think about the layout of the text. It also meant that I could easily erase or correct my first impressions. This proved necessary, particularly when both students in a pair spoke at once, which occurs frequently in the recordings [18]. These occasions required repeated listenings, as did those in which the students spoke very quietly or whispered. I was sometimes able to enhance the reproduction of their voices by playing the tape on a domestic stereo system and adjusting the graphic equaliser to eliminate some frequencies, although I still could not decipher everything the students said. Having produced a written draft, I played the tape through and made any corrections that arose. I then typed the transcript. An advantage of this unorthodox method is that on completion of a typed transcript, I had become very familiar with the contents, having spent considerable time working on it on two separate occasions. Subsequent reading of the typed transcripts has revealed occasional typing mistakes, which are corrected, after checking the tape if necessary.

## **Ethical issues**

A number of ethical issues have arisen in the conduct of this study. These concern the issues of working with children, interference with students' education, anonymity and the background of the students. My access to the school and to the students was granted by the headteacher and class teachers acting *in loco parentis*. I worked closely with the class teacher and discussed with her my ideas, proposed actions and the course of the research. The teacher had, and sometimes exercised, a right of veto over my activities. I was concerned from my first visits to the school, that I should not see my research as involving the impersonal extraction of data from a school, with nothing offered in return. As a teacher, I therefore offered my assistance to the class teacher in whatever way she chose. As well as the various modes of teaching support described earlier in this chapter, I was able to act as a form of discussant for the teacher, who particularly valued the opportunity to talk and think about her students and her teaching with someone less confined by the rigours of a busy teaching schedule than her hard-working colleagues. I have also provided the school with copies of relevant publications arising out of this work. In these modest ways, I contributed something to the education of the students in Year 5 and the school as a whole.

By withdrawing students from their lessons, I was concerned that I should not detract from their education. Some of the participants were recorded on four separate occasions, amounting to as much as two hours of class time. As I reported above, I negotiated with the teacher, so that students were only withdrawn from mathematics lessons and were working on tasks relevant to the classwork they were missing. The only exceptions to this practice was on one or two occasions when the class was not engaged in its usual classroom activity, such as when rehearsing a dance performance, an activity which did not involve all of the students at once.

I discussed the issue of anonymity with the headteacher once it was confirmed that I would be working with Year 5. We decided that anonymity should be maintained throughout the research and publication process. As a result, all names in this dissertation and other publications are pseudonyms. This has meant that I cannot play any of the

audio or video recordings, as part of discussions with colleagues or in conference presentations, for example. I have also been careful not to name the school in conversations with colleagues, so that only a handful of people know which school was involved. I do not believe anything I have said or written about the school would give a negative impression. Nevertheless, once words reach the public domain, it is not possible to prevent them being interpreted in unexpected and perhaps undesired ways.

A final ethical issue concerns the backgrounds and experiences of some of the students involved. Amongst the EAL students were several who have led relatively unsettled lives, travelling between several countries and sometimes living in difficult and dangerous circumstances. I have avoided probing students about their past experience of education, for example, or about when and where they use different languages, since I may inadvertently bring up difficult and possibly traumatic issues which I do not feel myself qualified to discuss. I have not therefore, for example, interviewed students directly. Furthermore, I have been mindful of this issue whenever I have been engaged in conversation with students. On occasions, students have raised such subjects themselves and I have found such discussions interesting and informative, but I have nevertheless avoided probing questions.

## **Summary**

In this chapter, I have given an account of what data I collected and of how I collected it. The primary data consists of 28 recordings of pairs or small groups of Year 5 students working on the word problem task, collected in 3 cycles from two different groups of students. These students included children from bilingual or multilingual Somali, Hong Kong Chinese, Vietnamese, and Pakistani backgrounds, as well as monolingual English-speaking children. Additional data includes photocopies of students' work, video recordings of some of their lessons, interviews with teachers and field notes of observations made over my own regular visits to the students' mathematics lessons. The audio recordings of students' work on the word problem task have all been transcribed in some detail. In collecting this data, I took care not to detract from students' mathematics

education, and indeed endeavoured to contribute to it myself. I also took care not to probe students for accounts of potentially traumatic experiences.

In this first part of the dissertation, I have developed my questions, as well as raised important methodological issues concerning the interpretation of the words and actions of students from diverse linguistic and cultural backgrounds. In Chapters 4 and 5, I have developed a methodological and theoretical approach to the treatment of interaction which addresses these methodological concerns. This approach is based on the notion that participants in interaction display attention to relevant concerns as part of the social practice of talking. This attention is deployed rhetorically. By describing patterns in participants' attention, and then examining how this attention is used in interaction, I can say something about how EAL students and their peers use language to think about mathematics and make sense of mathematical talk. In order to do this, I will address the more specific questions set out at the end of Chapter 5:

- What patterns of attention can I identify in students' interaction as they write word problems together?
- How is attention used by students in their work together?

My analysis of students' work on the word-problem task, through which I will address these questions, forms the subject of the second part of this dissertation. In the next chapter, I identify and describe a number of patterns of attention in students' interaction. In Chapters 8, 9 and 10, I explore how three of these patterns are used by students in interaction. Chapter 11 returns to my questions in the light of this analysis and considers the implications of my findings in the light of the literature reviewed in Chapter 2 and the methodological issues raised there.



## **PART TWO**

## Chapter 7

### Four patterns of attention

The purpose of this chapter is to describe, and provide evidence for, four patterns of attention identified in my analysis of the recordings made in this study. The chapter consists of four sections, one devoted to each pattern. Each section begins with a short discussion of the conceptual background which underpins the identification of the pattern of attention in question. The first pattern of attention I deal with, for example, is a pattern of attention to genre, in this case the genre of mathematical word problems. Before setting out evidence for this pattern, therefore, I briefly discuss the nature of this genre in a general sense. This discussion then informs my analysis. Following this conceptual introduction to each section, I set out evidence for the pattern from the transcripts. Before proceeding to the first pattern of attention, however, I will give some indication of how I worked with the transcript data to develop my analysis.

The full set of 28 recordings resulted in some 153 pages of transcript on my part and around 85 word problems on the part of the students who participated. Given the detailed nature of my analytic approach, the transcripts amount to a large quantity of data. How did I work with so much data? Initially, I concentrated on a small number of transcripts, particularly those featuring the work of Cynthia and Helena. In doing so, I was able to draw on a degree of familiarity with all the first set of transcripts (cycles 1A and 1B, summer 2000) gained from the process of transcribing the recordings as described in Chapter 6. This familiarity meant that although the interaction of Cynthia and Helena was subject to an intensive search for patterns, I also had a sense of the body of data as a whole. Thus, the patterns which emerged as I studied the transcripts of Cynthia and Helena resonated with patterns across several transcripts. From this initial analysis

(developed in Barwell, 2000c, 2000d, 2001a, 2002a, 2002b), two patterns of attention emerged which I was then able to look for and refine in the wider set of data. A similar process of moving between a small number of transcripts and the whole set led to the identification of two further patterns of attention (developed in Barwell, 2001b, 2002b). Having established the nature of each pattern of attention, I was in a position to work systematically through the full set of transcripts, identifying sequences of interaction which exemplified each pattern. I photocopied and marked these sequences and filed the copies, so building up one file for each pattern of attention (see Wetherell & Potter, 1992, for a similar approach). In some instances, the same sequence of interaction appears in more than one file, since patterns of attention do not lead to a mutually exclusive classification of the students' exchanges. For the same reason, it is not the case that every line of interaction is an example of one of the four patterns discussed in this chapter. There are certainly other patterns of attention displayed in the students' talk, though in these transcripts they are less salient (to me). Indeed, I cannot claim that every possible example of each pattern of attention has been copied and filed. My analysis is not an exercise in coding data in the mode of, say, Sinclair & Coulthard (1975), who developed extended frameworks of utterance categories designed to code comprehensively any classroom interaction. Rather, I am seeking evidence to support a claim that these four patterns of attention are present in the interaction of the students involved in this study. This evidence, the sequences filed under each pattern of attention, will then provide the basis for the next stage of analysis, in which I move on to consider the questions which emerged in Chapter 5. These files also form the basis for the evidence which is presented in this chapter. Space does not permit me to present every sequence from each file. Instead, I offer an illustrative selection which highlights the nature of the pattern and its identification. Although these illustrative extracts from the data will often be quite short, it should be kept in mind that I did not select these extracts and then analyse them. Rather, I examined whole transcripts from which these extracts have been selected to highlight what I saw. The first pattern to be addressed is of attention to genre.

## Attention to genre

The notion of genre was proposed by Bakhtin (1986, pp. 60-61) to refer to 'relatively stable' patterns of language in use. Such patterns included those which characterise recognisable types of text. Written genres include novels, letters, poems and school reports, for example [19]. The discourse of mathematics classrooms (see Pimm, 1987) includes various written genres, including those produced by students, such as their solutions to problems or longer investigative pieces of work (see Morgan, 1998). Students also encounter written mathematical genres such as mathematical questions or problems which are generally imported into the classroom via textbooks or assessment documents. Students are expected to solve many written problems of various types, but are rarely asked to prepare their own (see, for example, DfEE, 1999).

Arithmetic word problems are an example of a written mathematics classroom genre and are a form of mathematical task widely used around the world and across different historical periods (Gerofsky, 1996, p. 36; Mason, 2001a; Verschaffel, Greer & de Corte, 2000, p. xi). The following is a recent example from an English national mathematics test taken by both groups of students involved in this study in May of the relevant year:

Mrs Patel buys **4 milkshakes costing 65p each** and **3 sandwiches costing £1.70 each**.  
Work out the **total cost** (QCA, 1998, bold type in original).

I have found in work with primary school students and teachers in the UK that word problems appear to be instantly recognisable as a type or genre even from one example. This may be related to the prevalence of word problems in the exemplar questions shown in the National Numeracy Strategy (DfEE, 1999). What, then, are the features that make such problems so recognisable?

The generic (genre-related) nature of mathematical word problems has been examined by Gerofsky (1996, 1999), who identified a number of features, of which I want to focus on two.

1. A three-part structure, consisting of a 'set-up' to establish a scenario or minimal story-line, a number of items of information and a/some question(s) (Gerofsky, 1996, p. 37). In the case of the example above, the set-up consists of little more than 'Mrs

Patel buys'; some problems begin with an introductory sentence to set the scene. The problem continues by providing several items of information: 4 milkshakes, 65p each, 3 sandwiches, £1.70 each. The problem concludes with a 'question', in this case in the form of an instruction: 'work out'.

2. The scenarios which contextualise word problems have only a general bearing on the information components of the problem (*ibid.*, p. 41). Such information is therefore interchangeable and whole classes of problem are possible within the same scenario. So, for example, Mrs Patel could buy 5 milkshakes costing 50p each or any number of milkshakes costing more or less anything.

Gerofsky (1996) is not arguing that all word problems fit neatly into this characterisation. Rather, her work shows that such problems in general fit into some form of pattern and suggests some of the features we *may* expect to find. As her work is based on a particular sample of problems, there may well be differences with the problems encountered in Cynthia's mathematics class. In examining the transcripts, I am not, however, attempting to find out what the students think (in their heads) what a word problem is. Nor am I interested in setting the problems they write against Gerofsky's list of features to see how they compare. I have already observed that in writing their word problems, the students involved attend to 'what a word problem is like' (Chapter 4, pp. 46-48). In effect, they attend to various generic features of word problems as they see them. Let me illustrate this point with the following extract, in which two students, Farida (EAL 2) and Parveen (EAL 2), are starting the first problem of their first recording:

### Extract 7.1

84	F	do we have to do like this?/ um/	
85	P	no we have to write it/ if we have fifty p. like this/ those sort of things/	
86	F	like/ like this	<i>RB</i>
87			<i>withdraws</i>
88	P	yeah// yeah//	<i>writing</i>
89	F	add/ um//	
90	P	not add/ Farida	
91	F	what?	
92	P	you have to write you know you know how we write it look/ look/ we	
93		write// we did it last time if you/ have// twenty sweets	
94	F	oh right// and [ give away/ give/ give away five	<i>rubbing &amp;</i>
95	P	[ and you	<i>writing</i>
96	P	and you/ give//	
97	F	away five	
98	P	give/ away/ five/ no no not five/ eight	<i>writing</i>
99	F	eight	

100 P eight/ how many/ have you left/ like this/ oh//  
 101 F (*sound of agreement*)  
 102 P have/ you/ left *writing*  
 103 F and they bought/  
 104 P you give an answer and you said finished/ then you er do another thing  
 105 like that sort of thing yeah?/  
 1A/2F&P: 20/6/00

Farida asks if they have to “do like this” (line 84) to which Parveen responds by giving a brief example of what they should do, “if we have fifty p.” (line 85). Farida begins to write down a problem, seeking confirmation from Parveen that she is doing what Parveen expects. As she continues to write, she proposes using the word ‘add’ (line 89) which prompts Parveen to reject it. ‘Add’ is “not how we write it” (line 92), at least not in the context of what Farida has written so far. At this point the two students have not reached a common position on what kind of thing they are writing. Parveen proposes a new beginning for a problem, “if you/have// twenty sweets” (line 93), which Farida is able to continue, “and give away/ give/ give away five” (line 94). This continuation is accepted by Parveen, although she negotiates how many are given away, preferring eight (line 98).

In this negotiation, both students are attending to the generic detail of how many sweets are given away. No explicit justification is given for either five or eight sweets and the choice of eight rather than five has no explicit effect on the subsequent development of the problem. The choice is, in effect, arbitrary, with either number producing an equally suitable word problem. I could speculate at this point that for Parveen the subtraction  $20 - 5$  is too simple, but there is no evidence for such a claim and cannot therefore consider it. I can, however, consider what effect Parveen’s proposal has in the two students’ interaction. One clear social effect is that by changing five to eight, Parveen maintains her control over the problem. Having proposed a scenario to Farida, who is constructed as being in a position of ignorance, I can observe that in continuing Parveen’s set-up, Farida is gaining some control over the problem, which now (line 94) includes an idea of her own. By proposing and gaining acceptance for an alternative number of sweets, Parveen reasserts her ownership of the problem, and maintains Farida in a subordinate position. Parveen can do this without giving an explicit justification for her change from five to eight because in the genre of word problems, as the two students reproduce it, such details are interchangeable (Gerofsky, 1996, p. 41). Once the two

students have accomplished this change, Parveen provides a question for the problem, "how many/ have you left" (line 100) which Farida accepts. For Parveen, the question completes the problem, as indicated by her rejection of Farida's attempt to add a new part of the problem (line 103): "you give an answer...then you er do another thing" (line 104).

From this extract, we get some indications of the kind of features which are relevant to the two students in writing a word problem, without needing to know what is in their heads. Attention is paid to a set-up, a development of the set-up, including further numerical information, and a question which completes the problem. Two set-ups appear in the extract, though only the second leads to a jointly acceptable development. The first is "if we have fifty p." and the second "if you have twenty sweets". Both include numerical information. The development, giving some sweets away, involves a change to the situation given in the set-up, and includes further numerical information. Finally the two students attend to the question and establish its status as the conclusion of the problem. Much of this work appears to be initiated by Parveen. Farida nevertheless is implicated in the development of the problem, both through her own contributions (e.g. "give away five", line 94) *and* through her acceptance of Parveen's ideas. Farida's utterances are implicated in the two students' attention to generic aspects of the problem, shown by her agreements (line 99) and repetitions of Parveen's words (lines 97, 101). Their word problem is a joint accomplishment.

Extract 7.1 illustrates a number of generic features attended to by many of the participants in this study. In the rest of this section, I will focus on the students' attention to three of these features: set-ups, numerical information and concluding questions.

### **Attending to set-ups**

The vast majority of the problems written by the students who took part in this study begin with consideration of a set-up. These set-ups are tacitly accepted as the starting point for discussion. Many are of a locational nature, being about shops, morgues or burger restaurants, for example:

### Extract 7.2

88 S um/ Chris  
89 R (...)  
90 S Chris/  
91 R Chris  
92 S spelt that wrong  
93 R (...)  
94 S yeah/ Chris/ went/ to/ the/  
95 R shops  
*1B/1S&R: 11/7/00*

### Extract 7.3

49 J I know I need (...) there was/ there was fifty people/ in/ the/  
50 A (...)  
51 J swimming  
52 A swimming pool  
53 J swimming pool/  
*2B/5A&J: 5/12/00*

### Extract 7.4

27 T if [ um  
28 S [ if five peo-ple  
29 T peo-ple/ (*laughs*) people/  
30 S ummm/  
31 T five people went to a shop  
*2B/7S&T: 7/12/00*

In Extract 7.2, Safia and Rahim's (both EAL) set-up involves shops, as does Shaheen and Tahira's (both EAL) in Extract 7.4. In Extract 7.3, Afzal (EAL 2) and Jackson (non-EAL) refer to a swimming pool. Although different students involved different locations in their set-ups, the presence of such a location was implicitly acceptable to all. Such locations can therefore be seen as an unremarkable feature of such problems. Another common starting point, as with Farida and Parveen (Extract 7.1) is set-ups of a material nature, being about sweets, money, or pencils for example, as in Extract 7.5 (below). The material and the locational are sometimes combined, as in Extract 7.6:



### Extract 7.5

47 Z um/ do another one  
48 A now which one/ errr if there's a hundred/ if there's err/ if there's ten  
49 busses/ bus-ses/  
2B/1Z&A: 30/11/00

### Extract 7.6

36 C nine brains/ no  
37 J what's that  
38 C pardon?!/ no no/ yeah=yeah=yeah yeah=yeah/ okay then/ there're a *writing*  
39 hundred an' eighty brains// in the morgue//  
2B/3C&J: 4/12/00

Set-ups do not always pass without challenge. In the following extract, for example, Safia and Rahim consider several options as they negotiate a locational setting for their problem:

### Extract 7.7

182 S I know/ two hundred people were in the cinemas/ and/ one/ mm/ that's  
183 easy actually/ and then one thousand people/ were/ at/  
184 [ the mall/ no/[ at Ikea  
185 R [ (...) [ (...)  
186 yeah Ikea  
...  
200 R [ three hundred people went/ in  
201 S at/ the/  
202 R cinema (...) do  
203 S at the  
204 R at the/ seaside/ beach/ beach  
205 S beach/ beach/ and err/ one thousand  
1B/1S&R: 11/7/00

Although Safia and Rahim consider a variety of possible places as a setting for their problem, however, including cinemas, IKEA and the beach, their attention is consistently on this generic aspect of their word problem.

As the preceding extracts illustrate, the first step for the students in this study in writing a word problem is to come up with a set-up, which is therefore one of the generic features of their word problems. Their set-ups generally consist of a locational or material situation and generally include an item of numerical information. There are variations,

however, in how the students produce their word problems and in what they produce. 4 of the groups involved in Cycles 1A and 1B, for example, focus on agreeing a name for the character or characters to appear in their word problems, as in the following extract involving Safia (EAL 2-3) and Helena (non-EAL):

Extract 7.8

35 H what- name a name/ what name/ say a name  
 36 S you say it first/  
 37 H a name?/  
 38 S I can't think of one  
 39 H okay then// Vicky?  
 40 S (*laughs*)/ nah// (*sighs*)/ um/ my one is Indiana Jones  
 41 H (*laughs*)/ name a name// a boy name or a girl name  
 42 S girl/  
 43 H Leanne/ yeah?/ what else?/ how many people  
 1A/SS&H: 21/6/00

Again, although Helena and Safia negotiate what the name should be, the idea that they should have a name is taken for granted. Most of the problems produced by the 4 groups in Cycles 1A and 1B have named characters. The groups in Cycles 2 and 3 by contrast produced no problems with named characters [20] (see Appendix III, pp. 231-237, for students' problems). In all the recordings from these two cycles, there is only one reference to using named characters, from Jackson (non-EAL) and Afzal (EAL 2):

Extract 7.9

39 J this meant to be distance and capacity  
 40 A I know/ so that/s like um like juice/ like water  
 41 J tha's liquid  
 42 A I know  
 43 J let's do distance first *writing*  
 44 A let's choose a name  
 45 J how far it gets/ how far it takes/ to get to London  
 3B/6A&J: 22/6/01

Afzal proposes choosing a name (line 44) as an alternative course of action from Jackson's proposal. Afzal's suggestion is not taken up however, and no name appears in the problem in question. If names do not appear in the set-ups of Cycles 2 and 3, what are they like? In these groups, many of the problems begin with 'if', in expressions like 'if

you had...' or 'if there were...', as in Extracts 7.3 and 7.4. Finally, some problems written by students from both classes have set-ups which are incorporated into an item of numerical information, such as when Courtney (non-EAL) proposes "nine dinosaurs get hit by a meteor" (2B/3C&J: 4/12/00), an opening in which the set-up is 'nine dinosaurs' which moves straight on to the development 'get hit by a meteor'.

I have devoted considerable space to discussing the students' attention to what is a small part of a word problem. This discussion is merited for a number of reasons. Firstly, although the set-up is a small part of the students' word problems, sometimes only a couple of words, it literally sets up the ensuing deliberations, since the development and question for the problem must relate to the set-up. Secondly, the range of different openings used by the students demonstrates the diversity available within the word-problem genre as produced by these students. The variation between groups in how the students begin their problems suggests that they are not simply mechanically reproducing problems they have experienced, but are drawing on different aspects of their experience in a creative way. For several of the students from Cycle 1, this entails having a named character, for example, whilst for those involved in Cycles 2 and 3, it does not. I cannot conclude from this difference that the two groups of students have a different idea of what a word problem is like, only that they attend to different features of the word problem genre as they see it on the occasions in which I made the recordings. Despite this variation, however, it is clear that in all the recordings the students explicitly attend to the set-up of their problems. They then move on to the development of their problems, as the next sub-section shows.

### **Attending to numerical details**

As the discussion between Farida and Parveen (Extract 7.1) illustrates, a second feature of word problems which students attend to is the numerical information to be arithmetically combined in some way. As Gerofsky (1996, p. 41) observed, such information is somewhat arbitrary with respect to the basic scenario created by the word problems. It makes little difference to the story if there are 5 sweets or 8 sweets. In writing their own word problems, the students in this study regularly attend to the

numerical details of their problems, displaying an interpretation of the role of these details as arbitrary within the word problem scenario. Much of the numerical information of the students' word problems is introduced with the set-up, as the preceding extracts show (e.g. Extracts 7.5-7.7). Subsequent details are included with the development of the scenario. These details are frequently included with no specific justification and are accepted without challenge, thus indicating that the inclusion of numerical information is unremarkable and that the specific values which are used need not or cannot be justified on generic grounds, although justification may be sought on non-generic grounds, as I shall show in Chapter 8. Indeed even where numerical details are explicitly negotiated, the grounds for such negotiations are arbitrary. In the following extract, for example, Safia (EAL 2-3) and Helena (non-EAL) negotiate how much money they and their friends have on a trip to the cinema. The negotiation turns into a kind of auction:

Extract 7.10

29	H	Emily Helena Davina Alison Vicky Safia and Farida went to the	
30		(movies)	
31		( <i>whispering</i> )	
32	H	they each/ um/ how much money do we have/ seventy quid	
33	S	fifteen	
34	H	fifteen pound?/ where?	
35	S	um/ let's say/ fifty	
36	H	eighty/	
37	S	ninety	
38	H	hundred/	
39	S	hundred and ten	
40	H	( <i>laughs</i> ) okay	
41	S	(...) one hundred/	
42	H	each had/ two hundred and fifty/ no	<i>extended</i>
43	S	two hundred and fifty?	<i>calculator</i>
44	H	yeah/ each/ each had ninety/ eight pounds/ seventy/ no/ ninety eight	<i>use</i>
45	S	ninety eight pound what?/ seventy	
46	H	no/ ninety eight pound sixty/ (ninety eight pound) sixty three/ ninety	
47		eight	
48	S	how much time d'you have to do	
49	H	I said ninety eight in the first place/ ninety one/ ninety point	
50	S	no-o-o	
51	H	just ninety?	
52	S	ninety/ eight/	
53	H	oh ninety eight	
54	S	um/ sixty/ three	
55	H	ninety eight pound sixty three	
56	S	four	
57	H	sixty one	

58 S look what I just done  
 59 H ninety eight pound/ sixty four/ pence  
 60 S pence?  
 61 H ninety eight [ pounds and sixty pence  
 62 S [ oh/ sorry  
 63 H sixty p./  
 IB/4S&H: 12/7/00

Following the auction (lines 33-41), which ends on £110, Helena reopens the negotiation by offering a new figure of £250 (line 42) which is questioned by Safia, followed by £98 (line 44). This last amount is accepted by Safia (line 45) and the two students then negotiate the number of pence to be included. At no stage is any explicit justification given for any particular choice of number. So what is achieved by such arbitrary negotiations? What emerges from the two students' discussion is a dominant position for Helena, who responds to each of Safia's suggestions by offering an alternative of her own. Safia, meanwhile, is constructed as conceding ground throughout the discussion. As in the case of Farida and Parveen (Extract 8.1), whilst Safia and Helena continue to attend to genre, there is no obvious way to challenge Helena's different figures, since any of them would lead to an acceptable word problem.

### Attending to concluding questions

The final aspect of students' attention to genre I wish to illustrate is their attention to the questions which conclude their word problems. The students conclude all their problems with a question of some form. As with their attention to numerical details, often the initial question proposed by one of the participants is accepted without challenge so that such concluding questions can be seen as normal and unremarkable for the participants. Indeed, on one occasion, when one student, Afzal (EAL 2), suggests a word problem which does not include a question, his partner, Zeb (EAL 2), is prompted to add one:

#### Extract 7.11

29 A yeah two hundred and five/ two hundred and five// eggs// eggs/ two *writing*  
 30 hundred and five e- two hundred and five eggs/ um/ and/ and how much  
 31 breaks?/ about/ a hundred and thirty five/ a hundred and thirty five (...)  
 32 Z eggs break  
 33 A a hundred and/ twenty/ five/ eggs/[ eeeggs//eggs/ break/ two &

34 Z [ break  
 35 A & hundred=and (...)/ breaks// now what shall we do now  
 36 Z how much left  
 37 A nooo/ oh yeah/  
 2B/1Z&A: 30/11/00

Afzal writes down his word problem about eggs and, having completed the development, is ready to move on to a new problem “now what shall we do now” (line 35). Zeb, however, offers a question to complete the problem (line 36), a proposal which Afzal considers rejecting, “nooo”, supporting the interpretation that he had already completed his problem, before finally accepting Zeb’s addition, “oh yeah” (line 37). In this case, there is no negotiation of what the question should be. In some cases, however, the participants consider alternatives, as with Safia (EAL 2-3) and Helena (non-EAL) in the following extract:

Extract 7.12

86 H Leanne went to a rock and roll concert it cost/ eleven pounds fifty for  
 87 one person/ and there was/ twelve thousand one hundred and sixty three  
 88 people there when the/ show started and the doors were closed/ how  
 89 much money  
 90 S did they raise?  
 91 H how much money did/ how/ much/  
 92 S how much money is it alto-/ is it altogether/[ how much  
 93 H [ how much money/ does  
 94 everybody pay together//  
 95 (5 secs)  
 96 S (...)  
 97 (5 secs)  
 1A/5S&H: 21/6/00

The two students consider three possible questions, with Helena constructed as the student who decides which is suitable, much like the negotiation with Safia of the numerical details of another problem (Extract 7.10). Safia’s initial suggestion, which completes the phrase “how much money” supplied by Helena (line 89) seems to be appropriate but Helena rejects it by returning to “how much money”. Once again Safia completes the phrase and once again Helena rejects it, this time completing the question herself. Thus, as was the case with the negotiation of arbitrary details, consideration of the concluding question is as much about the production of a social relationship as it is about the production of a word problem. In this case, none of the three questions

proposed was challenged as unsuitable, something that rarely happens in the recordings. On one occasion, however, Zeb (EAL 2) challenges a question which does not appear to be suitable to him:

### Extract 7.13

- 89 C I have a hundred and fifty cars in my business/ group these  
90 into three groups see if you're clever//  
91 Z that don't even make (damn) sense  
92 C yes it does  
93 Z what's the question then?  
94 C huh/ group hundred and fifty into three parts/ now have your  
turn//  
95 Z oh yeah I (...)  
*2B/6Z&C: 6/12/00*

Zeb rejects Courtney's (non-EAL) problem on the grounds that it "don't even make (damn) sense" (line 91). It is not clear from these words what exactly he is arguing does not make sense to him, something that is clarified by his next turn, "what's the question then?". Zeb's words evaluate Courtney's proposed word problem as not having a question, possibly due to the final part of the problem "see if you're clever" (line 90). Courtney clarifies by stating the question more explicitly (line 94), including the relevant numerical detail from the problem's set-up, a clarification which Zeb accepts.

### **Summary**

In this section, I have set out and discussed some of the evidence for a pattern of attention to genre displayed by the students in the recordings. Throughout these recordings, the participants regularly attend to various generic features of word problems, including the set-up and development, the concluding question and the numerical details. My examination of this attention indicates the variety of manifestations of these various features in the students' interaction and problem production. The specific nature of any of these features varies from recording to recording and emerges from the discussions of the participants. My examination of students' attention to genre also illustrates how all the various features of a word problem are open for negotiation during the writing process,

although not every aspect is negotiated in every case. Such negotiations are social processes, implicated in the on-going conduct of the social relationship between participants. Since writing word problems is the task the students are faced with, their attention to the generic features of such problems provides a platform for their work together, and as such a form of 'default' focus of attention. In writing their word problems, however, the participants also attend to a number of other areas. The first of these to be considered is the attention they display to what I shall refer to as narrative experience.

### **Attention to narrative experience**

As Edwards (1997) observes, "one of the things that people do in discourse is recall and recount events in their lives" (p. 263). Such recollections or recountings are examples of narrative accounts. Bruner (1990) suggests the following constituents characterise such accounts:

A narrative is composed of a unique sequence of events, mental states, happenings involving human beings as characters or actors (Bruner, 1990, p. 43).

He goes on to argue that narrative forms the predominant way we experience, and indeed create, reality: "we live most of our lives in a world constructed according to the rules and devices of narrative (1996, p. 149). One of the features of Bruner's notion of narrative is that "actions have reasons" (1996, p. 136). Such reasons include beliefs, values or desires, for example. Indeed, for Bruner (1990), one function of a narrative account of a particular situation is to resolve differences in interpretations of human behaviour by finding an "intentional state" (pp. 49-50) which accounts for the behaviour at issue. I can make sense of what people do if I can construct an account for why they did it. For discursive psychologists, interest in narrative accounts is focused on how such accounts are constructed in interaction, and in what is accomplished by constructing an account in a particular way (Edwards, 1997, p. 269). One aspect of such accounts, for example, especially those which purport to be true or correct, is that they include accounts for the facts of the story. Details are not merely stated but backed up, through



corroborating evidence, for example, or through demonstrations of the reliability of the teller, such as, for example, presenting a 'vivid description' (Edwards & Potter, 1992, pp. 160-163; Chapter 5, p. 63).

Typically, in word problems, including those written in this study and those used in the National Numeracy Strategy, reasons are not given for the actions and events which take place or the facts which are included. Indeed, as Gerofsky (1996, p. 41) points out, such facts are generically not important. Mrs Patel buys her milkshakes and sandwiches but we are not told why she does so, who the milkshakes are for, what she thinks of the price, or any other explanation or accounting for what happens. Although such accounts or explanations do not appear in the students' written problems, there are occasions during the discussion around the production of these problems when they do attend to such factors. Since accounts and explanations are not part of the students' versions of the word problem genre, however, I will characterise this attention as distinct from their attention to genre. I will use the term *attention to narrative experience* to describe this pattern of attention, since such attention draws, sometimes explicitly, on students' narrative experience of why things happen and why people do what they do.

Students' attention to narrative experience does not occur as frequently as their attention to genre. Most examples in Cycles 1A and 1B involve Safia, Cynthia (both EAL) or Helena, who worked with both these students. One extended example also arises from Eleanor and Vicky (both non-EAL). In Cycles 2 and 3, it is the pairing of Zeb and Afzal (both EAL) which supplies almost all instances of this pattern of attention. The groups involving these students make up six out of fourteen combinations of students employed in the study, suggesting that attention to narrative does not arise in every discussion. This is not surprising since the students' task is to write word problems, so that they must necessarily attend to the nature of word problems. Since the genre of word problems does not generally require motives or explanations for events or actions, however, there is not necessarily any reason why attention should be devoted to narrative accounts. Of course, I can only analyse what is made explicit, what is spoken. It may be that individual students use narrative considerations in their own thinking. If this is the case, they do not often make them public. My interest is not, however, in what is going on in students'

heads. I am interested in how students write word problems through discussion with their peers, with the focus on the nature of that discussion, on what it is possible to use as part of the public process of writing and solving a word problem. In the rest of this section, I will illustrate this pattern of attention with examples from two of the transcripts.

### **Attending to narrative experience**

There are a number of occasions in the recordings when narrative accounts or explanations appear as brief comments in the students' discussions. In the following extract, for example, Rahim (EAL 2-3) attends to narrative experience to account for Safia's (EAL 2-3) suggestion of the cost of a packet of crisps:

#### Extract 7.14

109 R crisps/ yeah/ crisps/ which cost/  
110 S which cost  
111 R thirty p.  
112 S four pound each  
113 R (four pounds)/ because they're big  
114 S four pound/ four pound/ each  
*IB/IS&R: 11/7/00*

As they construct their problem, Rahim suggests 30p as the cost of the crisps (line 111). Safia instead proposes "four pound each" (line 112). Rahim accepts four pounds, but accounts for this value, "because they're big" (line 113). It appears that he is particularly accounting for the much higher cost that Safia has proposed. Whatever Rahim means, however, he is clearly accounting for the use of £4 instead of 30p, and he does so using narrative rather than, say, generic ('word problems don't have £4 packets of crisps') or mathematical ('£4 will make the mathematics unsuitable in some way') grounds. A similar accounting for the choice of a value occurs later in the same transcript. The two students are starting on a new problem:

### Extract 7.15

182 S I know/ two hundred people were in the cinemas/ and/ one/ mm/ that's  
183 easy actually/ and then one thousand people/ were/ at/  
184 [ the mall/ no/[ at Ikea  
185 R [ (...) [ (...)  
186 yeah Ikea  
187 S Ikea is big/ last time I went there it was too crowded/ number three/  
188 right/ three hundred people  
*1B/IS&R: 11/7/00*

Safia proposes that “one thousand people/ were/ at/...Ikea” (lines 183-184). In word-problem terms, one thousand is as good a number of people as any other. Safia, however, supports her suggestion by first arguing that “Ikea is big,” and then supporting this claim in turn by giving an account of having visited Ikea herself, “I went there it was too crowded” (line 187). This account both supports her claim that Ikea is a big shop and consequently that one thousand people is a plausible number. It does so in two ways: firstly, she uses vivid description (Edwards & Potter, 1992, p. 161) to demonstrate eyewitness reliability for her claim that the shop is big, description which include, for example, the claim that the shop was crowded. I cannot, of course, know whether Safia has ever been to Ikea or if she did, whether it was crowded. Indeed, I have never been to Ikea myself and could not support or refute Safia’s claims. I could attempt to do these things, but that would be to miss the point. Regardless of the accuracy of Safia’s claims, I can see that she is accounting for her suggestion of one thousand as a numerical detail of the word problem she is writing with Rahim. Again, this kind of accounting, involving accounts of personal experience and reliability, entails an attention to narrative concerns. These two extracts are characteristic of most of the occasions when attention to narrative arises, in that this attention is related to consideration of the validity of a numerical detail in the emerging word problem. Such attention is not always displayed so briefly, however. In the following extract, for example, Cynthia (EAL 2) and Joanne (non-EAL) are solving a word problem about Daniel’s pocket money that they have just written. Daniel (EAL 2) is also present but does not join in the discussion. Cynthia begins by reading out the problem:

### Extract 7.16

- 155 C alright then come on (...) look/ um/ listen properly alright/ Daniel he got  
156 five pound pocket money// five hundred write five oh oh/ in one week/  
157 how much pocket money/ he/ how many/ wait=wait/ how many pocket  
158 money/ how much/ pocket money/ he/ got/ he get in one year  
159 J oh dear/ five pounds/ how many weeks are there in a year?  
160 C umm/ four in/ calculator/ look=look=look/ um/ four week in one month  
161 innit?/ &  
162 J mm hmm  
163 C & and twelve months times four/ twelve/ times four/ equal/ forty eight/  
164 I've marked it/ st-/ sh-/ don't/ um/ forty six=forty eight yeah forty/ eight/  
165 no/ forty eight/ times/ times five/ equal/ two hundred and forty pound  
166  
167 J two hundred [ and  
168 C [ and fourteen pounds in one year he got  
169 J [ two hundred and forty  
170 C [ two hundred and forty pound  
171 J I want five pound a week  
172 C how much you got?  
*1A/4C,D&J: 21/6/00*

Following Cynthia's reading out of the problem, she and Joanne work towards the solution £240. (Cynthia cannot easily articulate the difference between -ty and -teen; in this extract she sometimes says two hundred and fourteen instead of two hundred and forty, e.g. line 168.) Joanne then makes a comment on the solution involving attention to narrative, "I want five pounds a week" (line 171). This remark can be seen as attending to narrative concerns since it is an expression of desire or envy, something which generically does not feature in word problems. As before, I cannot say if Joanne 'really' wants five pounds a week, only that she expresses a desire which evaluates the solution to the problem. I cannot know, for example, if Joanne thinks that £240 per year is a lot, or if she is being ironic in some way, or if she is merely humouring her peers. Cynthia does not indicate any of these interpretations. Instead, she seeks further information from Joanne by asking "how much you got?" (line 172). This question leads to a discussion about pocket money:

### Extract 7.17 (continued from 7.16)

- 173 J well/ on my birthday I get a hundred pounds for my birthday/ and a  
174 hundred pounds for Christmas/ so that's two hundred  
175 C and (...) and forty pound  
176 J oh my gosh you're rich Daniel  
177 C I five pound two week

178 J I get  
 179 C um two hundred and forty  
 180 J I don't know how much I get  
 181 C pounds  
 182 J I can either have sweets or money/ so (I'm gonna take the money ...)  
 183 C (in one week)  
 184 J it's doing it day to day  
 185 C (one ... forty eight) that's that  
 186 J please can I write this  
*JA/4C,D&J: 21/6/00*

Joanne responds to Cynthia's question by talking about occasions when she receives pocket money, whilst Cynthia writes out her solution to the word problem. Once Cynthia has finished writing (line 185), Joanne asks to write the next part herself. Cynthia, however, refuses:

Extract 7.18 (continued from 7.17)

187 C wait=wait=wait wait=wait=wait wait=wait/ I want to do something I  
 188 want to do something/ um/ two pound/ two hundred and forty  
 189 J two pound  
 190 C divided by two/ (oh yeah/ what fraction)  
 191 J divided by  
 192 C that (eng)/ that (eng)/ that (eng)/ that is not how much I got in one year/  
 193 because Daniel got one week but I got two week two week on five  
 194 pound/ he got one week on five pound/ (...)/ two five oh/ divided by two/  
 195 equal/ I got one/ hundred and twenty five pound in one/ year  
 196 J really?  
 197 C he more than me one/ one/[ one hundred pounds  
 198 J [ I only get a hundred pounds a year  
 199 C he more than me one hundred pound/  
 200 J you've both got more than me/ cause I get a hundred pounds a year  
 201 C no some of the time I get two pound in one week  
 202 J sometimes [(...) five pounds  
 203 C [ no some-sometimes I get five pound/ sometimes I get three  
 204 pound in two week  
 205 J sometimes I get five pounds sometimes I get three pounds sometimes I  
 206 get two pounds sometimes I get one pound  
 207 C sometimes/ I haven't got money  
 208 J sometimes if my mum hasn't got that much money I get/ 'bout two  
 209 pounds/ and if she has got money then/ I get five pounds  
 210 C if my/ if my dad sack/ unhappy/ he not gave money to me in one month/  
 211 I got no money in one month/ I got/ I got/ I got (earn) my pocket money  
 212 J me too I've gotta scrub  
 213 C I help my mum work during the morning/ and I got some money  
 214 J if I clean up/ I get money  
 215 C one pound one day/  
 216 J so if I was cleaning I'd get/

217 C every single day five o'clock I get up and if I done it and I/ go back  
218 home and sleeping/ can sleeping/ to/ eight o'clock and I get up go to  
219 school/ no/ um/ (I get) back after school and then something eat lunch  
220 and then/ until five o'clock/ o'clock and I sleeping/ come on have you  
221 done that/ look/ this is from Daniel work

1A/4C,D&J: 21/6/00

Cynthia makes a calculation which results in the announcement that she “got one hundred and twenty five pound in one/ year” (line 195). Cynthia and Joanne then move into a sequence of competing claims about how much (or how little) pocket money they receive and the labour and hardship they have to accept in order to do so. Again, I am not interested in whether these stories are in any sense true. Rather, I am interested in what these stories do. Part of what they do is to progress the social relationship between Cynthia and Joanne. They compete to show who is worse off in terms of money and work, as evidenced by Joanne’s statement “I only get one hundred pounds a year” (line 198), which contradicts her earlier claim to at least £200 (line 178). Rather than seeing this reversal as a bizarre inconsistency, discursive psychology asks what this change does. In this case, it contributes to a change in the tenor of the discussion, from one in which higher amounts of pocket money appear to be desirable, to a situation where the two students seek to show that they receive less, to the extent that Cynthia claims “sometimes/ I haven’t got money” (line 207). Throughout this phase of the discussion, Joanne is in a position of responding to Cynthia’s claims, rather than developing the discussion in new directions. Cynthia is depicted as having to work, to get up early in the morning, as having a father who may be sacked and who sometimes does not have money. Joanne, by contrast, starts off as someone who receives hundreds of pounds as gifts, before modifying her position to include the possibility of working for her pocket money, and as *sometimes* receiving less if her mother “doesn’t have that much money” (line 208). As the discussion progresses, the distance between the two students is reduced: a discussion which could potentially have arrived at being a poor student talking with a rich one, ends up as a poor student talking with a less poor student. The constructed reduction of social distance is the kind of relationship work this largely narratively-focused sequence is doing. Furthermore, far from being an irrelevant digression when it comes to the word-problem work, the two students make connections to their work. Recall that Cynthia calculated her own pocket money, five pounds every

two weeks, in relation to Daniel's five pounds weekly. She then comments "he more than me" (line 197), portraying herself as less well-off and in effect launching the race to the bottom in terms of income. Joanne joins this race by comparing her own income with both Cynthia and Daniel's, "you've both got more than me" (line 200). When talking about Daniel's pocket money, however, they are referring to the solution of the word problem which they had earlier created. Thus their discussion is closely tied to their word problem task and can be seen as a comparison between the circumstances of the Daniel of the word problem and their own. As such, their discussion is as much a making-sense of their word problem and its solution based on narrative concerns, as it is an example of relationship work. The two are intimately interwoven.

### **Summary**

In this section, I have illustrated a pattern of attention to narrative experience, evidenced by occasions in which students attend to narrative considerations to account for aspects of their word problems. Students account, for example, for the numerical details of their word problems. They also use extended narratively focused discussions to make sense of aspects of the problems they have written, including their solutions, as in the case of Cynthia and Joanne (Extract, 7.18). Attention to narrative occurs much less frequently than attention to genre and is more evident in some groups than others. Neither of the two patterns of attention set out so far is directly related to the mathematics of word problems. Students do, however, also attend to mathematical aspects of their task. This area forms the basis for the next pattern of attention to be considered, which I have termed attention to mathematical structure.

### **Attention to mathematical structure**

Although word problems can be treated as a generic kind of text, as Gerofsky (1996, 1999) has shown, when produced by curriculum writers or mathematics teachers their primary purpose is mathematical, often described as concerning the application of mathematics to 'everyday' or 'real world' situations (see, for example, Thomas &

Gerofsky, 1997, pp. 21-22; Toom, 1999, p. 36; Verschaffel *et al.*, 2000, p. xi).

Verschaffel *et al.* (2000) define the mathematical structure of a word problem as:

the nature of the given and unknown quantities involved in the problem, as well as the kind of mathematical operations(s) by which the unknown quantities can be derived from the givens (Verschaffel *et al.*, 2000, p. x)

They also define the semantic structure of a word problem as:

the way in which an interpretation of the text points to particular mathematical relationships (Verschaffel, *et al.*, 2000, p. x).

For my purposes, both Verschaffel *et al.*'s forms of structure are aspects of the mathematical structure of a word problem and, in discussing students' attention to mathematical structure, I shall not observe any distinction between them. I do not see this composite definition as equivalent to a specific arithmetic calculation required to solve a word problem. Indeed, there are likely to be several possible calculations. Rather, the mathematical structure of a word problem concerns the complex of relations between the various quantities which form part of the problem and interpretations of the text of that problem. My intention is not, however, to examine the word problems written by the students in this study in terms of their mathematical structure. Rather, I am interested in how the students themselves attend to the structure of their problems. Such attention is indicated by participants focusing on the elements of Verschaffel *et al.*'s definition, particularly "the kind of mathematical operations(s) by which the unknown quantities can be derived from the givens" (2000, p. x).

There are many occasions during the recordings of the students in this study when they attend to the mathematical structure of the problems they are writing or have written. To organise this section, I will consider examples of attention to structure in two sets of circumstances: those which arise during the writing of a problem and those which occur during the solving of a problem.



## Attending to mathematical structure while writing word problems

The students in this study frequently attended to the mathematical structure of word problems they were in the process of creating. Such attention generally functioned as evaluation of the structure of a provisional problem and as a basis for changing a provisional problem in some way. My own role in setting up the word-problem task is particularly relevant in this respect, as for many of the groups I specifically stipulated that students should write problems that were 'about' a particular operation. For the first recording of Cynthia and Helena (discussed in Chapters 5 and 6), I asked them to write problems requiring addition and for the recordings of cycle 2 I asked for problems requiring division, although on 3 occasions the participants renegotiated this requirement so that they could use other operations. For all of these groups, structure is sometimes attended to in the form of evaluation of the problem in relation to the task requirements. This evaluation may then lead to modification of the problem under construction, as in the following extract from cycle 2:

### Extract 7.19

38 C pardon?/ no no/ yeah=yeah=yeah yeah=yeah/ okay then/ there're a *writing*  
39 hundred an' eighty brains// in the morgue//  
40 (25 secs.)  
41 J mm// ninety gets took out how much left  
42 C no no no/ no no that's take away then// half/ what's half o' ninety/ forty  
43 five?/ four/ four monsters came and took/ an' et/ et/ forty five each  
44 J huh?  
45 C four monsters came and et forty five each/ co- yeah if four monsters  
46 came and et forty four each

2B/3C&J: 4/12/00

Courtney (non-EAL) writes a problem out. He reads the first part and then writes in silence (lines 39, 40). Jackson (non-EAL) then either reads or proposes the next part (I cannot say which from the transcript) "ninety gets took out how much left" (line 41). Courtney responds by commenting on the structure of this provisional problem, "no no that's take away then" (line 42). This attention to structure works as an evaluation of the problem in relation to their task, which is to write problems about division. Hence, 'take away' is not acceptable. Courtney then proposes changing the set-up of the problem to "four monsters came and et forty five each" (line 45), justifying this change by first

explicitly attending to the arithmetic relationship between 90 and 45. In this extract, there is a regular pattern of attention to mathematical structure, first to evaluate and then to change the two students' problem. Something similar occurs in the following extract, from cycle 1, in which Cynthia (EAL 2) is working with Daniel (EAL 2) and Joanne (non-EAL). Cynthia is proposing a new problem. In this extract, Cynthia's pronunciation sometimes conflates 'fifteen' and fifty, as well as 'five' and 'vive' (pronounced to rhyme).

### Extract 7.20

34	C	(...) Cynthia question// circle my name/ right/ okay// okay/ first I want	<i>RB</i>
35		( <i>laughs</i> ) first/ um we did this like um/ um/ what name we write?/ any	<i>withdraws</i>
36		name/ Daniel/ alright just write Daniel then/ Daniel/ <i>D A N I E L</i> / Daniel/	
37		has/ twenty pound a week/ have/ has/ twenty/ pound/ how d'you spell	
38		pocket money/	
39	J	um/ <i>P O</i>	
40	C	um/ say it/[ <i>C</i>	
41	J	[ <i>P/ P O/</i>	
42	C	yeah	
43	J	<i>CK</i>	
44	C	<i>CK</i>	
45	J	<i>ET</i>	
46	C	<i>ET</i> and I know money	
47	J	thank you for listening to the radio	
48	C	( <i>laughs</i> ) <i>M O N E Y</i> money/ pocket money/ in one week/ in/ one/ week/	
49		okay/ and/ every single day/ he bought three no/ ten pack of pokemon	
50		sticker/ yeah/ thirty p. no/ it's thirty p. each/ innit?/ they're thirty p. each	
51		innit?/ Daniel/ Daniel/ thirty p. each/ innit/ yeah/ thirteen/ times/ ten/ so/	
52		one day you just use/ three pound/ three/ pound/ one day you use/ three	
53		pound/ and what happen in seven day/ seven times/ three/ equals/ and	
54		you use twenty one pound it's more/ no that's wrong/ I'll have to	
55		change/ he got forty pound pocket money no/ fifty pound pocket money	
56		in a week/ five oh he got five oh/ vive voh/ vive voh/ 'kay/ and he got a	<i>'vive voh' =</i>
57		week/ eve'y single day/ how d'you spell a eve'y/ <i>E V E R Y/ R Y/</i> every	<i>five oh</i>
58		day/ he/ buy/ he buy/ he buy/ ten/ pack/ of/ pokemon/ yeah/ <i>P/ O/ K/ E/</i>	
59		<i>M O/ N/</i> pokemon sticker/ <i>S T I C K/</i> sticker/ an'/ he/ bought/ how d'you	
60		spell bought/[ <i>B/ oh B U Y</i>	

*1B/6C,D&J: 13/7/00*

Cynthia takes charge of the word problem, drawing on Joanne to support her spelling. During her monologue (lines 48-60), Cynthia develops the problem, commenting on and adapting it as she goes along. Indeed, she constructs a solution in tandem with constructing the problem. At various points in her monologue, she attends to the mathematical structure of the problem. Having settled on 30p for a pokemon card, for

example, and a purchase of 10 cards, she attends to the total cost *and* the arithmetic relationship on which her claim for this total is based, “thirteen [30] / times/ ten/ so/ one day you just use/ three pound” (lines 51-52). Cynthia then goes on to work out a total for a seven day week, again accounting for her total by attending to structure, “seven times/ three/ equals/ and you use twenty one pound” (lines 53-54). She then relates this total to her set up, in which Daniel had twenty pounds (line 37). She attends to the relation between her total and Daniel’s money “it’s more” (line 54), evaluating this as problematic, “that’s wrong” (line 54) and then adjusting the set-up for the problem to accommodate the weekly total she has reached “I’ll have to change/ he got forty pound pocket money no/ fifty pound pocket money in a week” (lines 54-56). (It is this last action which supports the interpretation of her previous evaluations on line 54 as referring to the original set-up). Thus, through her attention to mathematical structure, Cynthia evaluates her own emerging problem and modifies it so that the structure is acceptable. In both of the above extracts, then, attention to structure occurs as evaluation of a problem as it is proposed and developed, and as a basis for changing or further developing problems. Attention to mathematical structure also occurs when students attempt to solve their word problems.

### **Attending to mathematical structure while solving word problems**

The students were asked to solve their word problems, something which they usually did, often at my request, after they had finished preparing their set of problems. Sometimes, however, students solved their problems as soon as they had written them. Indeed, on some occasions, negotiating a problem merged into solving it, as in the previous extract (7.20). Attending to mathematical structure appears as an integral aspect of the interaction between students as they worked out their solutions together. This observation is illustrated by the following extract, in which Safia and Rahim (both EAL) solve a word problem they have just completed writing. Their unedited problem is:

Chris want to the shop and brot 2 crips wich cost £4 each and brort 5 drinks wich cost £10 each. What is the total

### Extract 7.21

- 129 S um/ if you add/ four pounds to ten pound/ which will make fourteen/ I  
130 don't need to use that  
131 R no you have to use that/ two pound because there are two fourteen/ four  
132 pounds/ and/[ (...)  
133 S [ no no if you just bought two crisps/ and it costs four pound  
134 [ if and/ each yeah/ oh  
135 R [ each  
136 S not one  
137 S oh yeah/ forgot  
138 R you've got your two [ four pounds  
139 S [ four add four  
140 R no let me do it for you  
141 S add [ ten  
142 R [ cause there's not two tens  
143 S equals/ [ eighteen  
144 R [ eighteen pound  
145 S pound  
146 R add/ add/ ten/  
147 S look  
148 R ten  
149 S four/ add/ four/ add/ ten/ equals eighteen  
150 R where's ten?/[ each  
151 S [ ten pound/ oh [ ten pound/  
152 R [ you've got five drinks  
153 S yeah five drinks  
154 R you put you put it too expensive  
155 S I don't care/ (...) done it harder than that (there)/ add/ four/ add/ ten/ add/  
156 ten/ add ten/ add/ ten/ equals/ forty eight/  
157 R let me just double check/ ten pounds/ add ten pounds/ add ten pounds *calculator*  
158 S you have to add the four two  
159 R I know/ ten twenty thirty forty/[ fifty  
160 S [ ten twenty thirty forty fifty sixty  
161 R fifty/ add four/ add four/ equals fifty eight pounds  
162 S no you done it/ wrong/ but/ look// you've got four *takes calc*  
163 [ add/ four/ add/ ten/ add/ oh/ I took ten/  
164 R [ add/ four/ add/ ten/  
165 S I done it wrong/ four/ add/ four/ add/ ten/ add/ ten/ add/ ten/ add/ ten/  
166 add/ ten/ equals/ fifty eight/ you're tight/ fifty eight  
167 R fifty eight/ pounds/ get the little sign  
*IB/IS&R: 11/7/00*

At the start of this extract, Safia attends to mathematical structure in offering the beginning of a solution, “if you add/ four pounds to ten pound/ which will make fourteen” (line 130) and then signals that she has finished by saying that she does not need to use the calculator (line 131). Rahim responds “no you do have to use that [the calculator]”, thus indicating to Safia that he does not regard her solution as satisfactory whilst maintaining continuity with what she has said. He then begins a mathematical justification for his position, but is interrupted by Safia: “no no if you just bought two

crisps/ and it costs four pound..." (lines 133-134). At this point, Rahim interjects "each" (line 135). Although he overlaps with what Safia is saying, he has proposed a possible completion for Safia's sentence. Their attention moves to the structurally significant word 'each', also indicated by Safia's repetition of the word (line 134) and Rahim's gloss, "not one" (line 136). Attention has thus been switched from mathematical structure to a part of the wording of the problem of structural significance. Furthermore, this attention should be seen as evaluating Safia's preceding offer of a solution. Rahim's utterance of 'each' implies that Safia has overlooked the significance of this word. Safia does now agree with Rahim, adding a face-saving "forgot" (line 137). I cannot say whether Safia really forgot or if she is just 'covering up' her mistake. I can say, however, that by invoking a plausible 'forgetting', she accounts for her concession to Rahim's argument, an accounting which reaches back to her first attempt at a solution.

There follows a short sequence which comes to a provisional solution of eighteen pounds (line 145). Once again, Rahim reopens consideration of the solution-so-far, adding "add/ add/ ten/", prompting Safia to run through it again: "four/ add/ four/ add/ ten/ equals eighteen" (line 149). Rahim's response first of all attends to the 'ten', "where's ten?" (line 150), which Safia takes as a request to explain something about 'ten', but as she begins (line 151) Rahim adds "each" (line 150). This 'each' breaks Safia's flow, "oh" (line 151). Rahim now offers further grounds for his challenging of Safia: "you've got five drinks" (line 152). He has now focused their joint attention successively from 'ten' to 'each' to 'five drinks', making explicit part of the structure of the problem. Safia now tries another solution (lines 155-156) performing a calculation out loud. Rahim again challenges Safia, inviting himself to "double check" (line 157). His total is different from Safia's, which she accounts for by asserting "you done it wrong" (line 162). She begins to rework the calculation again, interrupting herself "oh/ I took ten". It is not clear what she means here, but I am not concerned with meaning in this way. Instead I examine the action performed. Safia is accounting in advance, on the grounds of mathematical structure, for a forthcoming backing-down, "I done it wrong" (line 165). It is not possible to say whether or not she did take ten or not, only that she is plausibly accounting for 'doing it wrong'. Furthermore, her form of words serves to counteract her previous

account that Rahim was wrong. She can then repeat the calculation, again out loud, and agree with Rahim (line 166).

In solving their problem, then, the discussion between Safia and Rahim hinges around the word 'each'. My analysis does not try to decide whether or not Safia understands what 'each' means in the problem, or find some other way to explain her apparent difficulty with this word. My unfamiliarity with Safia's language and cultural background make such considerations difficult, if not impossible. What I can say about their discussion, is that the development of an agreed solution to the problem by the two students involves repeated attention to mathematical structure. This attention is used to challenge proposed solutions and as part of the process of negotiating a solution which is mutually acceptable. These negotiations are, moreover, of a social nature and attention to structure can be seen in this light. In particular, mathematical structure works rhetorically as a device to challenge readings of the problem which are not based on personal judgements. Rahim can challenge Safia with structure without the challenge being taken as a personal one. Rahim could have said 'that's wrong dummy' or 'can't you add up' or some other challenge of a more personal nature. By working with structure he avoids this potential difficulty so that the two students continue to work together to find a jointly acceptable solution.

### **Summary**

In this section, I have illustrated a pattern of attention to mathematical structure. This pattern is apparent throughout the process of writing and solving word problems. When writing their problems, the students attend to structure in evaluating their word problems, particularly in the light of a structurally focused task. They also attend to structure in justifying changes to their problems. In solving their problems, attention to structure is a key part of students' interaction, being used both in offering and evaluating proposed solutions, as well as being part of the social process of negotiating a solution acceptable to all participants. The three patterns of attention discussed so far all concern conceptual aspects of the task of writing mathematical word problems. The final pattern of attention I

will outline concerns the written production of the word problems which I have termed attention to written form.

### Attention to written form

For EAL students, learning English includes learning to write English. The task of writing and solving word problems requires the participants to produce an item of written text. As I have discussed in the earlier section on the word problem genre (pp. 87-99), such problems have certain generic features of their own, which the students clearly attend to during their discussions. They also, however, attend to various aspects of the linguistic form of their writing. Written language is not the same as spoken language. In particular written language is not simply a codified version of spoken language, though clearly there is a close relationship between the two. Writing has its own conventions which are related to the different nature and functions of writing (Halliday, 1989; Kress, 1982, p. 26; Stubbs, 1980, p. 23). These conventions operate at a general level, including spelling and punctuation, for example.

Throughout the transcripts collected in this study, there is evidence that the students attend to the written form of their word problems. Consider, for example, the following extract, in which Verity and Tahira are working on a problem about sweets:

#### Extract 7.22

- 56 V okay if you had twelve [sweets and you had six people/  
57 T [sweets and you had six people  
58 V how many sweets would they get each/ people  
59 T capital/ H/ how many  
60 V sweets/  
61 T sweets/  
62 V ^do^/ ^they^/ ^get^/  
63 T ^they^  
64 V ^have^  
65 T each have/ how many sweets/ *rubbing out*  
66 V each will they get  
67 T yeah  
68 V how many sweets/ each do they get//  
69 T (do a) question mark

2B/4T&V: 5/12/00





- 149 P ^oh yeah^  
 150 F put the question mark (and the equals)// (and) put the equal/ the equal/  
 151 P thank you/ alright now I do about/ mm/ pencils// no no  
 1A/2F&P: 20/6/00

Parveen and Farida attend to the need for a question mark (line 148) and an equals sign (line 148), which they write (unconventionally) immediately after the question. In the following extract, Safia (EAL 2-3) and Rahim (EAL 2-3) are coming to the end of a lengthy discussion about the solution of one of their problems:

#### Extract 7.24

- 162 S no you done it/ wrong/ but/ look// you've got four *takes calc*  
 163 [ add/ four/ add/ ten/ add/ oh/ I took ten/  
 164 R [ add/ four/ add/ ten/  
 165 S I done it wrong/ four/ add/ four/ add/ ten/ add/ ten/ add/ ten/ add/ ten/  
 166 add/ ten/ equals/ fifty eight/ you're right/ fifty eight  
 167 R fifty eight/ pounds/ get the little sign  
 168 S oh/ done/ mister Barwell *to RB*  
 1B/1S&R: 11/7/00

As the two students come to an agreement, Safia writes down their answer and Rahim brings attention to the punctuation needed to denote fifty-eight pounds (line 167).

#### **Attending to choice of words**

There are occasions when parts of word problems emerge from the process of joint writing-and-reading. In Extract 7.25 (below), for example, Zeb and Afzal (both EAL) negotiate the wording of the question in their problem over several turns.

#### Extract 7.25

- 123 A ten/ ten/ten hundred// what about one thousand and there're/ about/ err/  
 124 five thousand/ and one thousand/ how/ many/ are/ left  
 125 Z how many/[ how/ left/ how left  
 126 A [ left  
 127 A? how left  
 128 Z? how many left it should say  
 129 A how many look/ how/ many left/ now we've got to/ now we got to/  
 130 we've to say to him we've finished  
 2B/1Z&A: 30/11/00

Afzal initially suggests “how many are left” (line 124). Zeb begins “how many” (line 125) which Afzal completes as “how many left” (line 126), whilst Zeb simultaneously suggests “how left” (line 125). Both options are restated before Afzal asserts “how many” (line 129), emphasising and so attending to the ‘many’ missing from Zeb’s “how left”, making himself explicit by repeating “how many left” (line 129), which is what appears in their writing. Interestingly, this negotiation takes place as the two students complete their third question. Both their first two questions are also phrased ‘how many left’. An examination only of their written work might suggest that for Zeb and Afzal, ‘how many left’ is a routine, standardised form of words for a word problem. The evidence of the above extract suggests this assumption is not at all the case.

Another aspect of written form which arises as a choice between alternative possible words is that of tense. Gerofsky (1996, p. 40) argues that the tense used in word problems is somewhat strange, in that either past simple (‘bought’) or present simple (‘buys’) could be used with little difference in terms of interpreting the problem. It makes little difference to the doing of a word problem if ‘Mrs Patel buys 4 milkshakes...’ or ‘Mrs Patel bought 4 milkshakes...’ On a number of occasions, the tense used by students in their word problems becomes a focus of attention, as in the following extract:

Extract 7.26

129 H so/ Helena had ten pound pocket money in one week/ in every day she  
 130 bought  
 131 C four pack of chisp/[ each  
 132 H [ you don’t need in// actually/ every day she bought  
 133 C she bought  
 134 H she buys  
 135 C she bought/ because she  
 136 H she buys  
 137 C but bought/ it’s past  
 138 H but no  
 139 C no/ it’s past  
 140 H bought is past/[ unless/ unless (...)  
 141 C [ (...past it)  
 142 okay then/ bought  
 143 H buys  
 144 C buys  
 145 H don’t worry if if some-/ it’s/ it’s going to make [ sense  
 1B/2C&H: 11/7/00

Cynthia (EAL 2) and Helena (non-EAL) have agreed a set-up for their word problem, namely 'Helena has ten pound pocket money in one week' (line 129), which Helena reads from what Cynthia has written. In the above extract they are negotiating the development of the problem. Cynthia has written "in every day she bought" (lines 129-130) which Helena also reads out and which Cynthia completes. Helena then comments on the redundancy of the word 'in' in what Cynthia has written (line 132), so attending to written form. The attention of the two students turns to a choice between 'buy' and 'bought', which differ in tense. Cynthia argues for the past form, 'bought,' on the grounds that "it's past" (lines 137, 139) with Helena disagreeing but not giving such specific reasons. Indeed at one point Helena states that "bought is past" (line 140), apparently reading the 'it' of Cynthia's "it's past" as the word 'bought'. Cynthia treats this statement as a concession to her point of view, through her remark "okay then/ bought" (line 142). Helena, however, contradicts, averring "buys" (line 143), supporting her position by saying "don't worry...it's going to make sense" (line 145), thus reconstructing Cynthia's concerns as being about making sense rather than about tense *per se*. While Cynthia may have a point that the problem is set in the past and so should use past forms for any verbs, Helena avoids dealing with the issue by appealing to her own sense of judgement of what makes sense, implicitly positioning herself as a more competent or reliable judge than Cynthia.

### **Attending to legibility**

Most of the illustrations discussed above concern writing that is about to be, or is in the process of being written. Students' attention to written code is often also evident in their response to writing that has just been written. As the words are put down, they are often evaluated, commented on and sometimes changed. On occasions this takes the form of little more than a comment on the legibility of what has been written, as in the following examples involving Tahira (EAL 2) and Verity (non-EAL), and Afzal (EAL 2) and Jackson (non-EAL):

### Extract 7.27

109 V um/ so if there were one hundred people and there were/ fifty people and  
110 they wanted some sw-  
111 T sweets  
112 V no/ one hundred sweets I mean  
113 T one hun-  
114 V let me do it let me do it  
115 T (*sighs*)  
116 V sorry/ sweets *to tape?*  
117 T let me write it/ what you writing?/ what you writing?  
118 V sweets  
119 T that looks like symbols  
120 V um/  
121 T um/ if there were one hundred sweets and there were [fifty people  
*2B/4T&V: 5/12/00*

### Extract 7.28

102 A? got a gold what?/  
103 A (...)/ and two thousand get gold?/ sold/  
104 J mm  
105 A oh/  
106 J (*laughs*)  
*2B/5A&J: 5/12/00*

In both these extracts, the attention on what has been written is related to a process of making sense. In Extract 7.28, for example, Afzal reads a line written by Jackson as “two thousand get gold” (line 103). His previous utterance (line 102) shows him trying to complete what appears to be an incomplete sentence. Attention is on the word ‘gold’, which Afzal re-interprets as ‘sold’, approved by Jackson and accepted by Afzal. This extract offers a good example of how this approach to analysis attempts to remain with participants’ concerns. Looking at what Jackson wrote, it appears very much that the word is ‘sold’, although the S is a little irregular so that it is tempting to infer that Afzal has misread the S for G. Such an analysis is out of bounds, however. I can still observe that Afzal attempts to make sense of what he sees, whatever that might be, and that what he reads out changes from ‘gold’ to ‘sold’, and that this appears to make sense to him, as well as to Jackson (line 104). Previously, the sense Jackson and Afzal made of what was written is not taken as shared. Similarly, Tahira attends to what Verity is writing, asking her to read a word, which Verity does, saying “sweets” (line 118). Tahira accounts for her request by saying that the word “looks like symbols” (line 119). I cannot say whether it is

Tahira's reading or Verity's writing which 'causes' this mismatch, but by bringing attention to it, a joint interpretation is achieved, demonstrated by Tahira reading out the full sentence written by Verity (line 121). Thus, through a process of reading and attention moving to where the writing is problematic, the two students in each extract move from individual to a joint, taken as shared sense of what their words mean.

### Attending to spelling

This process of moving towards a sense of what has been written that is taken as shared by the participants occurs regularly in the seven transcripts, frequently leading to a focus on and alteration of spellings, or even a change of word, as in this extract from Zeb (EAL 2) and Courtney (non-EAL):

#### Extract 7.29

106 Z and/ I/ give// my/ (...)/ I/ sh-  
107 C share  
108 Z share/ yeah/ share it/ in/ to/ ten/ pieces//  
109 C I have two hundred police cars and/ sh- sh- sha-an't  
110 Z sha-an  
111 C shan't  
112 Z share  
113 C that says shan't/ sh-a-re/ that's supposed to be E/ and R/ or just say  
114 group//  
2B/6Z&C: 6/12/00

Here, attention focuses on the word 'share/shan't' in the process of making sense of already written words, leading to an agreed change in the spelling (to 'sher') and a suggestion for an alternative word ('group'). Although the altered spelling does not conform to standard orthography, the two students have moved forward to a position of shared sense. Similarly, in the following extract, Verity and Benjamin (both non-EAL) go through a process of jointly writing and then reading and sense making what has been written until they agree on both what the words are and that they make sense. Here, Verity is reading back what Benjamin has written:

### Extract 7.30

84 V there are one hundred children and twenty five children get/ left behind/  
85 and/ every single one of the/ them/ you've done that wrong/ does that  
86 say?/ behind/[ what does that say?  
87 B [ yeah/ behind  
88 V that what/ (this say)  
89 B oh/ every  
90 V every?  
91 B yeah/  
92 V that's not how you spell it/ look/ dis how you spell it/  
93 ? every single/  
94 V you don't spell single like that/[( sin-gle)  
*2B/8V&B: 7/12/00*

Attention shifts through this extract from word to word, from 'behind' (lines 85-87), to 'every' (lines 88-92), to 'single' (lines 93-94), with both 'every' and 'single' being crossed through and rewritten above by Verity, so that again shared sense is brought about.

The above extracts show that whilst engaged in a task taken from the mathematics classroom that requires them to write, these students are attending to the written form of their problems. The spelling, punctuation, choice of vocabulary and overall surface suitability are attended to in the task of writing word problems. Whatever experiences lead students to pay attention to the written form as they work on their task, it is interesting how much effort they devote to their writing, given that this is an explicitly mathematics lesson task. There is no sense that they ignore such concerns as the exclusive preserve of their English lessons.

### **Summary**

In this section, I have illustrated a pattern of attention to written form which is evident in the transcript data. The participants attend to various aspects of their writing, including the punctuation, spelling, tense and legibility of their words. Such attention is frequently part of a joint process of shared sense-making. By focusing attention on written form, students clarify the emerging text they are in the process of producing in a parallel process of developing a shared reading of that text. Through this process, all participants

are able jointly to produce a written word problem, with EAL students supported in the writing process.

## Further questions

In this chapter, I have described and provided evidence for four patterns of attention in the interaction of EAL students and their peers as they engaged in writing and solving mathematical word problems. These are patterns of attention to genre, to narrative experience, to mathematical structure and to written form. In discussing the various extracts used to illustrate these patterns, I have begun to highlight the social nature of students' attention and therefore of their work. The students' attention to different aspects of their task is shifted as part of the social interaction which takes place between the participants. Students use this attention to make sense of their word problems as they work together to write and solve their word problems. This finding leads to the question of *how* each area of attention is used by students in their work together. Given that the attention to genre can be seen as a default pattern of attention arising because of the requirements of the task, I am particularly interested in how the other three areas of attention are used in relation to genre. What is achieved by shifting attention to narrative? Or to mathematical structure? Or to written form? These three questions form the topics for the next three chapters, each of which considers the use of one pattern of attention in more depth. Chapter 8 considers the use of students' attention to narrative experience, Chapter 9 their attention to mathematical structure and Chapter 10 their attention to written form.

## Chapter 8

# **Presents for Cynthia's mum: the use of attention to narrative experience in writing and solving word problems**

The purpose of this and the next two chapters is to explore the use of the four areas of attention in students' interaction described in Chapter 7. Each of the three chapters explores the use of one area of attention in particular. In this chapter, I focus on *how* EAL students and their peers use attention to narrative experience as part of the social process of writing and solving word problems. Chapter 8 concerns students' use of attention to mathematical structure and Chapter 9 concerns their use of attention to written form. The use of attention to genre forms a backdrop to all three chapters, genre being a default area of attention arising from the word problem task.

I begin this chapter by briefly returning to relevant theoretical literature on word problems in order to raise substantive questions relating to attention to narrative experience. These questions particularly concern the nature of the relationship between 'real life' and the scenarios which form a key part of the word-problem genre. Through addressing such questions, I demonstrate the efficacy of the methodological approach developed in this dissertation. Using this approach, therefore, I set out several *uses* of attention to narrative experience, supported by extracts from the transcript data and accompanying discourse analysis. I then draw on these findings to consider the substantive questions raised at the start of the chapter. I begin, then, with a brief look at the word-problem literature and its concern with the relationship between 'real life' and word problems.



## Making sense of word problems

Students' work on mathematical word problems has been extensively investigated in mathematics education (see Fuson, 1992; Verschaffel *et al.*, 2000). Such problems are seen as presenting particular difficulties, especially in their need for students to relate the 'real world' scenario of the problem with the related mathematical task (see, for example, Reusser & Steubler, 1997). Lave (1992) suggests that students find word problems difficult to interpret realistically because the problems themselves are not realistic, being "stylized representations of hypothetical experiences - not slices of everyday existence" (p. 77). The activities described in word problems are not part of students' direct experience of the world, they are instead stylised treatments of more or less familiar situations. In a problem set in a shop, for example, students are not expected to use specific experiences of buying bananas or of a particular shop-keeper they know, to solve the problem. Rather, they must draw on more generalised notions of shops and shopping.

As I showed in the previous chapter (pp. 99-106), the students who took part in this study sometimes attend to narrative experience as they work together to write and solve word problems. My interest, then, is in how students use attention to narrative experience as part of their thinking, that is as part of the publicly accountable reasoning they display in their talk. This attention suggests, for example, that students are to some extent relating their experience of the 'real world' to the word problems they are creating. In this chapter, I want to explore the following questions:

- How do the students in this study use attention to narrative experience to work on their task?
- In particular, how, if at all, is attention to narrative experience used to relate the 'hypothetical experiences' portrayed in word problems to students' direct experience of the world?
- How is attention to narrative experience implicated in the students' solutions to their word problems?

To begin to tackle these questions, I will initially draw on my analysis of a sequence from a single transcript featuring Cynthia (EAL 2) and Helena (non-EAL) to highlight a number of uses of their attention to narrative experience. Later in the chapter, I compare

these uses to those drawn from extracts from two other transcripts, leading to the identification of an additional use.

### **Cynthia and Helena's use of attention to narrative experience**

In this section, I draw on my analysis of a sequence from a transcript of Cynthia (EAL 2) and Helena (non-EAL) (Cycle 1B). The sequence, which covers some four pages (see Appendix II, pp. 222-230), shows the creation and solution of a single word problem concerning a character called Cynthia buying presents for her mum. I have selected this sequence as a starting point since the two participants do attend to narrative experience on a number of occasions. Of course, they also attend to other things, including genre, mathematical structure and written form. The focus for my analysis and for this chapter, however, is on how they use their attention to narrative experience. In conducting my analysis, I am interested in moments when attention is shifted, either from or to narrative experience. Drawing on the discursive approach to analysis discussed in Chapter 5, I then consider what these shifts are used to do.

My analysis of the sequence featuring Cynthia and Helena and Helena reveals the following *uses of attention to narrative experience*:

- proposing, challenging and discussing generic details;
- agreeing on shared ideas of what generic details refer to;
- establishing (taken-as) shared sense for their emerging word problem and its solution;
- supporting changes in the mathematical structure of the word problem;
- linking the development of the word problem with its solution.

The evidence for these uses of attention to narrative experience comes from my discursive analysis of the sequence I have selected. This evidence is set out below, in the form of extracts from the sequence and accompanying analysis. First, however, I will briefly describe the nature of the two students' discussion.

## Presents for Cynthia's mum

During the two recordings of Cynthia and Helena working together, they write 6 word problems (see Appendix III, p. 231). All of their problems feature named protagonists. In the first recording (parts of which are discussed in Chapters 4 and 5), they write 4 problems in which most of the named characters are students in their class. In the second recording, they write two problems, featuring their own names, Helena in the first and Cynthia in the second. The sequence which forms the starting point for my analysis records the second problem produced and solved by Cynthia and Helena in their second recording. They write a word problem about Cynthia buying presents for her mum. There is discussion of how much money Cynthia has, of what is bought and how much it costs and of what the question that concludes the problem should be. The wording and nature of the problem change several times. Having agreed on a final version of the problem, Cynthia uses a calculator to work out her solution with Helena following what she is doing and occasionally intervening.

Helena's opening move (see Extract 8.1) in writing the two students' second problem is the choice of Cynthia as the protagonist:

### Extract 8.1

- 345 H Cynthia what d'you like  
346 C I like/ my mum  
347 H okay then/ Cynthia has fifty pounds/ to buy her mum a present  
348 C *(laughs)*  
349 H and she gets her/ a big dress/  
350 C big dress/ no/ my mum doesn't like dress/ I get her ahhh/ big music box/  
351 if you open it/[ it's music/  
352 H [ a stereo  
353 C no/ if you open it/ it's music/ it's music and you have put jewellery in/  
354 [ like/ like/ yeah  
355 H [ oh/ oh/ that that/ you open it and it goes beep ooo/  
356 C music  
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### **Proposing, challenging and discussing generic details**

This extract provides a first example of a *shift in attention* between genre and narrative experience. Helena invites Cynthia to say something she likes, an example of an intentional state (Bruner, 1990, pp. 49-50), which she then *uses to propose generic details* for the opening for the word problem. Helena thus shifts attention from narrative experience played out through a personal discussion with Cynthia, to a more impersonal, informative style. The words Helena suggests for the start of the problem are designed for a different audience, an audience which needs more explicit, self-contained information. A name (Cynthia...) is followed by information about money (...has fifty pounds...) which both frames the scenario which follows and introduces a numerical detail to be implicated in the ensuing arithmetic problem. The style conforms quite closely to the generic features of word problems identified by Gerofsky (1996), particularly in having the first two elements of the three-part structure, a 'set-up' and an item of numerical information. I am not suggesting that Helena worked through all these ideas as she offered her opening. Rather, she is drawing on her experience of what word problems are like (although I can never gain access to this experience, only observe the manner of its expression in different situations). By writing a word-problem-like sentence, she does not need to work to design the form of their problem, since much of this design work is built into the generic form itself. Furthermore, although it is Helena who proposes this generically suitable form of words, Cynthia tacitly accepts their suitability.

Cynthia does, however, *use attention to narrative experience to challenge generic details* proposed by Helena, shifting attention away from genre in order to do so. She does not argue that Helena's words do not make a word problem or do not sound right. She instead argues against one of the details in Helena's proposal, that of the choice of present ("a big dress," line 349), which Cynthia rejects by saying "big dress/no/ my mum doesn't like dress" (line 350). At this point, Cynthia's attention is once more on the narrative sense of Helena's proposed line. First, she indicates a concern with the 'big dress', as shown by her repeat of these words, before giving an explicit reason for rejecting the idea. This reason is based on narrative experience. She explains her rejection of the dress by invoking an intentional state (Bruner, 1990, pp. 49-50) for her mum (not liking dresses),

and by implication for the Cynthia in the word problem (not wanting to buy something her mum does not like). This does not mean that this situation has actually happened to Cynthia. But the idea of liking and of liking being a relevant concern in the buying of presents is part of narrative experience of the world. This attention to narrative sense is *used to challenge Helena and propose an alternative generic detail*. Cynthia's reasoning, furthermore, draws on Cynthia's particular relationship to her mother, which allows her to make claims about her mother which are difficult to undermine (Edwards & Potter, 1992, p. 160). Helena is not 'entitled' (p. 160) in the way that Cynthia is, to say anything about Cynthia's mother's likes and dislikes. Thus, we can see that Cynthia's use of the idea of what her mum likes is created for and situated in a particular moment and a particular social action (disagreeing) in the discussion. This point may seem obvious. Given the task of writing a word problem, however, there is no reason within the task why one item should be used instead of another. As Gerofsky (1996, p. 41) notes, the items are arbitrary. Cynthia must construct a suitable reason for her disagreement and uses attention to narrative experience to do so. In the same way, at the start of Extract 8.1, Helena uses the idea of what Cynthia likes as a basis for the beginning of the problem, a beginning which in generic terms has arbitrary content.

#### **Agreeing on shared ideas of what generic details refer to**

The use of attention to narrative experience is also used by Cynthia and Helena to develop a shared sense of some of the details of the word problem. In Extract 8.1, for example, having rejected a dress as a possible present for her mum, Cynthia proposes a 'music box' (line 350), a generic detail. In the ensuing exchange, the two students work to create a shared idea of what such a music box is like. To do so, rather than using abstract definition, they *use attention to the narrative experience of music boxes*, talking about opening them, putting jewelry in and to the sound they make (lines 353-355). Here, attention to narrative experience in the form of accounts involving actors and events supported by descriptive detail (Edwards & Potter, 1992, p. 161), is used to establish a shared sense of what a music box is. Within the word problem, however, the music box is

again, arbitrary. The choice of present is irrelevant for the word problem as a mathematics classroom task.

### Establishing shared sense

During Extract 8.2 below, Cynthia and Helena are going over the wording of their problem. Helena states the latest version of the opening line, "Cynthia has thirty pounds for/ for her mum's present" (lines 408, 410). In the middle of this statement, Helena is interrupted by Cynthia. There seems to be some confusion involving the words 'for' and 'from', a confusion that arguably is a result of Cynthia's developing proficiency in English:

#### Extract 8.2

- 371 C yeah three voh/ and I bought her/ um/ I bought her twenty five pound a  
372 music/ jewellery box  
373 H no it only cost/ sixteen pounds/  
374 C [ no I saw one  
375 H [ and you buy her something  
376 C no/ I I saw one/ it's thir-thirty pounds/ three voh/ no one three/ one three  
377 pounds I saw one  
378 H thirteen  
379 C one three/ on that shop/ you have to look at the magazine/ that they that  
380 the shop magazine/ and you choose a number and you write it down/ and  
381 you gave them/ and and that one you pay the money and you have to  
382 wait and they gave you/ you know that shop/ I saw it's just thirty pound/  
383 three/ thir-teen pounds/ one three/  
384 H okay then um/ Cynthia has forty pounds/ this can be easy one  
(...)  
408 H Cynthia has thirty pounds for/  
409 C no/ not for her her mum/ if (I bought)/ for my mum  
410 H for her mum's present  
411 C if give my mum thirty pound I bought nothing from her/ that not make  
412 sense  
413 H no/ I won't writing for you mother/ I said Cynthia has thirty pounds for  
414 her mother's present  
415 C thirty pound/ I gave thirty pound for my mum present  
416 H no/ I didn't say give it to her  
417 C then how why you  
418 H you have thirty pounds [ for your mum's present  
419 C [ no  
420 but/ I think this make sense/ Cynthia has thirty/ pound/ thirty pound/ she  
421 bought err something something something/ it's cost something  
422 something/ from her mum present/ and how much she left?/ is that make  
423 sense little bit

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Cynthia objects that Helena's latest opening line implies that Cynthia gave her mum thirty pounds. Throughout the extract in which the two students negotiate both the meaning of what Helena has proposed to write and the meaning of what they are ultimately intending to write, Cynthia uses attention to narrative experience, in this case concerning Cynthia's intentions in the word problem story. Helena, by contrast, uses attention to the proposed written form of the problem, so that attention is shifting between narrative experience and written form. Thus, Cynthia argues that "if give mum thirty pound I bought nothing from her/ that no make sense" (line 413) and Helena responds "I won't writing for you mother/ I said Cynthia has thirty pounds for her mother's present" (line 414). Helena thus shows that she sees Cynthia's challenge as based on a mishearing of what was proposed, and goes on to make clear the crucial (to her) words, not 'for her mother' but 'for her mother's present.' Cynthia continues to shift attention to the sense of the words as she sees it, offering another reformulation of what Helena is saying, "I gave thirty pounds for my mum present". She is particularly attending to what makes sense in the activity of present giving, arguing that giving thirty pounds as a present does not make sense. Both students then attempt to reformulate again in the search for a shared sense of their question. Helena shifts to the more personal 'you' and emphasises the word 'have' (you have thirty pounds). Cynthia takes up the verb 'have' and uses it to offer another version of the problem. Throughout this exchange Cynthia *uses attention to narrative experience to establish taken-as-shared sense*, as she works to overcome a breakdown in shared meaning with Helena. This breakdown appears to arise from Cynthia's developing proficiency in English, particularly in this case, in the use of the words 'from' and 'for'. In this case, however, shared sense is not achieved until Cynthia shifts attention again, this time to genre, setting out a version of the entire problem (lines 419-423):

419 C [ no  
 420 but/ I think this make sense/ Cynthia has thirty/ pound/ thirty pound/ she  
 421 bought err something something something/ it's cost something  
 422 something/ from her mum present/ and how much she left?/ is that make  
 423 sense little bit  
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She produces what is almost a 'pro forma' problem, with slots ("something something") for the present and the value of the present and including the closing question for the first time in the discussion. Her attention here is clearly on the generic form of the problem, on what elements should be included in what order. By stating a problem in full she adds weight to her version, balancing this by leaving the details open to renegotiation. She does include a reference to "her mum present", but in an inappropriate part of the problem where it has less relevance, in effect relegating its importance. This is the last specific reference to a present, although "from her mum" (glossed as 'for her mum') is later mentioned but not written into the question. By using an implicit depiction of how a word problem should be written, Cynthia has effectively modified the set-up for the problem, reducing it to "Cynthia has thirty pounds", the form of words which appears in the final version. She has thus effectively removed an element of information which is generically redundant.

### **Supporting changes in mathematical structure**

So far, the interaction between Cynthia and Helena has featured attention to genre, narrative experience and written form. Their task has not led the two students to attend to mathematical structure. Such an occasion occurs not long after the previous extract, following a period of attention to written form in which the two students negotiate the spelling of 'jewellery'. Helena then says "what else would you buy" (line 444, Extract 8.3, below). It is not clear what she is doing here, since Cynthia does not respond directly. She acknowledges Helena's utterance "wait wait wait wait wait" (line 445), but in such a way as to enable her to attend to some other aspect of the discussion. In this case, she brings their attention to the cost of the music box:

#### Extract 8.3

442	H	jewellery jewellery jewellery	<i>singing</i>
443	C	finished	
444	H	what else would you buy	
445	C	wait wait wait wait wait/ bought music box/ it's cost/ it cost/	
446	H	how much	
447	C	any you like fifteen or thirteen thirteen and	
448	H	it costs	



449 C fifteen  
 450 H fifteen pounds  
 451 C fifteen pound/ co-/ fifteen pound  
 452 H (...)  
 453 C fifteen pound and she bought/ she bought err  
 454 H and she bought/ Cynthia has thirty pounds she buys a music jewellery  
 455 box [ and  
 456 C [ and she bought a jew- and she bought a ring from her mum// wait  
 457 wait wait wait/ you write fifty pound/ um/ um um/ (miss)  
 458 H (miss)  
 459 C jewellery music box/ is costs fifty pounds/ and she bought/  
 460 [ and she um (...) fifty pound/ from one  
 461 H [and  
 462 C and she bought/ and she bought a ring/ because I've got/ tw- I've got  
 463 fifty pound left  
 464 H she bought a what  
 465 C a ring  
 466 H a ring?/ for fifty p- fif-teen pound  
 467 C no/ you know?/ I've got forty p- thirteen pound innit?/ and bought this/  
 468 and I got fifty pound left/[ and I bought  
 469 H [ not fifty  
 470 C one five how d'you say fif-teen/ no fifteen/ fifteen pound/ she's got fifty  
 471 I've got fifty pound there/ and I bought a ring/ from my mum/ and how  
 472 much/ cost everything

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Having established the cost of the box as fifteen pounds, Cynthia adds a second present, "and she bought a ring from her mum" (line 456), so responding to Helena's earlier suggestion (line 444). Cynthia justifies her addition by attending to both mathematical structure and narrative experience, "I've got fifty pound left" (recall that for Cynthia, there is confusion between fifty and fifteen, as well as between thirty and thirteen). This justification relies on attention to the mathematical structure of the existing problem, which is currently equivalent to the subtraction,  $£30 - £15 = £15$ . This attention is linked to the possibility of buying something else because there is still £15 available, a motive or intentional state (Bruner, 1990, pp. 49-50) for the proposed action of the Cynthia in the problem, and so an example of attention to narrative experience. Attention to the mathematical structure of the problem is further indicated by a change Cynthia makes in the wording of the problem's closing question. Until this point in the discussion, this question has been "how much she left" (line 422) or something similar. The addition of a second present, a ring whose cost is negotiated as £12.99, changes the structure of the problem. There are a number of possibilities. Cynthia alters the question to "how much/ cost everything" (line 472) and later to "how many she spent together and how many she

left" (line 494), conforming with a new two stage problem structure of: (1)  $\pounds 15 + \pounds 12.99 = \pounds 27.99$ ; (2)  $\pounds 30 - \pounds 27.99 = \pounds 2.01$ . Thus Cynthia uses attention to narrative structure (having money left over) *to support changes to the mathematical structure* of the problem.

### Linking the word problem with its solution

As I have observed already in this chapter (p. 124), word problems have a reputation in mathematics education as presenting difficulties for all students, a reputation which extends to EAL students in particular (Secada, 1991). Students are found to have considerable difficulty in relating the arithmetic calculation required by a problem to the 'real life' scenario used as its setting (Lave, 1992; Verschaffel *et al.*, 2000). These issues did not appear to arise for Cynthia in these transcripts. In Extract 8.4 (below) she uses a calculator to solve their problem:

#### Extract 8.4

506 C yeah how much (...) left/ okay/ do it now/ come on/ no no no/ do that/  
 507 um/ fifteen and/ one two nine nine and one five oh oh/ okay/ one/ no  
 508 H just like fifteen and twelve  
 509 C no/ I've got you've got twelve pound ninety nine/ twelve nine nine/ take  
 510 away/ one five oh oh/ eq-/ no/ not [ take away/ it's add/  
 511 H [ no not take away/ add  
 512 C two oh nine nine/ add/ one five oh oh/ two seven nine nine/ two seven  
 513 nine nine/ and three oh oh oh/ take away/ two/ seven nine nine/ equal/  
 514 two pound and one p./ how much she spent  
 515 H she spent  
 516 C yeah/ wait wait  
 517 H twenty seven ninety nine  
 518 C (...) spent/ *S P E N*/ she spent/ twenty seven pounds and ninety nine p./  
 519 left/ and/ she left/ shu left/ she left/ um/ two pound and one p./ done  
 520 it/mister Barwell

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Cynthia solves the word problem in three turns (lines 506-514). She punches the buttons on a calculator as she calls out the digits. Initially (line 509-510) she is about to subtract  $\pounds 15.00$  from  $\pounds 12.99$ , but then corrects herself (line 510) and adds them. She then subtracts the total from  $\pounds 30$ . It is striking how Cynthia works with the numbers relatively abstractly, referring to them almost entirely in digit form. She uses a mathematical

economy, working with the numbers entirely separate from the context invoked by the word-problem scenario. An explicit connection with this scenario is only made as Cynthia reaches the end of her calculations, when the outcome is given as pounds and pence (line 514). This connection is continued as Cynthia writes out her solution (lines 508-520).

The patterns of attention discussed in the previous sections make it possible to link Cynthia's solution to the activity of designing the problem. Within the solution process, there is attention to both structure and genre. The former can be seen at the point where both Cynthia and Helena simultaneously correct Cynthia's initial proposal of subtraction to addition (lines 510-511). At this point, both are concerned with the relationship between the two numbers 15.00 and 12.99 as given by the mathematical structure of their problem. This in turn links back to the point in their discussions where that structure was created (shown in Extract 8.3). Furthermore, the creation of that structure was *supported by the use of attention to narrative experience*, through Cynthia's justification that a second present could be purchased since there was money remaining (line 462-463). We also see attention to genre in the above extract at the end of the calculation process, when Cynthia shifts from working with numbers to working within the language of the problem (lines 514-519). This attention again links back to the attention devoted to students' use of attention to narrative experience to negotiate shared sense for the generic details and wording of the problem earlier in their discussion. Patterns of attention therefore run through the creation to the solution of the word problem.

### **Use of attention to narrative experience**

Using the above analysis, I have provided evidence for a number of ways in which attention to narrative experience is used by the two students in their talk as they write and solve their word problem.

Attention to narrative experience is used *to propose otherwise arbitrary generic details*, such as the scenario of the problem itself. This use can entail the two students using attention to narrative experience as a basis for disagreeing with proposed generic details.

and to support possible changes. The rejection of a dress in favour of a music box, for example, is supported by attention to what Cynthia's mum likes, as well as by Cynthia's use of an account of seeing a music box in a shop to support her suggestion for the cost of such a box.

A second use of attention to narrative experience is *to agree on shared ideas of what generic details refer to*. Thus, for example, they both attend to narrative experience of music boxes, resulting in a level of agreement on what they are referring to. I cannot say what either student *really* takes 'music box' to mean, but I can see that by attending to narrative experience they arrive at sufficient agreement of how to use the term for them to continue with their task. This approach is not always successful. When the two students attempt to resolve the sense of 'thirty pounds for her mum's present', Cynthia shifts attention to narrative experience to counter Helena's form-based alternative reading. It seems that in attending to different aspects of the words, each student reformulates them in incompatible ways. Resolution is only achieved by a shift to attention to genre. Again, attention to narrative experience plays a part in establishing a shared sense of the two students' emerging word problem.

A third way in which attention to narrative experience is used by Cynthia and Helena is *to establish shared sense* for their emerging word problems. By attending to narrative experience as they negotiate the generic details of their word problem, Cynthia and Helena establish shared, meaningful sense for the choices they make. The details of their word problem are therefore not arbitrary placeholders in the kind of fill-in-the-blanks problem produced by Cynthia at one point. Instead, they are explicitly related to the narrative experience the students bring to the discussion.

A fourth use of attention to narrative experience is *to support a change in the mathematical structure of the word problem*. Having money left over, a narrative concern, is used to justify buying an additional present and so to changing the structure of the problem from a one-step subtraction to a two-step problem involving both addition and subtraction.

Finally, through the various uses of attention to narrative experience set out above, the two students are able *to link the creation of their word problem with its solution*. Rather than solving an arbitrary problem set in an arbitrary scenario, they are solving a problem the meaning of which is linked for each student, with aspects of their narrative experience of the world.

These findings arise from my analysis of one sequence involving Cynthia and Helena. In the next section, I consider how Cynthia and Helena's uses of narrative attention compare with those of other groups of students in this study.

### **Use of attention to narrative experience in other transcripts**

I have identified a number of ways in which two students (Cynthia and Helena) who took part in this study use attention to narrative experience as they write and solve a word problem. As I noted in Chapter 7 (p. 106), this pattern of attention is not as widespread as the other three, though it nevertheless occurs in several transcripts involving a number of students. This situation raises the question of whether the way in which attention to narrative experience is used by Cynthia and Helena is the same or different from its use in the interaction involving other students in the study. In this section, I will draw on sequences from two other transcripts to show how some of the uses described above also arise in other transcripts. Analysis of these sequences also reveals an additional use relating to the on-going negotiation of students' social relationship with each other.

The first sequence I will refer to involves two non-EAL students, Eleanor and Vicky. The extract begins with the first emergence of their scenario for a new problem about supermarkets:

#### **Extract 8.5**

90	V	um/ two/ chil-/
91	E	-dren
92	V	go to the supermarket
93	E	huh?/ I'm going to a market on sunday to get some new shoes and some
94		steak

95 V where?  
 96 E Eastern market/ to get some new shoes and/ no/ I mean/  
 97 [ to get some steak  
 98 V [ two children go/ to/ the  
 99 E and I'm going to the market on sunday to get some steak and then I go to  
 100 town to get some new shoes/  
 101 V twen-/ twenty five pound  
 102 E gosh/ you must be rich/ fifty p. (*laughs*)  
 103 V my mum spends/ three hundred and seven pounds at Tesco's  
 104 E oh my gosh/ my mum spent/ my mum spent four hundred in Tesco's  
 105 before/  
 106 V but the thing is my mum keeps doin' it  
 107 E I know/ they goes to the/ supermarket/ like every day/ to get munchies/  
 108 sweets/ (*tuts*)  
 109 V anyway/ two children go to the supermarket with twenty five pounds  
 110 E yeah  
 111 V and  
 112 E fifty p. (*laughs*)  
 113 V buy/ washing up liquid  
 114 E (*laughs*) costing/ hang on  
 115 V costing  
 116 E costing/  
 117 forty p.  
 118 V yeah forty five/ pence  
 119 E and/ no just write they/ they/ and  
 120 V they bought  
 121 E each?/ buy washing up liquid (*laughs*)  
 122 V no  
 123 E yes/ or at least one of them/ buys/ one buys washing up liquid/ and the  
 124 other buys/ six packets of crisps  
 125 V (...)//  
 126 E no write it above that//  
 127 V (I'm gonna do)/ one/ of them buys/ ^(...)^/ costing forty five p./ soap  
 128 powder/  
 129 E ha?  
 130 V they're going shopping for their mum  
 131 E (*laughs*) no six packets of crisps  
 132 V no/[ twenty/ packets//  
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The two students' discussion involves some of the same uses of attention to narrative experience highlighted in the previous section. At the start of Extract 8.4, their attention is focused on generic details (lines 91-93). Eleanor responds to Vicky's proposal of supermarket as the basis for the scenario with an account of a trip to a market she is expecting to make, thus shifting attention to narrative experience. Vicky's question "where?" (line 95) allows Eleanor to continue with this topic, whilst Eleanor continues to write the problem. Eleanor does not treat Vicky's utterances as relevant to her own words, instead taking them to be an accompaniment to the process of writing. At the point where Vicky proposes the generic detail "twenty five pound" (line 101), Eleanor attends

to narrative experience to make an evaluation, "gosh/ you must be rich" (line 102). Vicky responds with an account of how much her mum spends at Tesco's, which has the effect of putting her proposed twenty five pounds in perspective. Compared with the hundreds of pounds spent by Vicky's mum, twenty five does not make the two children of the word problem as rich as Eleanor first suggests. Both students then engage in a short competition concerning whose mum spends the most, their accounts using extreme cases (Pomerantz, 1986), such as "my mum keeps doin' it" (line 106) and their particular roles as daughters, which allows them to make claims that are credible and hard to challenge (Edwards & Potter, 1992, p. 160). Thus, in the part of the extract discussed above, the two students use attention to narrative experience *to discuss a generic detail* (twenty five pounds).

Having established that both their mothers spend hundreds of pounds in the supermarket on a regular basis, twenty five pounds is an acceptable amount for the two children in their word problem. Attention returns to generic considerations (line 109) and continues with the building up of a shopping list for the children in the problem. Vicky then makes a link between the hypothetical problem situation and the earlier discussion of their mothers' spending habits, "they're going shopping for their mum" (line 131), thus reinforcing the link between the world of the problem and their own reported experience. The two students use these accounts *to build up a shared sense of what their word problem is about*, relating their stated experience of the world with the problem they are producing.

After further work, Vicky and Eleanor eventually solve their supermarket problem, as shown in Extract 8.6 (below):

#### Extract 8.6

- 290 E yeah we just got one more  
291 V two children go to the supermarket/ twenty five pound  
292 E you've got to say what you think you're/ doing/ cause it's recording  
293 V yeah/ right/ twenty five pound  
294 E yeah  
295 V twenty five pound/ take away//  
296 E (*sings*)  
297 V shush//

298 E    yes/ (we did the) same thing last week  
 299 V    what/ is it the (...) next week  
 300 E    I know/ (...) does assemblies on tuesday (...) (*sings*)  
 301 V    (you've) got fifty p./ from twenty five pound  
 302 E    haha/ what/ they've spent/ they've got  
 303 V    yeah/ left  
 304 E    fifty p./ okay/ we're done  
*IB/5E&V: 13/7/00*

Despite Eleanor's suggestion that Vicky talks about what she is doing, there is little discussion around the solution of Vicky and Eleanor's problem. There are, however, arguably links to their earlier discussion. When Eleanor says "twenty five pound" (line 293), rather than 'twenty five', for example, her words link back to the earlier discussion concerning the suitability of this amount of money, as well as the broader discussion about supermarkets. For Vicky and Helena, therefore, twenty five pounds is not an abstract quantity conjured up by the text of the word problem. Instead, through their earlier discussion, it relates to their experiences of shopping and spending money. Similarly, when Eleanor says "they've spent/ they've got" (line 302), 'they' are not brought into being by the word problem, "they're going shopping for their mum" (line 130), much like Vicky and Helena might go shopping for or with their own mums. Hence, the earlier use of attention to narrative experience *provides a link between the creation of the problem and its solution.*

Extracts 8.5 and 8.6 provide evidence for similar uses for attention to narrative experience to those described in the first part of this chapter for Cynthia and Helena. These extracts also, however, exemplify an additional use of such attention. Discussions of the sort shown in Extract 8.5, in which students apparently digress into discussions of experiences outside school, are often treated as only indirectly related to the business of school work. Maybin (1994, 1996), for example, refers to such interaction as 'informal talk' and shows how students work with issues of identity in such exchanges. In particular, they construct aspects of their identities as part of their ongoing social relationship with each other. Consider once more Vicky and Eleanor's discussion involving attention to narrative experience concerning how much money their mums spend at the supermarket:



### Extract 8.7

- 99 E and I'm going to the market on sunday to get some steak and then I go to  
100 town to get some new shoes/  
101 V twen-/ twenty five pound  
102 E gosh/ you must be rich/ fifty p. (*laughs*)  
103 V my mum spends/ three hundred and seven pounds at Tesco's  
104 E oh my gosh/ my mum spent/ my mum spent four hundred in Tesco's  
105 before/  
106 V but the thing is my mum keeps doin' it  
107 E I know/ they goes to the/ supermarket/ like every day/ to get munchies/  
108 sweets/ (*tuts*)

1B/5E&V: 13/7/00

Eleanor first describes her own plans to go on a shopping trip. When Vicky suggests twenty five pounds as the amount for their word problem, Eleanor comments "you must be rich" (line 102), which can be heard in relation to her previous shopping plans.

Although Vicky is suggesting an arbitrary amount for an invented word problem, Eleanor uses the suggestion to offer a judgement about Vicky's personal circumstances. Vicky responds by in a sense confirming this judgement by reporting that her mum spends a much *greater* amount of money than twenty five pounds, supporting her account with the detail of a particular shop, Tesco's. By attributing this spending to her mum, however, she distances herself from Eleanor's claim 'you must be rich'. If anyone is rich, it is Vicky's mum, not Vicky herself. Eleanor then gives her own account, using a similar format to Vicky's and increasing the amount spent slightly. By echoing Vicky's account, Eleanor identifies with her peer. Her words can be glossed as implying 'I'm like you'.

Vicky, however, attempts to create a degree of difference between the two students, arguing that her mum "keeps doin' it" (line 106). Eleanor again identifies with this account, however, first by agreeing with emphasis, "I know" (line 107). She then repeats Vicky's claim, this time referring to 'they' and providing a reason for this behaviour. By using 'they', Eleanor places herself as sharing Vicky's point of view, 'I am like you'. Hence, the two students' attention to narrative experience is *used to develop the social relationship between the two students*.

This additional use of attention to narrative experience can be seen in the following extract in which Safia (EAL 2-3) and Helena (non-EAL) are writing a problem about

going to a burger restaurant. This is the second problem they have written. The first was finalised as (unedited):

Leanne went to a Rock 'n' Roll  
concert, it cost £11.50 for one person  
and there was 12,163 people there when  
the show started and the doors were closed.  
How much money did the concert Raise  
altogether?

They are now discussing generic aspects of their second problem, which started from an opening suggested by Helena:

#### Extract 8.8

- 190 H oh/ yeah/ Paul and Chris/ went/ to/ McDonalds/ and had fifty seven  
191 meals/ which cost three pounds/ chicken burger and chips/ joke/ yeah  
192 yeah yeah yeah write it actually// what's that say?  
193 S McDonalds/ I can't spell it properly I don't  
194 H it says mac-a-donalds  
195 S I know *rubbing out*  
196 H McDonalds/ or Kentucky Fried Chicken/ just write McDonalds *M C* not  
197 *M A C*/ never mind/ went to Paul and Chris went to went/ to McDonalds/  
198 to/ McDonalds/ they bought/ seventy eight  
199 S okay just a sec  
200 H *B O*  
201 S I know how to spell it/  
*1A/5S&H: 21/6/00*

As Safia writes out their problem, the discussion between the students has become somewhat tense, with Helena being constructed as rather headstrong. Helena, for example, uses imperatives (“write it actually,” line 192; “just write McDonalds,” line 196) and emphasis “went to went/ to,” line 197). Safia, meanwhile accounts for Helena’s portrayal of her spelling as incorrect as due to her own deficiency, “I can’t spell it properly I don’t” (line 193). Her account is interrupted by Helena who reinforces the issue by reading out Safia’s writing in an unorthodox manner. By agreeing with this reading, Safia is further constructed as in a subordinate position to Helena. Several turns later, Safia attempts to hand responsibility for writing to Helena (line 218, Extract 8.9), which Helena does not accept, attending instead to the written form of the problem, instructing Safia to write ‘three pounds’ (the cost of the burgers):

### Extract 8.9

- 218 S three pounds/ why don't you write it out and I'll check it/ I can work that  
219 out actually  
220 H three pounds please  
221 S what were you going to say/ hmm?/ what were you going to say  
222 anyway?  
223 H um actually/  
224 S [ you've/ *rubbing out*  
225 H [ let's do five million/  
226 S nah  
227 H no just do it/ they bought/ no just say/ they bought five/  
228 S wait/ wait wait wait wait  
229 H thousand/ six hundred/ and fifty four  
230 S can you eat that many?  
231 H no but  
232 S can a human being eat that many  
233 H no/ they shared it amongst the concert  
234 S you're mad/  
235 H this is to do with the concert/ why're you writing twenty for?  
236 S cause/ five million/ blah blah blah won't [ really (...)  
237 H [ alright though you can work  
238 that out easily/ you need a/ you don't need a calculator to work that out//  
239 just write/ five/ just write five/ put a comma thing/  
240 S dot comma  
241 H no just write that/ just that little thing  
242 S decimal  
243 H no/ just little thing there  
244 S [ what little thing?/ I don't know what you're talking about  
*IA/SS&H: 21/6/00*

It is in the context of the rather strained discussion that has been taking place that the two students consider the generic detail of how many burgers Paul and Chris should buy. Helena suggests "five million" (line 225). Safia disagrees, "nah" (line 226) but Helena does not accept this disagreement, instructing Safia to write what she is told, "no just do it" (line 227), although she does reduce the number of burgers to "five thousand six hundred and fifty four" (lines 227-229). Safia then shifts attention to narrative experience: "can you eat that many?" (line 230), in this case based on practical, 'real life' reasoning. Within the word problem genre, the number of burgers is arbitrary. What effect does Safia's shift in attention have? Unlike Safia's immediately previous disagreements, Helena responds to Safia's question. Instead of ignoring Safia's view, she accepts its legitimacy, "no but" (line 231). Safia then generalises her point to encompass the entire human race, "can a human being eat that many" (line 232), an example of an 'extreme case formulation' (Pomerantz, 1986). By formulating her position as an extreme

case Safia makes it much harder for Helena to refute, since if no human being can eat so many burgers, it is hard to justify the protagonists buying so many (Edwards & Potter, 1992, p. 162). Helena's response maintains the attention to narrative experience, proposing a link between the problem under discussion and the previous one about a concert. Hence once again, attention to narrative experience is used *to negotiate a generic detail* for a problem. In shifting attention to narrative experience, Safia also uses that attention to assert herself in relation to the subordinate position in which she has been constructed. When the two students attended to genre or to written form, Helena was constructed as dominant. By shifting her attention to narrative form, Safia resists this construction. Thus Safia uses attention to narrative experience *to develop her social relationship* with Helena.

Using the preceding extracts from recordings of Vicky and Eleanor, and Safia and Helena, I have shown how the five uses of attention to narrative experience highlighted in the first part of this chapter, are all found in other transcripts. I have also identified an additional use relating to the social relationship between the participants. As the analysis shows, however, this use is interwoven with the other five.

To conclude this chapter, I will now return to the substantive questions I set out in response to parts of the literature on word problems:

### **Use of attention to narrative experience and writing and solving word problems**

At the beginning of this chapter, I set out three questions arising from the finding that some of the participants in this study attend to narrative experience as part of their talk in writing and solving word problems with a fellow student. The analysis and discussion carried out in this chapter suggests some progress. I will address each question in turn.

*How do the students in this study use attention to narrative experience to work on their task?*

I identified six uses of attention to narrative experience in the data collected for this study:

- proposing and discussing generic details;
- establishing (taken-as) shared sense for their emerging word problem and its solution;
- agreeing on shared ideas of what generic details refer to;
- supporting changes in the mathematical structure of the word problem;
- linking the development of the word problem with its solution;
- negotiating students' social relationship.

I am not claiming that these are the only such uses, that all six uses will be used by all students or at all times. Nor am I claiming that these uses are mutually exclusive categories. I have, however, shown some possible uses for attention to narrative experience, which, as I have demonstrated, do arise in the interaction between some students, some of the time.

*In particular, how, if at all, is attention to narrative experience used to relate the 'hypothetical experiences' portrayed in word problems to students' direct experience of the world?*

Those pairs or groups of students in this study who did attend to narrative experience used it in a number of ways relating to the creation of shared sense. Students particularly attended to narrative experience to negotiate generic details for their problems, such as by accounting for suggested costs for items in a shop, or for suggested amounts of pocket money. Two students also used attention to narrative experience in relation to written form and mathematical structure, although this was unusual in this body of data. Students also used attention to narrative experience in the form of accounts of events or situations which provided a more developed context for the word problems they were engaged in writing. Thus, by discussing shopping trips or pocket money, the participants were sharing accounts of their experience of the world, accounts which could then act as a general backdrop for discussions about the details of the word problem. Their word problems were not generally set in identical situations to those produced in such

accounts. Rather these sharings seemed to act as a way of connecting the two students with each other and with their word problem. In this way, then, attention to narrative experience is used to relate the 'hypothetical experiences' used in word problems (Lave, 1992), including those created by the participants in this study, to the students' own experience of their world.

My focus on attention as social action means that I have been able to examine how attention to narrative experience is used by students, regardless of what the 'content' of that attention means to those students. I do not need to know whether Cynthia's mum *really* does not like dresses to be able to see how Cynthia and Helena create a coherent, meaningful scenario drawing on their narrative experience of the world.

*How is attention to narrative experience implicated in the students' solutions to their word problems?*

Word problems have been shown to be particularly challenging for EAL students (Secada, 1991). When it comes to the role of attention to narrative experience in EAL students solving their word problems, the evidence is less abundant. There is generally much less discussion recorded during the solving stage of the task, with the word problems often being divided between the participants to do individually. In the case of Cynthia, however, it seems that the attention to narrative experience in the discussion through which the problem was composed is echoed in her rapid production of its solution. She does not need to move from words to scenario to calculation and back to words in a laborious 'decoding' approach to solving the problem. There is a sense in which she is in all these places at once. The words, the scenario and the structure of the problem are all linked through the work she and Helena have done to create a problem that is meaningful for them.

## Chapter 9

# **‘Call that a division one?’: The use of attention to mathematical structure in writing and solving word problems**

In Chapter 7, I described four patterns of attention in the interaction recorded for this study. These four patterns of attention were to genre, to narrative experience, to mathematical structure and to written form. In the previous chapter, I explored how attention to narrative experience was used by the students to write and solve their word problems, particularly in relation to attention to genre. The focus of this chapter is on the *use of attention to mathematical structure* in the interaction between students as they work on the word-problem task. Like the previous chapter, this one begins with a brief look at aspects of the literature on word problems in order to raise three substantive questions. To address these questions, I will initially focus on two sequences from Cycle 2 in which attention to mathematical structure plays a key role in the development of the students' discussions. Drawing on these two sequences, I illustrate a number of different uses of attention to mathematical structure. I will then consider examples of the use of attention to mathematical structure from elsewhere in the data. I conclude the chapter by returning to the substantive questions raised in the first part of this chapter. Through addressing these questions I demonstrate the efficacy of the methodological approach developed in the first part of this dissertation.

## The structure of word problems

To work with arithmetic word problems, students must at some point engage with the structure of the problem. They must consider how the various aspects of the problem are related to each other and carry out an arithmetic calculation. In Chapter 7, I drew on Verschaffel *et al.* (2000), for a definition of the structure of a word problem:

the nature of the given and unknown quantities involved in the problem, as well as the kind of mathematical operations(s) by which the unknown quantities can be derived from the givens...[and] the way in which an interpretation of the text points to particular mathematical relationships (Verschaffel *et al.*, 2000, p. x).

This definition does not concern any particular operation which may be used (or expected to be used) to solve a word problem, but is concerned with the mathematical relationship between the various quantities which occur in such problems. Most word problems can be solved in several different ways using different operations (Verschaffel *et al.*, 2000, p. 134). In attempting to solve a word problem, students must engage with its mathematical structure, that is, they must consider the 'given and unknown quantities' and mathematical operations of the problem, as well as the relationship between them. As I demonstrated in Chapter 7 (pp. 106-114), the students in this study sometimes attend to the mathematical structure of the word problems they are in the process of writing. On occasions, for example, students attend to the operation their word problem is 'about' or to a particular arithmetic relationship between two of the quantities included or proposed. This finding raises questions about the role of EAL and non-EAL students' attention to mathematical structure:

- How do the students in this study use attention to mathematical structure to work on their task?
- What is the role of attention to mathematical structure in how students solve their word problems?
- How is attention to mathematical structure related to the requirements of the task?

To address these questions, I will first draw on my analysis of a sequence from a transcript featuring Tahira (EAL 2) and Verity (non-EAL), to highlight three uses of their



attention to mathematical structure. Later in the chapter, I compare these uses to those drawn from extracts from two other transcripts.

### **Tahira and Verity's use of attention to mathematical structure**

In this section I draw on my analysis of a sequence in which Tahira (EAL 2) and Verity (non-EAL) write their first word problem in the recording session. Their problem is about sharing sweets. I have selected this sequence as mathematical structure becomes an explicit focus of discussion during the students' work on their problem. The two students also attend to other aspects of their task, particularly generic ones. My interest in this chapter, however, is on their attention to mathematical structure. In conducting my analysis, I am interested in moments when attention is shifted, either from or to mathematical structure. Drawing on the discursive approach to analysis discussed in Chapter 5, I then consider what these shifts are used to do.

My analysis of the sequence featuring Tahira and Verity reveals three *uses of attention to mathematical structure*:

- justifying generic details,
- managing the social relationship between the participants,
- criticising the emerging word problem.

The evidence for these uses of attention to mathematical structure comes from my discursive analysis of the sequence I have selected. This evidence is set out below, in the form of extracts from the sequence and accompanying analysis. First, however, I will briefly describe the nature of the two students' discussion.

#### **If you had twelve sweets**

During the first recording of Tahira and Verity working together, they write 3 word problems (see Appendix III, p. 235). All of their problems begin with the word 'If...'. The sequence which forms the starting point for my analysis records my introduction to the

task, followed by the production of their first word problem. They begin by considering topics which are then discarded before settling on 'sweets' as a scenario.

The sequence begins with my instructions for the task, which involves writing word problems 'about' division:

Extract 9.1

7	RB	yeah?/ word problems/ you remember about word problems?/ okay/ um/	
8		all I want you to do/ for a few minutes/ is/ write/ together/ I want you to	
9		write/ some word problems for me/ about division/ okay?/ so together	
10		write some word problems about division/ um I'll give you about ten	
11		minutes and then see how you're getting on/ okay?//	
12			<i>RB</i>
13	V	how many people/ how many/ how many people/ were there/ if there	<i>withdraws</i>
14		were/ ten people// if there were ten people and/ um/ you had a big cake/	
15		had/ a/ had/ a big cake// and	
16	T	^it's wrong/ it doesn't make sense [(...)^	
17	V	[ if there were ten/	
18	T	people/ and you a big p- cake	
19	V	wait a minute/ if there were ten people and you	
20	T	had	
21	V	had	
22	T	[let's rub that out	
23	V	[if	
24		what this	
25	T	there	
26	V	you	
27	T	can I have a rubber mister Barwell/	
28	V	[yeah	
29	RB	[there's one on the end of you pencil/	
30	T	oh/ sorry	
31	V	if you had// a big cake and shared it/ shared it/ into two/ it/ into two//	
32		how many pieces no/ how many c- how/	<i>paper</i>
33	T	^(...)^	<i>turned over</i>
34	V	could you/ tell me your (birthday)/ so I can write it down// can't you	
35		think of one/	
36	T	I can think of times one	
37	V	mm	
38	T	if/[ if there were um	
39	V	[ y-	
40	T	if you had um/ twelve sweets	
41	V	twelve/ sweets/	
42	T	and you had um/	
43	V	you had/ how many people?/ six people	
44	T	six people	
45	V	yeah 'cause half of twelve is six/ if you/ had	
46	T	six people	
47	V	six people/ how many sweets/ how many sweets would they get each/ ac-	
48		no/ actually/	
49	T	twelve divide six	

50 V yeah twelve divided by six/  
 51 T do times  
 52 V no we're not allowed to do times/  
 2B/4T&V: 5/12/00

### Justifying generic details

After I introduced the task, the two students attempt to produce a problem concerning a cake. Their discussion is somewhat fractured, involving Tahira asserting that Verity's idea does not make sense (line 16) and an agreement to rub out what they have written. Verity then asks Tahira to say when her birthday is so that she can write it down (line 34), though it is not clear for what purpose since Tahira does not respond. Verity treats the pause as relevant, and as concerning Tahira thinking, asking "can't you think of one" (line 34-35). 'Not being able to think of one' is here used to account for Tahira's non-acceptance of Verity's possible proposal of a problem about birthdays, as well as her non-contribution of an idea for an alternative. Tahira says that she can think of a "times one" (line 36), thus partially agreeing with Verity that she cannot think of a division problem as requested, whilst avoiding the appearance of being entirely bereft of ideas. An opening line is agreed and written down, 'if you had twelve sweets' (lines 38-41). Attention is on generic aspects of the problem, with its future course still very open. There are many possible problems that begin 'if you had twelve sweets'. Tahira offers a further few words, which still do not close down the problem, "and you had" (line 42). Verity then moves the problem on, shifting attention from generic details to mathematical structure as she does so:

43 V you had/ how many people?/ six people  
 44 T six people  
 45 V yeah 'cause half of twelve is six/ if you/ had

Verity first echoes and writes down, and so clearly accepts, Tahira's previous contribution, "you had". She then asks "how many people?", her question inviting attention to a generic detail of the problem whilst also bringing it into existence. Framed as a question in this way, followed by a pause, this move includes Tahira, who has the possibility of responding. Verity answers her own question, however, moving the task forward in a few words. Tahira's repetition of Verity's new detail "six people" (line 44)

is treated by Verity as a request for an account or justification for her suggestion, which she provides through a shift in attention to mathematical structure: “yeah ‘cause half of twelve is six” (line 45). Her *use of attention to mathematical structure acts as a justification* for her earlier suggestion of the generic detail ‘six people’. Indeed, it is difficult to see “half of twelve is six” acting in any other way. Consider some of the alternative ways this exchange could have been. At line 43, Verity could have said ‘you had/ six people/ half of twelve is six.’ The recourse to structure seems to act as a justification, even without the causal language of “‘cause”. Even if the structure is introduced first, it still appears to act as a justification. At line 43, for example, Verity could have said, ‘half of twelve is six/ so let’s do if you had six people.’ Thus, in this exchange, attention to structure acts as a justification for a development in the generic aspects of the problem.

### **Managing the social relationship**

What is achieved by using attention to structure in the way described above? Other forms of justification are possible. Verity could have said ‘trust me’, or ‘I know best’, or ‘obviously’, all persuasive devices rather than accounts for her ideas. Alternative accounts could have involved invoking previous experience of word problems, remembering a particular problem or citing the teacher, for example. All these possibilities, however, rely on Verity and therefore have implications for the social nature of the discussion. In particular, such approaches require Tahira to accept either Verity’s judgement or her memory. Attending to mathematical structure, by contrast, distances Verity from her account, so making it both more authoritative and less personal (Edwards and Potter, 1992, p. 162). Her account, in effect, appears to be more ‘objective’. Thus, *attention to mathematical structure is also used to manage the social relationship between the two participants.*

### **Criticising the emerging word problem**

Following Verity’s justification, Tahira accepts the generic detail ‘six people’ indicated by her completion of the phrase “if you had” started by Verity (line 46). Verity then

completes the problem by offering a question, "how many sweets would they get each." She backtracks on this idea, "ac- no/ actually". Her attention is once again, however, on generic aspects of the problem. Tahira shifts attention to mathematical structure once more, "twelve divide six." Tahira's reformulation of Verity's earlier "half of twelve is six" (line 45) appears to be an 'answer' to the 'question' that Verity has posed in completing the problem. Although Verity is engaged in writing a question as part of the task of writing a word problem, Tahira has taken the opportunity to treat it as a 'live' question, and questions generally demand answers (Sacks, 1987). What does she accomplish by shifting attention to structure once more? In her next turn, Verity affirms Tahira's reformulation, "yeah twelve divided by six" (line 50). Tahira has succeeded in bringing Verity's attention explicitly back to structure, with that structure formulated in terms of division. This, then, allows Tahira to make a comment on the structure of the problem. She says "do times" (line 51) (this interpretation is supported by Tahira's intonation), linking back to her offering at the start of this extract to think of a "times one" (line 36). This earlier remark has framed the whole of the two students' discussion: that is, as 'thinking' of a times one. They have portrayed their problem, however, as a division problem, as Tahira acknowledges through her injunction to "do times". Tahira's redirection of attention (line 49) is rhetorically managed as an answer to Verity's statement of the problem's question. This shift, however, is also used by Tahira to criticise the problem that has emerged as not conforming to her originally expressed intention. *Mathematical structure is used to criticise the emerging word problem.* This form of criticism works through its appearance of logic-based objectivity, avoiding direct personal criticism of Verity (Edwards & Potter, 1992, p. 162).

### **Use of attention to mathematical structure**

Using the above analysis, I have provided evidence for a number of ways in which attention to mathematical structure is used by the two students in their talk as they write and solve their word problem.

Attention to mathematical structure is *used to justify generic details*, such as the choice of numbers to include in the word problem. Verity, for example, justifies the selection of six

as the number of people in the word problem she is writing with Tahira, by arithmetically relating six to the previously agreed detail of twelve sweets. This justification, it should be noted, is accepted by Tahira; both students are implicated in their interaction.

Attention to mathematical structure is also *used to criticise the provisionally created word problem*. By attending to mathematical structure, Tahira is able to criticise the word problem as not conforming to an earlier stated objective to write a 'times one'.

Both justifying and criticising using attention to mathematical structure avoid personalising the discussion drawing on the 'objective' nature of mathematical reasoning. Thus, a third use of attention to mathematical structure is *to manage the social relationship between the two participants*.

The uses of attention to mathematical structure described above are more widely apparent in the corpus of data collected in this study. My analysis of other transcripts, however, reveals two further, though related uses:

- modifying word problem structure;
- solving word problems.

These two uses are illustrated in the next section.

### **Use of attention to mathematical structure in other transcripts**

In this section, I want to illustrate two ways in which these social uses for attention to mathematical structure are themselves part of broader activities. The first I will discuss is the role of the attention to mathematical structure in modifying the structure of the word problem under construction. The second concerns students' use of attention to mathematical structure in carrying out calculations as part of the process of solving their word problems.

## Modifying word problem structure

Attention to structure is regularly used to justify changes to the emerging word problem. Such changes are generally generic in nature. On some occasions, however, the structure of the problem is itself modified. One such occasion was discussed in Chapter 8 (pp. 131-133), in which Cynthia (EAL 2) and Helena (non-EAL) modify their problem about presents for Cynthia's mum by including a second present. This change was motivated by Cynthia's observation that there was money left over from the purchase of the first present of a music box. In that case, attention to narrative experience appeared to be the primary justification for the structural change, although the two students did explicitly relate the two areas of attention. In the following extract taken from the first recording of Cynthia and Helena, in which they were asked to prepare addition word problems, a change in structure is brought about through their attention to mathematical structure. The two students are working on their first problem and have agreed to use the name of a student in their class as the starting point for their problem.

### Extract 9.2

- 56 H Daniel um *writes*  
57 C Daniel um  
58 H went to the shop  
59 C n-no can/ umm/ um write that/ Daniel work/ n-no/ Daniel/ w=um/  
60 Daniel/ well if he work/ (...) he have/ he have/ hundred pound/ and how  
61 many/ in/ the month/ (for example) like easy one  
62 H but you've got to use it in addin'/ addin'/ addition/  
63 C oh yeah  
64 H so you say Daniel/ yeah it's kind of like a addition thing isn't it/ because/  
65 Daniel went to work/ he had hundred pound/ a month?  
66 C um/ a week  
67 H oh that's ^(okay then)^ a hundred pounds a week/ how many/ how many  
68 um/ how ma=how much money do he have in a month  
69 C yep  
70 H (okay then)  
71 C Daniel work  
72 H Daniel work/ has a job?  
73 C no Daniel has a job/ no no/ Daniel work/ one week/ a hundred pound  
74 H no wait/ Daniel has a job/ he worked one/ [ week/ he has a hundred &  
75 C [ week  
76 H pounds/ how many/ how many what?/ how many  
77 C oh like that like that like that/ um/ like that like that/ Daniel work/ um/  
78 no/ Daniel/ no/  
79 H [ work  
80 C [ have a job/ um no/ Daniel have a job/ one month he have err/ um/





many in a week" (lines 80, 81), changing Daniel's wage from 100 to 4,340 pounds. She also reverses the relationship between weeks and months, so that Daniel's wage is for a month and the question is about how much he gets in a week. This version is therefore in contrast to Helena's previous formulation in which Daniel's wage was per week and the question concerned his monthly income. Helena accepts Cynthia's new version (line 86) and begins to write the word problem onto the paper.

### Extract 9.3

86 H okay// Daniel/ [ Daniel has a job/ he gets paid *writes*  
 87 C [ has a job  
 88 he got/ uh he get/ he got/ four hundred and fifteen pound in a week  
 89 H what?  
 90 C four hundred and fifteen pound in a week  
 91 H paid/ how much?  
 92 C four hundred fifteen/ pound on a week/ no/ on a month  
 93 H 'kay/ four hundred fifteen pound  
 94 C in a week/ no no/ in a month  
 95 H in *writes*  
 96 C month  
 97 H a  
 98 C month  
 99 H month  
 100 C how many in a week/ no oh yeah/ how many in a week  
 101 H (...) okay then/ how many/ how many/ how much money does he get/ in  
 102 a year/  
 103 C in a week  
 104 H a week?  
 105 C no that's (...)  
 106 H no cause/ you said in a month/  
 107 C yeah/ no/ I said/ [ no/ I said/ Daniel has a job he gets paid four &  
 108 H [ how many  
 109 C hundred and fifteen pound in a month/ how many in a week  
 110 H how much he gets  
 111 C yeah/ how-how much he get/ on one week  
 112 H that's dividing innit  
 113 C oh yes that's divide/  
 114 H that's sort of like dividing cause there's four/ four weeks in a month so  
 115 that's four divided by (three) I mean four hundred and fifteen  
 116 C I'll just do/ how many in a year// [ ^(...)^  
 117 H [ 'kay/ how// many// does// he// get *writes*  
 118 C your turn//  
 1A/OC&H: 21/5/00

As Helena writes the problem, she speaks the words out loud, thus inviting Cynthia to comment on them and so participate in their production. Cynthia does so, by continuing Helena's words. Thus, for example, Helena reads out "Daniel has a job/ he gets paid"

(line 86) and Cynthia continues, giving yet another formulation, "he got four hundred and fifteen pound in a week" (line 88). This elicits an expression of surprise from Helena. Cynthia then repeats the new version, emphasising the word 'week'. Helena accommodates this new version, requesting the amount so that she can write it down. In repeating herself, however, Cynthia corrects 'week' to 'month'. As Helena writes down the problem, reading out the words as she does so, Cynthia repeats the word 'month' several times, until Helena has written it down (lines 92-99). This repetition serves to counteract any possible uncertainty engendered by her earlier change. The problem is now half written and concerns Daniel earning 415 pounds in a month and can be completed with a suitable question. Cynthia proposes "how many in a week" (line 100). Helena proposes "how much...in a year" (lines 101, 102), emphasising 'year' as of key relevance. Cynthia repeats her own version "in a week" (line 103). Helena now questions this form of words (line 104) before providing a reason for her query "no cause/ you said in a month" (line 106). The discussion hinges around the choice between year and week with both students restating their positions (lines 107 – 111). The impasse is only broken when Helena *shifts attention* explicitly back to the structure of the problem "that's dividing innit" (line 112), emphasising the arithmetic operation she sees Cynthia's version as entailing and linking mathematical structure to the *choice of generic detail*. Helena uses attention to mathematical structure *to criticise* what Cynthia is proposing, a criticism which Cynthia accepts. Helena reinforces her argument by setting out the mathematical relationship between weeks and months (line 114), drawing on the authoritative, objective rhetoric of mathematical argument (Edwards & Potter, 1992, p. 162). This rhetoric allows her *to manage her social relationship* with Cynthia by distancing Helena from her criticism. Her argument can be seen as persuasive since Cynthia now accepts Helena's version "how many in a year" (line 116), restating it in her own words, rather than concede directly to Helena's point of view. In accepting 'year' rather than 'month', the two students have negotiated a change from what they saw as a division problem, to one requiring addition. Of course, the operation of addition could play a part in either alternative. As well as negotiating a change in structure, therefore, the two students have also negotiated a jointly shared interpretation of what their word problem means. In Verschaffel *et al.*'s (2000, p. x) terms, the development of semantic

and mathematical structure are inseparably inter-related. For these two students, a division problem has been turned into an addition one. This change in the structure of their problem arose from the structural attention introduced at the start of their deliberations and returned to later in the discussion. In both cases, attention to mathematical structure acted in the form of a criticism. Although in both cases the shift to mathematical structure was initiated by Helena, it was taken up by Cynthia as a tacitly acceptable aspect of their discussion. Attention to mathematical structure is therefore *used to modify the structure of their word problem.*

### Solving word problems

Part of the task used in this study entailed solving the completed word problems. In many of the recordings, the participants elected to solve their problems individually, often in silence. Sometimes, however, some level of talk around the solution did occur. In the following extract, for example, Tahira (EAL 2) and Shaheen (EAL 2) are solving a problem they prepared earlier in the recording. Shaheen begins by reading out the problem:

#### Extract 9.4

- 134 S if I had a plank of wood that was forty centimetres and I added another  
 135 plank of wood that was eighty centimetres what is the total answer  
 136 T alright  
 137 S we have to [ add  
 138 T [ forty  
 139 S forty add eighty  
 140 T forty cent-  
 141 S forty [ cent-  
 142 T [ forty centimetres add eighty centimetres  
 143 S okay [ we/ put centimetres/ zero/ um/ eight  
 144 T [ um  
 145 S add four is err/ there's eight//  
 146 T um// err/  
 147 S thirteen/[ no (...)  
 148 T [ no=no/ let's check double check it/  
 149 (sound of pencil marks)  
 150 S twelve  
 151 T one hundred and twenty/ that's the answer  
 152 S twenty centimetres  
 153 T we've done/ we've done

to RB

3B/SS&T: 22/6/01

The two students jointly work their way through from reading the problem to an agreed solution, each building on preceding contributions. Shaheen begins their thinking by using attention to mathematical structure to assert, “we have to add” (line 137), thereby offering an arithmetic interpretation of the problem. Her assertion is overlapped by Tahira, however, who focuses on a generic detail, “forty” (line 138), thus making it relevant. Shaheen combines these two turns plus an additional generic detail to make a structural statement “forty add eighty” (line 139). Tahira relates this abstract statement of a calculation to the more specific aspect of the problem, reformulating the numbers as centimetres (lines 140, 142). The two students then work through an addition calculation. At this stage, Shaheen is taking the calculation forward, while Tahira keeps her place with discourse fillers like ‘umm’. Thus, Shaheen states “we put centimetres/ zero/ um/ eight” (line 143) and then “add four is err/ there’s eight” (line 145) before coming up with a total “thirteen” (line 147). Although Tahira appears to have been contributing little, at Shaheen’s total of thirteen, she disagrees (as does Shaheen), managing the dispute by suggesting that they ‘double check’ (line 148). They do so and this time Shaheen comes up with the total twelve (line 150) which Tahira interprets into the problem solution “one hundred and twenty/ that’s the answer” (line 151).

Most of the talk in this extract shows attention to mathematical structure. This observation may seem unsurprising, since the two students are solving a word problem. I am nevertheless interested in what this attention to mathematical structure achieves. In this extract, explicit attention to structural aspects of the problem makes the emerging solution accountable. By providing public accounts of particular relationships between the quantities *in* the problem, or between the quantities *and* the problem, both students are also accounting for their actions. In so doing, they each enable the participation of the other, since their accounts are public and open to evaluation and modification. This approach creates a collaborative process involving both students, an approach reinforced by Shaheen’s use of ‘we’ (line 143). This small word has the effect of maintaining the inclusive nature of the two students’ thinking, whilst also adding a degree of authority to Shaheen’s method of approaching the calculation. The word works both as the generalised voice of the mathematics classroom (Pimm, 1987, pp. 64-73) and as a means to include Tahira. Thus, attention to mathematical structure plays a role in the joint

process of solving a word problem through the social acts of accounting for the mathematical actions of the participants.

In some of the recordings, attention to mathematical structure is sometimes linked to difficulties or errors in students' talk about their solutions. In the first recording of Farida and Parveen, for example, mathematical structure emerges as a factor as they solve a set of problems they have just written. Their problems are:

If you have 20 sweet and you gave away 8 how many have you leaft?=  
=

If you have 4 paper and you had two partns eath what shaell we do with the paper?=  
=

If you have 5 childre and 20 Book how many can you give the Book?=  
=

If we have 58 peiln and we find 68 peiln How many or together?=  
=

If you have 200 pound and we gave 68 pound gave someone ease and how much you have left?=  
=

The sequence in which the two students solve their problems begins as follows:

### Extract 9.5

256 RB yeah no/ five's enough/ okay/ but what I'd like you to do now/ is/

257 [ to work out the answers for me? as well/

258 P [ pound

259 easy

260 RB make sure they're okay

261 P we gave

262 F we can work on a computer

263 P (laughs)

264 F (use) the calculator

265 P gave um/ sixty eight pounds

266 F these are all add/ remember/ so we put a [ sentence/ maths/[ but/ add

*calculator*

1A/2F&P: 20/6/00

Having been asked to work out their answers, Farida asserts that "these are all add/ remember" (line 266). This statement, which makes a structural evaluation of the

problems the two students have prepared, is echoed throughout the process of working out the solutions (e.g. Extract 9.6, lines 294, 308).

### Extract 9.6

- 290 P if we have twenty sweet and/ we gave eight sweet/ how many have you  
 291 left/ we have twenty add/ minus  
 292 F eight/ *calculator*  
 293 P twelve/  
 294 F why're we minus/ because we add?  
 295 P no it's okay/ it's okay/ first/ I do a line here/ now you do yours  
 296 F oh/ wait/ what/ answer// *writing*  
 297 P Farida/ I think you're dumb/ look/ this line's will be go there  
 298 F oops  
 299 P you do yours/ I rub this out this/ stupid line yeah?// (*rubbing*) that's fine//  
 300 now this is gonna be line there/ and this is gonna be a my line/ your line/  
 301 my line  
 302 F 'kay/ ooh (*inaud*)// right// off/ (*clear*)// four papers add two  
 303 P what what what what you said?  
 304 F four add two equals six  
 305 P you didn't/ oh my God/ if you have five children and twenty books/ how  
 306 many/ can you gave/ the books/ oo hard one a little bit/ um/ I do it by  
 307 myself/ thank you/ twenty  
 308 F twenty five/ cause it's add inmit  
 309 P I know/ we're giving them/ not having them  
 310 F oh yeah that's true/  
 322 P um/ five (...)/ (*laughs*) you got your five do like that five/ five/ and  
 312 twenty/ I gave one person each/ now I have mine/ oh/ one minute/ if I  
 313 gave to (each)// it's going to be a three each/ no sorry four  
 314 F four  
 315 P four books each  
 316 F do this answer/  
 1A/2F&P: 20/6/00

Parveen offers a solution for the problem "twenty sweet and/ we gave eight sweet/ how many have you left" (lines 290, 291) which entails subtracting 8 from 20. Farida evaluates this approach against her earlier assertion that "these are all add". She questions why "we minus"/ because we add?" (line 294). Unlike the previous extract involving Tahira and Shaheen, however, there is no public account for her actions from Parveen. Indeed, she marks a clear separation between her own work and that of Farida's, "your line/ my line" (lines 300, 301), disparaging her classmate in the process (lines 297-301). A similar pattern of interaction occurs as Farida solves the next problem, once again using addition. She does give an account of what she is doing, "four papers add two" (line 302) which Parveen queries (line 303). Farida gives a more mathematical

description of her actions, "four add two equals six" which Parveen again disparages, though she gives no explicit reason for this. Farida again suggests addition for the third problem (line 308) and on this occasion, Parveen gives a reason for disagreeing once again, "we're giving them/ not having them" (line 309), implying an interpretative difference between these two words which in turn argues for a different arithmetic operation. Farida accepts this argument and Parveen reasons out her solution in terms of giving "one person each" (line 312). This extract depicts a qualitatively different form of discussion from that between Tahira and Shaheen, for example. There is no sense of a collaborative building of solutions to the word problems. Instead, there is an explicit separation between the two students' work. Farida follows up her claim that "these are all add" by using addition for every problem she encounters. Parveen's responses rarely attend to mathematical structure, generally involving unsupported evaluations of Farida's contributions. This avoidance of mathematical structure can itself be seen as part of the strategic use of attention to mathematical structure by Parveen. By *not* attending to that to which Farida attends, she creates a dominant position for herself as the arbiter of what is relevant. The resulting mismatch in the two students' attention leads to a sense of tension in their interaction which could be linked to the personalised nature of Parveen's criticisms, such as "you didn't/ oh my God" (line 305), which contrast with the more distanced mathematical arguments used in earlier episodes discussed in this chapter. Farida and Parveen do nevertheless come to some form of agreed solutions, even if that agreement is reached through a division of labour and even if some of those solutions are incorrect.

The above analysis provides an important counter-example to those which have preceded it in this dissertation. I have largely analysed and discussed extracts in which the participants come to what I would interpret as a correct solution. This is not always the case, however. My analysis demonstrates that students use of the different patterns of attention I have identified is not necessarily linked to more or less successful (in mathematical terms) talk. My interest is in how the participants in this study use attention as part of the social business of working on their task, whatever the outcome of their work. Attention to mathematical structure can be used as part of interaction which leads to a correct *or* an incorrect solution. This observation raises the interesting question of

whether there is any difference in how that attention is used in the two cases, but there is nothing inherent in the attention itself which leads to one or other outcome. Furthermore, although I may interpret students' solutions to their problems as being correct or incorrect from my perspective as a mathematics teacher, I do not necessarily share the sense of the problems created between the students that produced them. Although some of Farida and Parveen's solutions appear to be incorrect, for example, their interaction presumably makes sense to the two students in some way, perhaps on the level of the on-going relationship between them, rather than on the level of their mathematics task. This argument is supported by the analysis which shows Farida to be rather rigidly interpreting all the word problems as requiring addition and Parveen as rarely attending to mathematical structure at all. Thus, although mathematical structure *is* attended to in the two students' interaction, it is used, including by being avoided, to construct Parveen as dominant and Farida as "dumb" (line 297). It is this outcome which may be the sense the two students take away from the encounter, rather than the mathematical success or otherwise of their solutions.

In this chapter, I have described five related uses of attention to mathematical structure, uses which arise throughout the data. To conclude this chapter, I will now return to the substantive questions I set out in response to parts of the literature on word problems.

### **Use of attention to mathematical structure and word problems**

I began this chapter by raising a number of questions in relation to students' attention to mathematical structure. The above analyses take me a few steps forward in addressing these issues. I will address each question in turn.

*How do the students in this study attend to mathematical structure?*

I identified five uses of attention to mathematical structure in the data collected for this study:

- justifying generic details;



- managing the social relationship between the participants;
- criticising the emerging word problem;
- modifying word problem structure;
- solving word problems.

As I observed in the previous chapter in relation to my analysis of the uses of attention to narrative experience, I am not claiming that these are the only such uses. I have, however, shown some possible uses for attention to mathematical structure, which, as I have demonstrated, do arise in the interaction between some students, some of the time.

*How is attention to structure used by students in solving their word problems?*

Attention to mathematical structure plays an important role in the solution of students' problems. In particular, by 'thinking aloud', that is by giving accounts of their mathematical actions, students also make those actions accountable, thus giving their co-participants the opportunity to evaluate, affirm or contribute to their reasoning. At the same time, the use of mathematical reasoning lends rhetorical weight to students' proposed solutions, whether they are correct or not. Reasoning in this way is therefore seen to be an inherently social process. Indeed, on occasions, as the case of Farida and Parveen demonstrates, attention to mathematical structure or avoidance thereof, forms part of a less mathematically productive discussion which serves to position one participant as socially dominant, the other as inadequate.

*How is attention to mathematical structure related to the requirements of the task?*

It is apparent from the analyses above that the nature of the task is implicated in the students' attention to mathematical structure. Criticism such as "you call that a division one," which occurred in many of the recordings, relate to the task negotiated at the start of each session. Requiring students to produce a particular kind of word problem, such as one 'about' division, frequently leads them to attend to mathematical structure at some point during the preparation of their problems. I do not need to be able to say what constitutes a problem 'about division' for the participants to see how they attend to structure in this way. This observation does not mean that in sessions where no arithmetic operation was specified students did not attend to structure. My observation is merely that

where such a specification was made, that is where *I* attended to structure in setting up the task, some students then drew on this earlier specification in order to make criticisms or justifications in their subsequent discussion which involved attention to mathematical structure. Thus, a part of my introduction to the task provided a discursive resource or catalyst for students' attention to mathematical structure.

## Chapter 10

### **‘What are you writing?’: The use of attention to written form in writing and solving word problems**

In Chapter 8, I described several uses of attention to narrative experience and, in Chapter 9, I explored the use of attention to mathematical structure by students as they write and solve their word problems. The focus of this chapter is on the *use of attention to written form*. Like the previous two chapters, this one begins with a brief discussion, in this case relating to EAL students’ writing. This discussion leads to a number of substantive questions. To address these questions, I will initially focus on two sequences from the same transcript in which attention to written form plays a key role in the development of the students’ discussions. Drawing on these two sequences, I illustrate a number of different uses of attention to written form. I will then consider examples of the use of attention to written form elsewhere in the data. I conclude the chapter by returning to the substantive questions raised in the first part of this chapter. Through addressing these questions I demonstrate the efficacy of the methodological approach developed in the first part of this dissertation.

#### **Writing and English as an additional language**

Students who, like those in this study, are learning English as an additional language find some aspects of language use more demanding than their monolingual peers (Cummins, 2000, pp. 68-69). The mechanics of writing English (forming letters, spelling words, punctuation, etc.) are likely to require more deliberation for students who have only

recently begun to learn the language. A 'dilemma' for teachers of such students (Adler, 2001, pp. 115-134) concerns the issue of whether to focus on language or mathematics. In a mathematics class discussion, for example, should the teacher correct students' mathematical English so that it conforms to more widely accepted practice, or should the teacher only be concerned with mathematics? This is a dilemma since intervening on language could on the one hand provide linguistic support and so enable the student to express their ideas more successfully, while on the other hand such an intervention moves the discussion away from mathematics. In the terms I have developed in this dissertation, the teacher is faced with the tricky task of managing shifts in attention between mathematics and linguistic form. One of the questions which Adler's work raises for me is whether this dilemma exists for students, or more generally, what happens when attention is shifted away from the immediate business in hand to considerations relating to the production of language? The task used in this study involved students writing and solving word problems. Whilst this is superficially a mathematics activity, taken from the students' mathematics lessons, there are clearly linguistic aspects to the task, not least of which is the requirement to produce a written text.

As I demonstrated in Chapter 7, the students in this study frequently attend to surface features of their writing, including spelling, grammar, punctuation and legibility. They move their attention from various aspects of the task of developing and solving a word problem, to the process of producing their problem in written form. This situation leads to the following questions:

- How do the students in this study use attention to written form?
- Does shifting attention between written form and mathematical structure present students with a dilemma?

To begin to address these questions I will examine two contrasting sequences involving Tahira (EAL 2) and Verity (non-EAL). The issues and observations raised by this analysis are followed up later in the chapter with further discussion, illustrated by a number of sequences from other transcripts.

## **Tahira and Verity's use of attention to written form**

The two sequences I will discuss come from the first recording of Tahira and Verity and chart the development of their first and second word problems. They had been asked to write problems 'about' division. The first sequence, in which they write a problem about sweets, was also discussed in Chapter 9 (pp. 149-152). In that chapter, I was focusing on the two students' use of attention to mathematical structure. In this chapter, I am interested in their use of attention to written form. The two analyses (here and in Chapter 9) of the same extract illustrate the complexity of the students' interaction, in which a great deal is going on even in a few seconds of talk.

My analysis of the sequence featuring Tahira and Verity reveals two *uses of attention to written form*:

- managing the social relationship between the two students;
- facilitating the negotiation of the wording of the word problem.

The use of attention to written form to manage the social relationship between the students may arise through:

- using attention to written form to construct a balanced, collaborative form of interaction in which neither student dominates;
- using attention to written form to monitor, criticise and regulate writing as it emerges leading to one student dominating the other.

These different uses for attention to written form are related to which of the students is acting as scribe.

The evidence for these uses of attention to written form comes from my discursive analysis of the sequence I have selected. This evidence is set out below, in the form of extracts from the sequence and accompanying analysis.

### **If you had twelve sweets**

It is important to be clear that I am conducting a moment by moment analysis. I cannot say, from these extracts, what the next moment will bring. Thus, in considering the social

relationship between participants, I am not making claims about the more 'permanent' relationship, as it might traditionally be conceived. Indeed, my analysis rather undermines the notion of a stable, homogenous kind of relationship. Rather, it shows two events of quite different import within a few minutes in the on-going series of events that make up the intersecting 'individual histories' (Bruner, 1996, p. 14) of Verity and Tahira.

In the first part of the following extract, Tahira (EAL 2) and Verity (non-EAL) attend to generic and structural aspects of their task. Some form of discussion then continues at an inaudible level for over half a minute. Verity is the scribe for this problem:

Extract 10.1

- 36 T I can think of times one  
 37 V mm  
 38 T if/[ if there were um  
 39 V [ y-  
 40 T if you had um/ twelve sweets  
 41 V twelve/ sweets/  
 42 T and you had um/  
 43 V you had/ how many people?/ six people  
 44 T six people  
 45 V yeah 'cause half of twelve is six/ if you/ had  
 46 T six people  
 47 V six people/ how many sweets/ how many sweets would they get each/ ac-  
 48 no/ actually/  
 49 T twelve divide six  
 50 V yeah twelve divided by six/  
 51 T do times  
 52 V no we're not allowed to do times/  
 53 T ^(...)^  
 54 40 secs. of whispering  
 55 T let's (do it)  
 56 V okay if you had twelve [sweets and you had six people/  
 57 T [sweets and you had six people  
 58 V how many sweets would they get each/ people  
 59 T capital/ H/ how many  
 60 V sweets/  
 61 T sweets/  
 62 V ^do^/ ^they^/ ^get^/  
 63 T ^they^  
 64 V ^have^  
 65 T each have/ how many sweets/ *rubbing out*  
 66 V each will they get  
 67 T yeah  
 68 V how many sweets/ each do they get//  
 69 T (do a) question mark  
 2B/4T&V: 5/12/00

### **Managing the social relationship: collaboration**

Following the whispered interlude (line 54), the two students begin to write out their problem and attention shifts to written form. They attend, for example, to the capital H, the wording of the question and the question mark with which they complete their word problem. How is this attention created and used? Following Tahira's injunction "let's (do it)" (line 55), the two students rehearse the opening line of their problem. Verity, who is writing, starts with the beginning of the opening line (line 56). Tahira joins in part way through, so that they speak in unison for 6 words (lines 56, 57). Verity continues by attending to genre with a formulation of a question to complete the problem (line 58), before attention shifts to the word 'people', possibly because she has now started to write again. Tahira then explicitly attends to written form, saying "capital H" (line 59), leading Verity to change what she has written. Tahira's intervention is very direct: it is treated by Verity as an instruction, an order, even, and is accepted without challenge, as is a similar move at the end of the extract when Tahira says "do a question mark" (line 69). To describe Tahira's actions as direct seems to be stating the obvious, but it is worth considering alternative ways of bringing attention to the need for a capital letter at the start of the question. Tahira could have said, "shouldn't that be a capital H", or "oh, you did a little H", or any number of less direct ways of shifting attention to the case of the H. Her choice of words, and Verity's acceptance, begins to construct a relationship in which Tahira can use some degree of authority. This is not to cast Tahira as being in some sense 'in charge'. In fact, the overall impression is of a balanced relationship. Thus, following her instruction "capital H", Tahira repeats, and so affirms, Verity's earlier offer for the question, "how many" (line 59). Verity accepts this by continuing the sentence, "sweets" (line 60), which is in turn repeated, and so affirmed by Tahira. Thus, *attention to written form is used by the two students to manage their social relationship, in this extract through bringing about a balanced, collaboration between the two students.*

### **Facilitating the negotiation of the generic wording of the word problem**

Unlike the use of attention to narrative or mathematical structure, attention to written form is not used to justify particular suggestions or changes to the emerging word

problem. Generic changes to the problems do occur, but arise from the opportunities for reflection that writing creates. Reflection can take place in the spaces created by the time it takes to write out the words. Seeing words in written form also makes reflection possible. Thus, for example, in Extract 10.1 (above), Tahira and Verity work on the question for their first word problem:

62	V	^do^/ ^they^/ ^get^/	
63	T	^they^	
64	V	^have^	
65	T	each have/ how many sweets/	<i>rubbing out</i>
66	V	each will they get	
67	T	yeah	

2B/4T&V: 5/12/00

It may appear that many of the words used in the two students' word problem originate with Verity, who whispers them as she writes, her attention on the business of writing. Tahira's role would then be to accept passively and repeat Verity's words. In this case, however, I argue that Tahira's role is a more active one of affirming, of attending to the sense of the words and then allowing Verity to proceed. Thus, Verity proposes the words 'do they get', read out individually at dictation speed (line 62). Tahira says aloud the word Verity is actually writing, bringing Verity back to the point she has reached (line 63). Verity then *changes* the next word from 'get' (line 62) to 'have' (line 64), using the space between speaking and writing words down to modify her original formulation. Verity's change is followed by a negotiation (lines 65, 66) which results in a change to what Tahira has already written, so that she rubs out some of her writing in order to update it with the newly agreed version. Thus, attention to the business of writing the words onto the page (lines 62-64) leads to a revisiting and negotiation of generic aspects of the problem. This attention is not used to justify or account for these changes. Rather the use of attention to written form makes the revisiting possible. *Attention to written form is therefore used to facilitate the negotiation of the generic wording of the students' word problems.*

The following extract which comes from the same transcript is offered as in some ways contrasting with the extract just discussed. Verity and Tahira are moving on to their next problem, with Tahira now holding the pencil.



## Extract 10.2

86 T I can't think of one  
87 V pardon  
88 T I can't think of none/  
89 V um/err// um/ maybe you could do if there were/ um/ one hundred people  
90 and it/  
91 T if/ slow down slow down  
92 V if there were one hundred people  
93 T if there/ were/ one/ hundred  
94 V peop-  
95 T people/ what else?  
96 V um and/ there were fifty/ people  
97 T and  
98 V and they wanted some sweets  
99 T slow down/ and there/ fifty/ people/ or sweets?/ if there were t- one  
100 hundred  
101 V if there were/ one hundred people [and there were fifty people/  
102 T [ and there were (fifteen) people/  
103 V not fifteen people  
104 T what?  
105 V I said/ fifty people  
106 T fifty  
107 V yes/ rub that out  
108 T ^fifty people...^// what else  
109 V um/ so if there were one hundred people and there were/ fifty people and  
110 they wanted some sw-  
111 T sweets  
112 V no/ one hundred sweets I mean  
113 T one hun-  
114 V let me do it let me do it  
115 T (*sighs*)  
116 V sorry/ sweets *to tape?*  
117 T let me write it/ what you writing?/ what you writing?  
118 V sweets  
119 T that looks like symbols  
120 V um/  
121 T um/ if there were one hundred sweets and there were [fifty people  
2B/4T&V: 5/12/00

### **Managing the social relationship: monitoring, criticising and regulating**

This extract begins with Tahira saying “I can't think of one” (line 86), which Verity treats as an invitation to ‘think of one’ herself. She introduces a possible beginning with “maybe you could do” (line 89), inviting Tahira to comment or negotiate with the ensuing suggestion. She offers a generic opening “if there were/ um/ one hundred people” (line 89). Tahira responds “if/ slow down slow down”. Her attention has shifted to the words that Verity has uttered and on the act of reproducing them on the page. She focuses on

'if' before asking Verity to slow down. What follows is essentially a period of dictation, with Verity coming up with the words and Tahira scribing them onto the paper. There is a subtle difference with their work on the previous problem, in which words in-the-writing were constantly open to being reshaped. Both participants are implicated in this change to dictation mode. Tahira, for example, asks "what else?" (line 95), inviting Verity to continue her dictation. Later she again requests "slow down" (line 99) before seeking clarification of what Verity is saying: "fifty people/ or sweets?" (line 99). This question cedes further control over the words to Verity. Now, if Tahira cannot reproduce Verity's words, she seeks clarification. Contrast this with, for example, the reintroduction of 'each' in Extract 10.1 which was jointly negotiated by the two students.

Tahira's repetitions start to become more fractured (see line 99) and Verity begins to correct Tahira. In the previous extract, the words in the problem were mutable, allowing the problem to emerge in a balanced way. Here, through subtle changes in their interaction, Verity is being socially positioned in the role of the 'dictator' of the problem and the interaction is becoming less collaborative. Instead of taking variations in what is said into account in the process of developing the wording of the problem, Verity is now asserting a preferred wording. Thus, Verity asserts "not fifteen people" (line 103), a direct refutation. Tahira does not accept this, "what?" (line 104), so Verity reasserts her position, supporting herself by constructing her choice as already said: "I said/ fifty people". This places Tahira as not keeping up, or not paying attention, so that Verity *uses attention to written form to monitor* what Tahira is doing. Tahira still resists, repeating the key word of difference, "fifty" (line 106) and Verity reasserts her choice "yes/ rub that out". *Attention to written form is now being used in a more regulative way*, constructing Tahira as writing Verity's words by shifting her attention from possible wordings of the problem, or from the written code, to the words that Verity has already dictated. Furthermore, that attention is brought about in a way that sets up Tahira's writing or repeating as either right or wrong, denying her a share of the sense of the words.

This pattern of interaction continues. Verity repeats the problem so far, but stops part-way through a word (line 110), leaving Tahira to complete her sentence, only for Verity

to contradict what has gone before: “no” (line 112). Verity then gives a different version of what she has just said. Tahira’s incomplete response invites Verity to seek control of the pencil: “let me do it let me do it” (line 114). The stakes have been raised and Verity has taken over. Tahira resists, first by protest, “let me write it” (line 117) and then by criticism, “that looks like symbols”, suggesting that Verity is not doing a very good job, and by implication that Tahira was doing a better one. Verity is now *using attention to written form to criticise Tahira’s writing*. Thus, *through the use of attention to written form to monitor, criticise and regulate, a relationship that was constructed as balanced and negotiated a few minutes before is now emerging for a period as one in which one student dominates the other*.

One difference that appears to be key in the contrast between these two extracts is the role of the writer. In the first extract, Verity carefully manages negotiations over the words from her position as scribe. The interaction is supportive for both students, in the sense that a space is created in which ideas can be considered and shaped. In the second extract, Tahira is writing, and her position emerges as disadvantageous. She accounts for this mainly in terms of the speed of the dictation. As scribe, Tahira seems to lose ground against Verity and she accounts for this by invoking the speed with which Verity dictates. The use of attention to written form to manage the social relationship between the participants is therefore related to which of them is doing the writing.

### **Use of attention to written form**

The above analysis illustrates two uses for attention to written form in Tahira and Verity’s discussions as they write two word problems.

Attention to written form is used to *facilitate the negotiation of the generic wording of the emerging word problem* and is strongly implicated in *the students’ management of their social relationship* as they work on their task. These two uses are inter-related. In particular, if attention to written form is used to position one participant as dominant, there is little opportunity for negotiation of wording to occur. Thus, in the first extract (10.1) involving Tahira and Verity, attention to written form is used to negotiate the final

text on the page. Contributions from both students are incorporated into the final written version. In the second extract, Verity uses attention to written form to regulate the writing of Tahira, using attention to aspects of what Tahira is writing to monitor and criticise not just the form of what is written, but the generic content as well. Thus, Verity instructs Tahira to “rub that out” (line 107) and even takes over the writing herself (line 114), while Tahira’s contributions are rejected, as when she suggests “sweets” (line 111) and Verity responds “no” (line 112). This take-over is brought about through the use of attention to written form, attention which is then used to criticise and so to resist that take-over, such as when Tahira criticises Verity’s spelling.

The contrast between these two sequences, which follow one another, is related to which of the students has the single pencil. In the first extract, Verity writes. She does not, however, write ideas presented as her own. Instead, through a process of speaking aloud, she negotiates generic aspects of the problem with Tahira. This process continues as words are put down on the page, with attention to their written form being used to maintain a balanced discussion in which Tahira and Verity both have a voice. In the second extract, it is Tahira who writes. The process of negotiation becomes problematic, with attention to written form being used to regulate not just the words, but a different relationship between the two students. Tahira no longer has a voice. This positioning is accounted for by both students in terms of the process of writing, such as Tahira not being able to keep up, for example. Interestingly, once Verity takes over the writing process herself (Extract 10.2, line 114), the fracture in their interaction is maintained, with Tahira using attention to written form to resist Verity, rather than returning to the more balanced pattern of interaction apparent in the previous extract.

In the next section, I consider how the above findings can be seen elsewhere in the data. In particular, I will explore further the management of students’ social relationships using attention to written form, showing how attention to written form can be used to construct a social relationship in which one student is dominant or to *avoid* such a construction.

## Use of attention to written form in other transcripts

In this section, I will draw two transcripts involving Helena (non-EAL). In the first, she is working with Safia (EAL 2-3); in the second, with Cynthia (EAL 2). The extracts of Helena working with Safia illustrate how Helena uses attention to written form to dominate the interaction between the two students. The extracts from the work of Helena and Cynthia illustrate how Cynthia successfully avoids being positioned by Helena in this way. The analysis shows the complex nature of the social relationships which emerge through the use of attention to written form.

The first sequence I will explore involves Helena (non-EAL) working with Safia (EAL 2-3) to write a problem set in a burger restaurant. I have already discussed this sequence in Chapter 8 (pp. 141-143), where I showed how Safia uses attention to narrative experience (“can a human being eat that many [burgers]”) to criticise Helena’s generic formulations. In that discussion, I observed that Safia’s criticism involved attention to narrative experience, in the form of an extreme case formulation (Pomerantz, 1986). This attention comes during a period of tension between the two students. I now want to look again at this sequence, which I have reproduced below, this time focusing on the students’ use of attention to written form. At the start of the extract, Safia is writing and Helena is proposing possible formulations of a problem.

### Extract 10.3

190 H oh/ yeah/ Paul and Chris/ went/ to/ McDonalds/ and had fifty seven  
191 meals/ which cost three pounds/ chicken burger and chips/ joke/ yeah  
192 yeah yeah yeah write it actually// what’s that say?  
193 S McDonalds/ I can’t spell it properly I don’t  
194 H it says mac-a-donalds  
195 S I know *rubbing out*  
196 H McDonalds/ or Kentucky Fried Chicken/ just write McDonalds *M C* not  
197 *M A C*/ never mind/ went to Paul and Chris went to went/ to McDonalds/  
198 to/ McDonalds/ they bought/ seventy eight  
199 S okay just a sec  
200 H *B O*  
201 S I know how to spell it/  
*JA/SS&H: 21/6/00*

At the beginning of this extract, Helena offers a generically suitable problem (lines 190-192), although she hedges her idea, by portraying it as a “joke” (line 192). She then shifts attention to written form, asking a question about what Safia is writing, “what’s that say?” (line 192). Safia treats this both as a request for clarification and as an implicit *negative evaluation*, since she reads out a word, “McDonalds” (line 193) and then accounts for Helena’s apparent difficulty, “I can’t spell it properly” (line 193). Helena then *does* read the word, apparently giving a pronunciation based on Safia’s spelling, “mac-a-donalds” (line 194), so portraying that spelling as incorrect. In attending to the written form of the word, Helena is monitoring Safia’s writing, positioning herself as in some sense more literate. Following Safia’s claim that she cannot spell the word, Helena not only shows that she can spell it, “*M C* not *M A C*,” (line 196), but that she can also read out Safia’s incorrect spelling. This positioning is maintained over the ensuing course of the problem, with Helena offering alternative formulations, instructing Safia “just write” (line 196), giving Safia permission not to correct her spelling, “never mind” (line 197) and dictating words directly, emphasising some words in a form of monitoring and regulation “went to Paul and Chris went to went/ to McDonalds” (line 197). Like Tahira, Safia uses time as a way to account for the difficulties she has been constructed as having, as when she says, “okay just a sec” (line 199). Helena treats this as a sign of difficulty and begins to give Safia a spelling (line 200), which Safia resists (line 201). As their work continues, the discussion between the two students continues to display signs of fracture similar to those apparent in the second sequence involving Tahira and Verity discussed above (Extract 10.2):

#### Extract 10.4

- |     |   |   |                    |
|-----|---|---|--------------------|
| 218 | S | three pounds/ why don’t you write it out and I’ll check it/ I can work that |                    |
| 219 |   | out actually  |                    |
| 220 | H | three pounds please   |                    |
| 221 | S | what were you going to say/ hmm?/ what were you going to say                |                    |
| 222 |   | anyway?   |                    |
| 223 | H | um actually/  |                    |
| 224 | S | [ you’ve/   | <i>rubbing out</i> |
| 225 | H | [ let’s do five million/  |                    |
| 226 | S | nah   |                    |
| 227 | H | no just do it/ they bought/ no just say/ they bought five/                  |                    |
| 228 | S | wait/ wait wait wait wait   |                    |

229 H thousand/ six hundred/ and fifty four  
 230 S can you eat that many?  
 231 H no but  
 232 S can a human being eat that many  
 233 H no/ they shared it amongst the concert  
 234 S you're mad/  
 235 H this is to do with the concert/ why're you writing twenty for?  
 236 S cause/ five million/ blah blah blah won't [ really (...)  
 237 H [ alright though you can work  
 238 that out easily/ you need a/ you don't need a calculator to work that out//  
 239 just write/ five/ just write five/ put a comma thing/  
 240 S dot comma  
 241 H no just write that/ just that little thing  
 242 S decimal  
 243 H no/ just little thing there  
 244 S [ what little thing?/ I don't know what you're talking about  
 1A/SS&H: 21/6/00

As in the discussion between Tahira and Verity, a change of scribe is mooted. In this case, it is Safia who attempts to reverse the positions of herself and Helena, "why don't you write it out and I'll check it" (line 218). Helena, however, avoids this move by reasserting her own dictatorial position, "three pounds please" (line 219). The following few turns consist of Helena attending to generic aspects of the problems, trying out a range of possible formulations. Safia, however, treats Helena's words as dictation and again has to account for not being able to keep up, "wait/ wait wait wait wait" (line 228). Again, attention to written form is used to monitor and regulate what Safia is writing. It is at this point that Safia shifts attention to narrative as a way of criticising Helena's formulations (see Chapter 8, pp. 142-143). Helena responds to this criticism, thereby validating Safia's position and for the first time for several turns allowing her a substantive role in discussing their word problem. Helena's response is to use attention to narrative experience to account for her ideas, "this is to do with the concert" (line 235), before shifting attention back once more to written form to monitor and criticise what Safia is doing, "why're you writing twenty for?" (line 235). The upshot of this shift is that Helena is once again positioned as the arbiter of what appears on the page. By focusing on aspects of written form, such as punctuation (line 239), she also maintains control of the discussion and the development of the problem. Thus, as in the second sequence (Extract 10.2) involving Tahira and Verity, attention to written form is used in the interaction between Safia and Helena to construct a social relationship in which one student is being in control of the word problem and the other as a scribe. Again, it is the

EAL student holding the pencil who is positioned as responding to their fellow student and writing down the words they are given, under supervision.

In the above sequence, attention to written form is again used to establish differential positioning between the two participants in their interaction. By focusing attention on the writing of Safia (the EAL student), Helena constructs herself as more skilled in the business of writing. This positioning is not seen as arising out of any inherent skill on the part of either student. Rather, attention to written form is used as a way to constitute these different roles through interaction. As my analysis of the two sequences involving Tahira and Verity (Extracts 10.1 and 10.2) shows, the same pair of students can use attention to written form to bring about different positions at different points in their interaction. This use of attention to written form to construct differential roles seems to draw on the visible, accountable nature of writing. In discussing generic aspects of their word problem, these students can introduce different ideas and negotiate agreed scenarios, details or questions. In putting pencil to paper, their writing becomes public and is exposed to possible criticism. In attending to written form, these students draw on notions of standardised spellings, punctuation and generically appropriate tenses to evaluate each other's writing. Drawing on the conventions of writing in this way is often difficult to refute in a way which is similar to the authoritative rhetoric of logical reasoning (see Edwards & Potter, 1992, p. 162). It is largely through these evaluations that social activities such as dominating or collaborating are conducted. Thus, attention to written form can create spaces in which generic features can be revisited, leading to a more collaborative process, or attention to form can be used to construct dominant and subordinate roles leading to a more unbalanced pattern of interaction.

For the remainder of this chapter, I want to look at two sequences from the recordings of Cynthia (EAL 2) and Helena (non-EAL). In their two recordings, these two students regularly attend to written form, more so than in most other transcripts. Furthermore, the positioning work in these transcripts is in some ways more complex than in those considered so far in this chapter. In particular, although there is evidence of dominating talk, a more complicated pattern of interaction arises. The uses of attention to written form, which in two of the sequences discussed above lead to one student being



constructed as dominant, are undermined in much of the talk between Cynthia and Helena. In the following extract, for example, Cynthia is writing. The extract begins with the two students negotiating generic aspects of the problem.

### Extract 10.5

120 H in// okay// and you've got to do the next one right/ I'll tell you someone  
 121 C yep  
 122 H another name could be// Michael?  
 123 C no/ um/ Sophie?  
 124 H no/ not everybody in the class  
 125 C ah/ Megan// [ (...)  
 126 H [ could be  
 127 C how do you spell Megan?  
 128 H M  
 129 C M  
 130 H E  
 131 C E  
 132 H G  
 133 C G  
 134 H A N  
 135 C A N/ Megan// and then  
 136 H Megan/ um/ goes to a shop five time/ no/ [ five times a week  
 137 C [ oh *writes*  
 138 Megan go// to/  
 139 H goes  
 140 C goes  
 141 H er just put a S/  
 142 C E S E S/ goes/ squash/ goes to the shop/ five times a week  
 143 H double E// two Es// week// um/ she buys  
 IA/OC&H: 21/5/00

### **Avoiding being dominated**

Having agreed on a name, 'Megan', Cynthia asks Helena "how do you spell Megan?" (line 127). In this situation, rather than a spelling being corrected or dictated by Helena, Cynthia has the initiative. She shifts attention to written form by asking for information which Helena supplies. This strategy avoids Cynthia being constructed in a subordinate position, a situation which may have arisen if she had written the word. Putting a word on paper, as I observed above, makes it accountable and open to criticism. As it is Helena who is invited to spell the word, it is she who must put her spelling on the line. It is now not possible for Helena to criticise Cynthia's spelling, assuming Cynthia writes down the letters Helena provides. Cynthia does accept rather than evaluate Helena's spelling,

thereby maintaining the initiative whilst avoiding leaving herself open to criticism. That such a criticism is a possibility is evidenced by the exchange which follows the spelling of 'Megan'. Cynthia invites Helena to provide further generic information (line 135), which Helena does (line 136). Cynthia reformulates part of this information prior to writing it down, "Megan go// to"(line 138). Helena then shifts attention to written form, correcting 'go' to "goes" (line 139). This criticism by Helena is in the monitoring, regulative mode discussed earlier in this chapter. Cynthia repeats the word (line 140), before Helena gives further instructions, "just put a S" (line 141). Cynthia follows these instructions, spelling letters out loud and commenting on the spacing of the words. The initiative has shifted towards Helena, who is dictating the spelling. In some of the sequences discussed above, this pattern of interaction may have been maintained, with Helena adding additional words and monitoring Cynthia positioned as the scribe. This positioning is avoided, however, since Cynthia, on completing the writing of the word 'goes', continues the word problem herself. She shifts attention from written form to genre, using words "E S E S/ goes/ squash/ goes to the shop/ five times a week" (line 142), using words which Helena has already proposed, but attending to them when she has completed writing, rather than struggling to keep up with dictation. By attending to written form, therefore, Cynthia is able to hold up Helena and work at a manageable pace. This gives the two students' interaction a more complicated intermeshing of positions, with Cynthia keeping the initiative in terms of writing, but Helena setting the agenda in terms of genre.

A similar pattern of interaction is apparent in the following extract, in which Cynthia again asks Helena to provide a spelling, this time of 'pocket money' (line 50).

#### Extract 10.6

- 50 C ten pounds/ pocket how you spell pocket money/  
 51 H you have to do the pound sign  
 52 C oh yeah/ ten pound pocket money how you spell a pocket/ pocket  
 53 money// pocket money/ in one week// in/ eve'y/ is that eve'y/ eve'y day/  
 54 H (...)// E V E R Y  
 55 C E V E R Y/ eve'y/ day/ she bought/ she/ bought  
 56 H comma/ you need a comma in between one and (...)  
 57 C ^I know^

58 H Helena has ten pound pocket money [ in one week  
59 C [ in one week/ [ in  
60 H [ comma [ every day  
61 C [ at in one/  
62 every day she bought  
1B/2C&H: 11/7/00

On this occasion, Helena's response undermines the evaluation that this move can achieve, by evaluating a different aspect of Cynthia's writing, "you have to do the pound sign" (line 51). Cynthia, however, merely accepts this and returns to her own agenda. Receiving no word from Helena, she continues writing, shifting attention to genre and back to written form in relation to the word 'every' (lines 53-55). She again invites Helena to support her "is that eve'y/ eve'y day" (line 53). Helena spells the word (line 54), which Cynthia repeats before continuing the line. Helena again shifts attention to punctuation (line 56), monitoring Cynthia's writing. She continues this monitoring by reading out what Cynthia has written, facilitating the negotiation of several generically suitable ways forward (lines 58-62). Cynthia joins in with this negotiation by taking over what Helena is saying (line 59). This is, however, circumvented when Helena again attends to punctuation. The picture that emerges, then, is of both students jockeying for position. Helena attends to written form as a way of monitoring Cynthia's writing and so gaining the initiative. Cynthia, on the other hand, keeps control of the pace of writing and shifts attention from written form to genre in order to develop the word problem. There is a sense in which Cynthia uses Helena as a resource to provide information about how to write down the ideas they are discussing. She must therefore work hard to avoid Helena using this situation to take over. She uses attention to written form to do this.

The above analysis shows how the use of attention to written form is closely bound up with the social organisation of the work on the word-problem task. Attention to written form can be *used in the construction of a balanced, collaborative mode of interaction*, with both participants contributing to the negotiation of the words that get written on the page. Attention to written form can also be *used, however, to construct a more one-sided pattern of interaction, in which one student dominates*, often by dictating the problem, whilst the other acts as scribe. Whilst this pattern often occurs in interaction between an EAL student and a non-EAL student, with the non-EAL student in the dominant position,

this outcome is by no means contingent on such a pairing. As the first extract in this chapter showed, the same pairing can exhibit different patterns of social organisation at different points in the same recording. The sequences involving Cynthia and Helena discussed in the previous section show how more complex forms of social organisation can arise, with *different students dominating different aspects of the interaction, through their use of attention to both genre and written form.*

In this chapter, I have described two related uses of attention to written form, uses which arise throughout the data. I have particularly focused on the use of attention to written form to manage the social relationship between the participants in different ways. To conclude this chapter, I will now return to the substantive questions I set out in response to parts of the literature on word problems.

### **Uses of attention to written form and the word problem task**

I raised two questions at the start of this chapter. Some progress has been made towards tackling these questions. I will address each in turn.

*How do the students in this study use attention to written form?*

I have identified two uses of attention to written form:

- managing the social relationship between the two students;
- facilitating the negotiation of the wording of the word problem.

The above analysis of several sequences from the data shows how shifting attention to written form can contribute to the construction of different patterns of social organisation, through *monitoring, criticising and regulating* the writing process. In such situations, one student is constructed as dominant, the other as subordinate. Dominance is brought about through monitoring of spelling, punctuation, tense or other aspects of the written form of the problem as it appears on the page. Subordination, meanwhile, is accounted for in terms of the writing process, which may be portrayed, for example, as too fast. Use of attention to written form can be used *to include both participants in a more collaborative*

*mode of interaction.* In such situations, both participants are able to evaluate the written form of the problem and suggest alternatives. Such collaborative patterns of discussion are more likely to be associated with negotiation of generic aspects of the word problem. Attention to form can also be used *to avoid potentially dominant positionings*, with, for example, one student drawing on the other as a literate 'resource', thus keeping some degree of initiative whilst avoiding potential take-over bids.

*Does shifting attention between written form and mathematical structure present students with a dilemma?*

The evidence of the above analyses and the rest of the data collected in this study shows that the participants are able to shift between attention to generic considerations relating to the content of the task and attention to written form relating to formal linguistic aspects of the task. Furthermore, they are able to shift with some degree of freedom and seem able to maintain progress in the development of their word problems whilst also attending to the nature of the words on the page. In situations in which attention to form leads to the more fractured forms of interaction seen in some of the above sequences, the dominant student works on the content whilst using attention to form to monitor and regulate the writing of the subordinate student. Such a pattern does not constitute a dilemma, but offers one student a less constructive role in the task. These observations do not imply that the use of attention to written form is somehow a separate part of the students' work on the task. Through their attention to written form, the participants reflect on the generic aspects of their word problem, revisiting some of them. Hence, their use of attention to written form is linked to the process of developing the content of their problem.

## Chapter 11

# Uses of attention: implications for teaching and research

In this chapter, I want to summarise the various outcomes of the work set out in this dissertation, both methodological and substantive, as well as consider my work and its implications in the context of the mathematics classroom. I begin with a brief summary of the main argument developed in the preceding chapters. Subsequent sections look at:

- implications of this work for teaching mathematics, particularly when EAL students are involved;
- implications of this work for research in bilingualism in mathematics education and in the development of discursive psychology.

Each of these sections raises further questions.

### **The use of attention by EAL students and their peers in writing mathematical word problems: the development of a methodological approach**

From the start of this dissertation, I have raised the methodological question of how interaction involving students from diverse linguistic, cultural, social and educational backgrounds can be investigated. Recognition of this diversity led me to question the extent to which it is possible to interpret the words of EAL (or multilingual or multicultural) students with any degree of validity. This dissertation has given an account of how I have developed a methodological approach to the investigation of mathematical interaction which does not rely on an assumption that the meaning of students' words is

somehow transparent. In discussing previous research on bilingual students and the teaching and learning of mathematics (see Chapter 2), I noted that little attention was paid to the perspective of the student. Most research concerned student outcomes or the process of teaching. I could find little that looked at how students like those who took part in this study participated in mathematics lessons. This observation led me to ask how EAL students like Cynthia or Farida, for example, use language to think about mathematics and how such students make sense of mathematical talk. At the end of Chapter 5, in the light of the theoretical and methodological perspective developed in the first part of the dissertation, this issue was crystallised in the following questions:

- What patterns of attention can I identify in EAL students' interaction as they write word problems together with their peers?
- How is attention used by EAL students and their peers in their work together?

This dissertation also sets out how my methodological approach was used to address the questions mentioned above.

At the heart of the methodological approach developed in this dissertation is a particular notion of *attention*. My treatment of attention is rooted in conversation analysis and the idea that in interaction participants explicitly attend to relevant aspects of preceding events (Sacks, *et al.*, 1974). This fundamental property of talk is the basis for the possibility of meaningful interaction (Sacks, 1992). This perspective does not treat attention as a mental phenomenon, a function of the brain which co-ordinates what of the outside world is taken in. Rather, I am interested in the attention which is publicly available when people interact; attention is seen as part of the socially organised action which talk and interaction entails. Using this notion of attention means that analysis, still an interpretive process, is based on what participants do and say, rather than on what is in their heads. Analysis can therefore be placed alongside data so that readers can evaluate the rigour with which the analysis has been conducted. One aspect of my analysis entailed identifying patterns of attention. My analysis led to the identification and description of four patterns of attention in the interaction of EAL and non-EAL students working on the word-problem task. These patterns were of attention to the word problem genre, to narrative experience, to mathematical structure and to written form.

My methodological approach is also informed by ideas found in discursive psychology, particularly the notion of *rhetoric*. This perspective (e.g. Edwards, 1997; Edwards & Potter, 1992) sees all talk as situated, designed to respond to what has preceded as well as to anticipate, and perhaps pre-empt, what will follow. Psychological constructs such as memory, knowing or thinking are treated as discursively produced. Instead of treating thinking or sense making as processes which go on inside the head, I have treated them as what could be termed 'social reasoning'. That is, in justifying, arguing or accounting for suggestions or ideas, participants in interaction are presenting a thought process. Similarly, in offering interpretations or negotiating meaning, participants are making public sense of the words and actions around them. Thought processes and sense making are therefore seen as situated and are analysed in terms of how they are designed for the circumstances in which they occur. Thinking, for example, is treated as the publicly available reasoning students make available in interaction - the accounts, justifications and reasons they use to support their actions. Attention is a basic aspect of these social processes. An investigation of how EAL students use attention in interaction therefore sheds light on how they think about or make sense of a mathematics task such as writing word problems. Thus, my questions concerning how EAL students use language to think together with their peers, and how they make sense of mathematical language as they work on the word problem task have been addressed through an analysis of how attention is used by students in their work together, of what attention to different things does, and of what is achieved by shifting attention from one area to another. The analysis based on this approach and set out in Chapters 8-10 revealed the following points:

*Attention to narrative experience*

The students in this study used attention to narrative experience to:

- propose and discuss generic details;
- establish shared sense for their emerging word problem and its solution;
- agree on shared ideas of what generic details refer to;
- support changes in the mathematical structure of the word problem;
- link the development of the word problem with its solution;



- negotiate students' social relationships.

In using attention to narrative experience in these ways, students developed a rich, shared sense of the scenarios around which their word problems were created. This shared sense supported the students in linking the world of the word problem with the arithmetic calculations involved in solving their problems, thus overcoming one of the challenges word problems are reported as presenting students (e.g. Verschaffel, Greer & de Corte, 2000), particularly EAL students (e.g. Secada, 1991).

#### *Attention to mathematical structure*

The students in this study used attention to mathematical structure to:

- justify generic details;
- manage the social relationship between the participants;
- criticise the emerging word problem;
- modify word problem structure;
- solve word problems.

Students' use of attention to mathematical structure was related to the requirements of the task negotiated in each recording. Many of these tasks required the students to produce word problems involving a particular arithmetic operation (e.g. division). During their work, therefore, students often criticised proposed problems against this requirement. Attention to mathematical structure also played a role in how students solved their word problems. By explicitly attending to mathematical structure, students' proposed approaches to solving their problems were made available for other participants to comment on and work with. The use of attention to mathematical structure made the process of solving word problems accountable.

#### *Attention to written form*

The students in this study used attention to written form to:

- manage the social relationship between the two students;
- facilitate the negotiation of the wording of the word problem.

The use of attention to written form to manage the social relationship between the students may arise through:

- using attention to written form to construct a balanced, collaborative form of interaction in which neither student dominates;
- using attention to written form to monitor, criticise and regulate writing as it emerges leading to one student dominating the other.

These different uses for attention to written form are related to which of the students is acting as scribe. Where an EAL student was writing, for example, attention to written form could be used to construct them as subordinate. EAL students could, for example, be positioned as lacking in literacy skills, such as spelling or punctuation, or as slow at writing. A dominant non-EAL student could take on the role of dictator, producing a verbal text to be written by their fellow student, and monitoring and evaluating the production of that writing. One EAL student, Cynthia, was able to use attention to written form to avoid this kind of positioning, however, by treating their non-EAL partner as a literate resource. She asked her partner to spell words, for example, thus pre-empting any criticism of her own spelling.

### **Using language to think in mathematics; making sense of mathematical language**

My description of four patterns of attention and my analysis of how students used attention to these different areas highlights some of the ways in which the students in this study use language to think as they work on the word-problem task. These students use the word-problem genre as a basis for their work. Students draw on the discourse of narrative experience to create meaningful word problems. They draw on a mathematical discourse of structure and arithmetic relationships to create mathematically suitable problems. The students also draw on discourses of writing and text production to produce appropriately written problems. Crucially, these four patterns of attention are interwoven throughout the students' discussions. Use of attention to narrative experience contributes to the production of meaningful problems; use of attention to mathematical structure leads to meaningful connections between the words of the problem and the arithmetic

task it encapsulates; use of attention to written form links the written words on the page with the spoken discussion between the participants.

What emerges from my analysis is an awareness of the complex social ways attention to different aspects of the task is used. Creating a word problem is a social activity which entails the negotiation of on-going social relationships between the participants, including me. Attention to narrative experience, mathematical structure and the written form are all used in different ways to support different possible versions of students' problems. They work by distancing the speaker from particular ideas, drawing on the eye-witness credibility of narrative, the logical authority of mathematics or the conventional authority of written English. The various uses of attention described in my analysis are not only the means through which the students create their word problems. They are also the means by which complex social relationships are produced. Students are negotiating who they are as much as they are negotiating what they are doing. It is noteworthy, therefore, that having English as an additional language is never explicitly relevant to participants' discussions. At no stage do any of the participants directly bring in issues of bilingualism, of difficulty with using English or of language being a problem. There are, however, examples of more subtle, language-related issues, particularly when students are attending to written form, when lack of proficiency at writing is used to position students in subordinate roles. Cynthia's facility at undermining such positioning demonstrates, however, that constructions of lesser proficiency can be used by EAL students themselves as a means to maintain their place in any discussion.

### **Implications for teaching mathematics to EAL and other students**

In this section, I consider my findings in the context of the teaching and learning of mathematics, particularly, though not exclusively, when EAL students are involved. In making the suggestions for classroom practice which follow, I draw on my own experience as a teacher of mathematics, particularly my experience of working in Pakistan (see Chapter 1). I will address the following issues:

- What implications do these findings have for how teachers work with EAL students?
- What implications do these findings have for how teachers work with students on word problems?

My first observation concerns the patterns of attention shown by the students in this study. Three of the four patterns can be traced back to the task I negotiated with them. I stipulated a genre of problem, negotiated structural requirements and expected a written product. Thus, the opening exchanges of each recording formed a discursive resource, in that in those first words, attention was focused on specific aspects of the task, foci which many of the students maintained in their discussions. This implies that the initial introduction to any mathematical task, a shared social, discursive process, has an impact on what aspects of that task students attend to. As a teacher reflecting on this observation, I am aware that in negotiating a task with students, what is often attended to is the generic. In working on arithmetic operations, for example, written methods or algorithms can become the discursive focus, rather than, say, the structural relationships between numbers. Similarly, in the algebraic genre of solutions to equations, specific procedures such as 'taking something from both sides' are attended to as part of the genre, rather than as relating to mathematical structure. I do not mean to argue that genre is unhelpful in doing mathematics. Rather that, as the students in this study show, several areas of attention are possible. Furthermore, these students show that they are able to shift their attention from one area to another and that this shifting is part of the social process of jointly making sense of their work. Thus, for teachers, the task is to think carefully about what they want students to attend to in the tasks they offer and to find ways to bring about such attention. Such attention will arise not from teachers simply directing students. Rather, as my data shows, it will arise in how tasks are presented and negotiated with students.

In terms of working with EAL students, this study demonstrates how EAL students are able to participate productively in talk around a mathematics classroom task. They are able to use attention to the four areas described in this dissertation to make sense of and work on their task. In particular, the EAL students in this study, like their monolingual peers, are able to draw on different elements of their experience of the world, including

their experience of word problems (genre), of mathematics (structure), of writing (form) as well as their experience outside of school (narrative experience). EAL students use these different experiences to negotiate and interpret the task and the words of their peers. They are thus supported linguistically, through the rich, meaningful context the resulting talk provides (see Cummins, 2000, p. 44) and enabled to work with the complex linguistic form of the word problem.

As a teacher, I am also concerned that issues of linguistic proficiency, particularly relating to writing, may be used to subordinate EAL (or any other) students. This study highlights alternative patterns of interaction in which more collaborative working occurs, mediated by the writing process. The task here for teachers, therefore, is to find ways to support EAL students, through developing collaborative patterns of interaction between class members which allow such students to bring their own diverse experiences to their work. As with the principle underlying the research methodology developed in this dissertation, teachers do not need to have first-hand experience of each student's cultural, linguistic, social or educational background in order to allow those students to bring their experiences to the classroom and to their work.

How specifically can teachers put these ideas into practice? As an example, let me briefly consider how teachers can approach work on word problems in the light of this study. A widely identified aspect of word problems which students find difficult is the link between the story of the problem and the mathematics required (Reusser & Steubler, 1997; Verschaffel *et al.*, 2000). Such links are seen as particularly problematic for students from minority ethnic backgrounds (Secada, 1991). The linguistic nature of word problems is complex and therefore likely to be more challenging for EAL students. This study demonstrates how students, including EAL students, in writing their own problems, are able to draw on narrative experience to negotiate a shared meaning for the problem and are able to shift attention among these narrative concerns, the generic details of the problem and its mathematical structure. Teachers can therefore seek ways to bring about attention to these three aspects of word problems in students' discussions and to find links between them. Asking students to write word problems of their own, with constraints on the operation to be used, is clearly one approach. By asking for problems

'about' division, for example, students had to attend to the structure of their word problems, even if, in the end, they did not always write division problems. Students must ultimately, however, be able to work on problems set by others, including in nationally set examinations. Working with students on solving such problems could therefore entail taking examples of word problems and working on some of the following questions or invitations (which are not necessarily sequential).

- Look at two problems. What is the same about them? What is different?
- Write a problem which is the same as one of these. Write one which is different.
- Explain how they are the same or different.  
*(Attending to different aspects.)*
  
- Tell me what is happening in this problem?
- Tell me something which has happened to you that is similar to what is happening in the problem.
- Write a story about the problem.  
*(Attending to narrative experience.)*
  
- How would you work out an answer to the question in the problem?
- Why?  
*(Attending to links between structure and narrative and genre.)*
  
- What can we change in the problem?
- What effect will that have?
- How can the problem be changed so that it has the same story but a different calculation?
- How can this addition problem be changed so that it is a subtraction problem? Or a multiplication problem?  
*(Attending to structure and to links between the different aspects.)*

As well as potentially focusing attention on different aspects of word problems, and the links between those different aspects, these questions and invitations, offered both to a whole class and to smaller groups to work on, provide opportunities for EAL students, indeed all students, to bring their own experience to their work. By working on the story of a problem, for example, students are invited to bring narrative experience into the

classroom and use it to make sense of word problems. By comparing different problems, students draw on their experience of word problems, as well as begin to think about what word problems are like. Students can therefore develop an explicit sense of the genre which will support them in future work on previously unseen problems.

The above suggestions specifically concern work on word problems. My work also raises the following more general questions:

- How does a focus on the use of attention inform the teaching and learning of other aspects of the mathematics curriculum, particularly where EAL students are involved?
- How can the above approach be modified to other topics or to other subject areas?

## **Implications for research**

In this section, I want to consider the work in this dissertation in two contexts, substantive and methodological. In the case of the former, I want to consider how the findings of this study add to existing research on bilingual students in mathematics classrooms. For the latter, I will set out some of the methodological implications of this work.

### **Bilingual students in mathematics classrooms**

My discussion of previous research in the area of EAL and mathematics education (see Chapter 2) found that most studies used quantitative instruments to test students' mathematical attainment, finding some positive relationship between English proficiency and test scores (e.g. Clarkson, 1992). Word problems proved to be particularly problematic for EAL students as compared with other forms of mathematics test items (Mestre, 1988). Where researchers have investigated the nature of classroom interaction, they have generally concentrated on the teacher's perspective. Khisty (1995), for example, found that more successful teachers of Spanish-English bilingual students in the United States encouraged a culture of shared, negotiated, meaning-making, in which

students were expected to explain their ideas. She also noted that such teachers tended to give explicit attention to mathematical language. Moschkovich (1999), in her work, argues that such attention must go beyond a simple focus on vocabulary. The balance between attention to mathematics and attention to language emerged in Adler's (2001) work as a particular dilemma for teachers. While valuable, this work gives little insight into EAL *students'* perspectives on doing, thinking and learning mathematics. The research set out in this dissertation is a contribution towards addressing this deficiency, showing how a number of students work together on a word-problem task. By exploring the nature and use of students' attention, rather than introducing my own concerns and interests, I have shown what is relevant for these students as they work on their task, as summarised earlier in this chapter. How do these findings relate to those of other researchers? I will address two broad issues in response to this question: the nature of students' sense making and the nature and role of language.

The first key area I want to discuss concerns the nature of students' sense making as they work on the word-problem task. This study shows that the students involved were able to write *and solve* word problems successfully, indicating a strong familiarity with the word-problem genre. The solutions to their problems were not, generally, trivial. There is little sense that the participants designed 'easy' problems for themselves. Indeed, on a number of occasions students set out to write 'hard' problems. In the case of Cynthia, the two word problems she was involved in writing *and solving* (one is discussed in Chapter 8, pp. 125-134) both involve several stages of calculation using addition, subtraction and multiplication. Both problems appear to be correctly solved, a record which compares favourably with her performance in solving word problems in the class annual test, in which she answered one correctly out of three and achieved a relatively low score overall. This situation suggests that for Cynthia at least, her work on word problems is more successful when she works with other students. What is interesting about her participation, when compared with that of other EAL students such as Tahira working with Verity (see pp. 169-175) or Safia working with Helena (see pp. 178-180), is that she is able to maintain an active position within the interaction, relative to non-EAL participants. In short, she avoids being constructed as weak at English and subordinate. She is also one of the students who gives a range of explanations for her ideas, using



structural and narrative accounts as part of her reasoning, reasoning which is jointly developed with her partners, notably Helena. Cynthia's relatively successful participation contrasts with that of Safia, say, who becomes increasingly dominated by Helena, or that of Farida and Parveen, whose competitive discussion leads to Farida insisting on treating all of their word problems in one recording as addition problems.

These observations support work, such as that of Khisty (1995), which has found more successful classrooms involve opportunities for students to negotiate the sense of their mathematics together. This study shows how a group of students go about negotiating such sense for themselves, away from the strong discursive influence of their teacher. The study also shows the social nature of their negotiations, with mathematics not necessarily being the primary concern of students, being secondary on occasion to identity work, for example (see Chapter 9). This social dimension to students' interaction leads to different aspects of students' experience, and the different discourses associated with them, being used in different ways. Attention to mathematical structure and narrative experience are both used, for example, to negotiate generic details of word problems, and contribute directly or indirectly to students' solutions. The use of attention works socially or rhetorically in different ways, however, with, for example, attention to mathematical structure drawing on an authoritative, depersonalised rhetoric and attention to narrative experience drawing on the personalised eye-witness credibility of first-hand accounts. Students' negotiation of shared sense for their word problems is therefore bound up with their on-going negotiation of their relationships with each other, negotiations which take place in a range of contexts of which the mathematics classroom is but one. Further research could usefully explore in more depth the interaction between students' negotiation of mathematical sense and their negotiation of social relationships, including the following issues:

- How does the negotiation of social relationships affect the mathematics under discussion?
- How does mathematics affect students' negotiation of their relationships with each other?

The second broad area I will address in this section is the nature and role of language. An insight which emerges from this study, which is significant in the light of previous research, is that the English language *is* an issue for the students who took part, although *multilingualism* is not *explicitly* relevant. Thus, students negotiate ways of expressing ideas, work together to find appropriate vocabulary and attend to spellings, verb tenses and other formal linguistic features (see Chapter 11). Their attention to the generic features of word problems is also a linguistic concern. Clearly, these students' attention to language goes beyond a narrow concern with vocabulary to encompass a range of linguistic and discursive features. A focus on vocabulary in relation to word problems might lead to teaching based on different words for arithmetic operations. Words signalling *addition* might include *plus*, *and*, *more than*, *greater than*, and *altogether*, for example, often featured as posters in classroom displays. Such a focus can lead word problem solving to become a kind of decoding exercise, with words from the above list taken to indicate a particular arithmetic operation, which is then performed on any available numbers featuring in the problem. The data in this study shows that the students involved are able to use a wide range of linguistic forms to express the idea of division or addition and that they are able to use them in suitably contextualised ways, ways which do not necessarily conform to a neat taxonomy of word problem terms. Thus, not only is a focus on vocabulary unhelpful in terms of developing the discourse of school mathematics (Moschkovich, 1999), it also underestimates the sophistication with which EAL students are able to use and develop that discourse. This sophistication is only apparent if students have opportunities to engage in extended discussion, however. A fruitful line of future work would be to investigate:

- How do EAL students use mathematical terms or other features of mathematical discourse?
- How do these uses develop over an extended period?

For such an investigation to be productive, however, the students involved would need suitable opportunities to engage in mathematical discussion both with and without their teacher. Research along these lines would be particularly illuminating if it involved EAL students in the earliest stages of learning English, since their discursive development in that language would be particularly vivid.

A final point I wish to make also concerns the role of language. The students in this study seem able to shift between mathematical and linguistic concerns relatively fluently, often doing so several times in a few seconds. In particular, they are able to attend to the generic or written form of their work and then return to mathematical considerations. This finding suggests that teachers' concern with a dilemma (Adler, 2000, p. 130) of when and whether to attend to language or to mathematics may not be significant for students who may be able to attend to one and then the other without disruption. Such a claim would need further investigation, and would need to focus on the following:

- To what extent is shifting attention from language to mathematics an issue for students?
- How do different patterns of interaction influence students' experience of such shifts? Are EAL students supported, for example, if such shifts in attention are explicitly marked by the teacher?

### **Methodological implications**

The chief methodological challenge raised at the start of this dissertation was to develop a methodological approach which could say something about EAL students' participation in classroom talk without making assumptions about what they mean by the words they use. The subsequent chapters set out an account of the development of such an approach based on ideas from conversation analysis and discursive psychology. I cannot claim, however, that the development of this approach is somehow finalised or complete. Rather, it marks a beginning. Further development will occur through further research. In this sub-section, therefore, I want to outline two directions this development might usefully take. The first relates to the role of rhetoric, the second to the diverse backgrounds of the participating students.

The first topic I will address concerns rhetoric. The theoretical perspective of talk as social action derived from discursive psychology (see Chapter 6) includes the notion that what is said is designed not only for present circumstances, but with the future course of interaction also addressed. The choice of words and of the form of words makes a difference to what happens next, but can also pre-figure what happens next. Santa

presents his hole in the mountain as a grotto rather than as a cave so that he is not arrested or shot (see Chapter 5, p. 60). In working these ideas into my discourse analysis, I have drawn on Edwards & Potter's (1992) list of rhetorical devices (pp. 160-163) used in English talk. These devices are rather general and are derived from research in discursive psychology and conversation analysis (e.g. Edwards & Middleton, 1986; Pomerantz, 1986; Sacks, 1992; Wetherell & Potter, 1992). This work is based on discourse analyses of interaction from a range of settings, including courtrooms (see Edwards & Potter, 1992), counselling sessions (Edwards, 1997), political reports in news media (Edwards & Potter, 1992), psychological laboratories (Edwards & Middleton, 1986) and ethnographic interviews (Wetherell & Potter, 1992). None, to my knowledge, investigate mathematics classroom interaction. Indeed, classroom settings appear to be explored very rarely in discursive psychology to date (Edwards, 1993, being a rare example). This situation does not invalidate the analysis set out in this dissertation. The interaction of mathematics classrooms draws on discourses available in any English-language interaction. Giving an eye-witness account works just as well in a mathematics classroom as in the playground or in a courtroom, as my analysis shows (see Chapter 9). The question does arise, however, of what the rhetoric of the mathematics classroom is like. Both mathematics and teaching are rhetorical activities. Teachers use language to organise and convince, both socially and epistemologically (see, for example, Edwards & Mercer, 1987; Mercer, 1995, 2000) and doing mathematics involves presenting arguments, in the form of proofs, for instance (see, for example, Mason, 2001b). Further research could therefore usefully investigate the following issues:

- What rhetorical devices are used and by whom?
- How are they used? Are there devices which are specific to school mathematics?
- Are any of Edwards & Potter's (1992, pp. 160-163) rhetorical devices used in particular ways in mathematics classrooms?

Addressing these questions will strengthen the methodological approach developed in this dissertation, but will also have wider applications in the analysis of mathematics classroom interaction.

The second issue I want to discuss in this section concerns the diverse cultural, linguistic, social and educational backgrounds of the students involved in this study. I have consistently problematised the implications of this diversity for conducting classroom research. In the study described in this dissertation, I have taken a particularly strong position, refusing to introduce any ethnographic material from outside the school environment (unlike some studies, such as Tomlin, Baker & Street, 2002). My argument is that even if I were to visit students' homes, learn their languages or go with them to IKEA or McDonald's, our experience of these things will not be the same. What each of us sees will mean different things to each of us and the difficulty of making valid interpretation remains. My position has therefore been to explore how much I can say working with classroom-based interaction. The resulting approach, as set out in the preceding chapters, involves focusing on interaction as social action, and in particular on the attention students create and use in their discussions. A key question in examining a particular utterance, is 'what does this do?' in a social-discursive sense. Having reached this point, it seems possible to revisit the possibility of using ethnographic evidence from outside the classroom. Such evidence would, however, be used in accordance with the methodological approach I have developed.

Let me give an example. During the fieldwork for this study, I observed Parveen counting on her fingers using her thumb to mark off three points on each finger of the same hand. This behaviour is one I had previously observed in Pakistan. My difficulty in saying anything about this behaviour is that I cannot say what such counting means to Parveen. I cannot see inside her head as she counts on her fingers in this way. I can, however, treat Parveen's actions in the same way as I treat her words. I can explore how she uses such actions as part of the social actions involved in participating in the mathematics classroom. Furthermore, if I observe her finger counting in different settings, I can then examine how it is used, discursively, in each one. It may then be possible to examine how such counting patterns are discursively modified or transformed according to the context in which they occur.

The finger-counting example illustrates a more general course of future methodological development. Observing EAL students in different settings could explore the following questions:

- What patterns of discursive action can be identified in specific settings, or in more than one setting.
- How are these patterns discursively related to the settings in which they occur?
- Where such patterns appear to arise in different settings, how are they similar or different in each setting?

The analysis of these behaviours, however, would proceed discursively, along the lines of the analysis exemplified in this dissertation.

To conclude this section, I want to look beyond the specific substantive concerns of this study to consider the methodological approach in a more general light. Cultural and linguistic diversity are an increasingly significant feature of classrooms around the world. Such diversity presents considerable challenges for research, since many methods and techniques were designed in monolingual environments and therefore implicitly take monolingualism for granted. As classrooms become more diverse, these assumptions no longer hold and must be revisited. Existing methods need to be reconsidered and adapted. New methods need to be developed. Methodologies similarly need to be revisited to take account of both the diversity of classrooms and other research sites, but also to take account of the difference in background and experience between researchers and researched. The methodological approach developed in this dissertation is a contribution to this process of revisiting, taking existing approaches to classroom research, such as recording students as they work, and developing more robust ways of making sense of the resulting data. This approach therefore has applications beyond the primary mathematics classroom.

## **Summary**

In this chapter, I have outlined the main findings of this study and explored some of the implications they have for teaching and research. The key methodological outcome of

this study is the application of ideas from conversation analysis and discursive psychology to develop an approach to the analysis of interaction involving EAL students. This approach has greater validity of interpretation than existing approaches and provides a methodological basis for further classroom research involving students from diverse backgrounds in mathematics education or other subject areas.

Applying this approach in a primary mathematics environment resulted in substantive findings which include:

- EAL students are able to draw on a range of different forms of experience in working on mathematical word problems, including their experience of mathematics, of the world outside the classroom and of text;
- students use these experiences in the joint, social process of sense-making in and through their task, including negotiating shared mathematical sense;
- EAL students' participation in the joint production of a mathematical text can lead to their being positioned as less capable by other students;
- the students in this study appear to be able to attend to both linguistic and mathematical concerns at different times and can smoothly shift attention between these different concerns.

These findings support research which suggests that EAL students benefit from opportunities to work with other students to negotiate shared sense in the classroom, although these opportunities may need to be managed to avoid the subordination of such students to more dominant peers. They also highlight the social nature of classroom interaction and show how this is a relevant part of students' work together.

## Notes

1. English as an additional language (EAL) refers to any learner in an English medium environment for whom English is not the first language and for whom proficiency in English is not developed to native speaker level. Different professional and research communities employ the acronym 'EAL' in different ways. In this dissertation, I treat EAL as an adjective, as in 'EAL student'.
2. The biographical information about Farida given in this paragraph was collected in interviews with staff at Farida's school, particularly the school's EAL co-ordinator (see Chapter 6, p. 75).
3. In the UK, bilingual or multilingual students learning English are generally referred to as EAL (English as an additional language). Each country seems to have its own label and acronym and some have several. All are unsatisfactory. For consistency and ease of reading, in this chapter I have adopted 'EAL' or 'bilingual' in place of whatever term was used in the original research.
4. L1 is used to refer to a student's 'first' language, that is the main language they acquired from birth. L2 is used to refer to a student's 'second' or additional language, of which there may be more than one.
5. In Papua New Guinea, the L1 was designated as pidgin, which I must assume was the students' second language.
6. The UK state education system operates a system of national tests for students, often referred to as SATs, although the Qualifications and Curriculum Authority (QCA), the national body which administers the system, simply calls them 'national tests'. Students are required to take national tests in English, mathematics and science at ages 7, 11 and 14. The results of these tests are reported nationally. QCA also prepares tests for other age groups which schools may use if they wish. The scores of these optional tests are not reported nationally.
7. For Adler (2001, p. 166), multilingual classrooms are those in which students bring with them more than two languages, although the term does not imply that every student



in such a classroom speaks the same languages or the same number of languages. Some students may be monolingual.

8. Students learning English as an additional language may already be highly proficient in using another language, in both spoken and written form. Such students would correspond to Cummins' (2001, pp. 71-75) middle level, with no cognitive advantage or disadvantage, although there may be other kinds of advantage or disadvantage, such as social or cultural. As such students gain proficiency in using English, they may cross Cummins' proposed upper threshold and begin to show cognitive advantages. Other EAL students may lack proficiency in any language and would therefore fall below Cummins' proposed lower threshold, showing signs of some cognitive disadvantage. As such students became more proficient in English, they may cross the lower threshold and move away from the previous cognitive disadvantages. Of course any EAL student takes time to develop proficiency in English, time during which their peers are making further progress in their studies. Many EAL students are therefore constantly attempting to catch up with their peers (Collier, 1987, p. 638; Cummins, 2000, p. 76; Thomas & Collier, 1997, pp. 32-39).

9. The NNS has since been developed and introduced at secondary level (DfES, 2001).

10. From this point on I will indicate students' status as EAL or non-EAL, as well as EAL students' school-assessed English proficiency stage, in parentheses following their names. Thus Cynthia (EAL 2) indicates that Cynthia is an EAL student assessed as bordering stages 2 and 3 of the proficiency scale (see Chapter 3, p. 27).

11. A number of researchers have been interested in attention as a mental state alluded to through talk or action, including Bruner (1983) and Wertsch (1985) who explore the social origins of attention in interaction. In mathematics education, some have explored the role of attention (the mental state) in teaching and learning (e.g. Mason, 1989; Mason & Davis, 1988). Attention-as-mental-state arguably also arises in second language acquisition research in work exploring the role of the 'noticing' of linguistic features in the acquisition process (see, for example, Skehan, 1998, pp. 48-62). Skehan's notion of noticing is somewhat different from Mason's (2002) use of the term in mathematics education (for some comparison of the two, see Barwell, 2000b).

12. For an opposing point of view, see Schegloff (1997, 1998).

13. At the time of Sacks' (1992) work (the 1960s and early 1970s), audio recording was a relatively new approach made possible by developments in audio-recording technology. Video recording was still a technically difficult proposition. Sacks' remarks (*ibid.*, vol. 2, p. 622) apply equally well to the use of video recording (see, for example, Williams, 2002). My own preference for the use of audio-recording in this study is explained in Chapter 3.

14. Since I have selected particular students in this study because they are learners of English, I will continue to identify them as such in the text.

15. The idea that the social organisation of talk takes precedence over the organisation of its content is supported by studies of the social origins in infants of various aspects of language use, such as those by Bruner (1983), Halliday (1975) and Wertsch (1985).

16. The expression 'shift in attention' has been used by others in mathematics education, including Mason & Davis (1998) and Mason (1989). Although my usage bears some similarities, a key difference arises from my focus on what might be termed the social production and deployment of attention, where attention is in the sense developed in Chapter 4. Mason (1989) and Mason & Davis (1988), by contrast, treat attention as a mental state and consider how changes or shifts in this mental state are related to awareness and change in the learner.

17. Even my being explicit about the decisions I have made during the research process is a presentation, carefully designed for this dissertation and should be read as such (see Ashmore, 1989; Latour & Woolger, 1986, pp. 252-258).

18. Sacks' (1992; Sacks *et al.*, 1974) demonstration that turn-taking is a key aspect of the structure of talk does *not* mean that interaction falls into an orderly pattern of turn-by-turn exchanges. Rather, turn-taking is a norm against which deviations such as interruptions or overlapping speech carry particular significance and may need to be accounted for by participants (see Sacks *et al.*, 1974).

19. Bakhtin (1986, pp. 60-61) proposed a distinction between what he called primary and secondary genres. Primary genres are the patterned ways of speaking and writing present in all language use, the different ways in which words and phrases are put together by different people in different circumstances. Secondary genres can be described as patterns of patterns, the different ways in which words and phrases are organised within a text to produce a recognisable type of text.

20. The difference in the word problems written by students in two successive Year 5 groups indicates a degree of variation in the word problem genres between classes. All of the students were approximately the same age (9-10 years) when they took part in this study and all of whom were taught by the same teacher at that age. Such variation is likely to emerge from the many occasions the class experience word problems in different ways, experiences which are unlikely to be identical from year to year.

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## Publications relating to this dissertation

### Research publications

- Barwell, R. (2002, forthcoming) Bilingual identity and empowerment in school mathematics. Paper to be presented at the Second University of Vigo International Symposium on Bilingualism, Vigo, Spain, October.
- Barwell, R. (2002, submitted) Patterns of attention in the interaction of a primary school mathematics student with English as an additional language. MS submitted to *Educational Studies in Mathematics*.
- Barwell, R. (2002) E is for empowerment? EAL and the National Numeracy Strategy. Paper to be presented at 35th Annual Meeting of British Association for Applied Linguistics, Cardiff, September.
- Barwell, R. (2002) Dealing with mathematics: multilingual learners and primary school mathematics in the UK. Paper presented as part of the symposium 'Cultural and linguistic diversity in mathematics classes' at the 5th congress of the International Society for Cultural Research and Activity Theory (ISCRAT), Amsterdam, The Netherlands, June 2002. With Dr. G. de Abreu (University of Luton), Prof. T. Cline (University of Luton), Dr. D. van Eerde (Erasmus University Rotterdam, convenor), Dr. C. van den Boer (Utrecht University) and Dr. M. de Haan (Utrecht University).
- Barwell, R. (2002) Attending to the rhetoric of attention to think about mathematical thinking. In Goodchild, S. (Ed.) *Proceedings of the British Society for Research into Learning Mathematics* 22 (1&2) 1-6.
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- Barwell, R. (2001) Investigating mathematical interaction in a multilingual primary school: finding a way of working. In van den Heuvel-Panhuizen, M. (Ed): *Proceedings of the 25th meeting of the International Group for the Psychology of Mathematics Education (PME)*, vol 2, pp. 97-104.

- Barwell, R. (2001) Difficulties with mathematical word problems. In Winter, J. (Ed.): *Proceedings of the British Congress of Mathematics Education (BCME) 5, (Proceedings of BSRLM) 21(2) 63-74.*
- Barwell, R. (2001) Unity and adversity: orientations in the interaction of primary school learners with English as an additional language. Paper presented at 34th meeting of the British Association for Applied Linguistics (BAAL), Reading, UK, September.
- Barwell, R. (2001) When the meaning is uncertain: patterns in the interaction of English additional language learners. Paper presented at the Cultures of Learning conference, University of Bristol, UK, April.
- Barwell, R. (2001) Recruiting context: an investigation of English as an additional language and the learning of mathematics. Paper presented at the 3rd International Symposium on Bilingualism (ISB3), University of the West of England, UK, April.
- Barwell, R. (2000) Uncrossable boundaries?: A discourse analysis investigation of English as additional language and the learning of mathematics. Paper presented at 33rd meeting of the British Association for Applied Linguistics (BAAL), Cambridge, UK, September.
- Barwell, R. (2000) How many burgers can a human being eat? Writing word problems when English is an additional language. Rowland, T. (Ed): *Proceedings of the British Society for Research into Learning Mathematics 20(3) 1-6.*
- Barwell, R. (2000) Underwriting action: discursive psychology and the discourse of a primary mathematics classroom. In Jaworski, B. (Ed): *Proceedings of the British Society for Research into Learning Mathematics 20(1) 55-60.*

## **Writing for teachers and other practitioners**

- Barwell, R. (2002, forthcoming) Understanding EAL issues in mathematics. To appear in Leung, C. (Ed.) Watford: NALDIC Publications Group.
- Barwell, R. (2002, forthcoming) Making a difference: learning, teaching, mathematics and English as an additional language. To appear in Cline, T. and Abreu, G. (Eds.) Watford: NALDIC Publications Group.
- Barwell, R. (2002) Whose words? *Mathematics Teaching* 178, 34-36.
- Barwell, R. (2001) Learning from listening: talk in a multilingual mathematics classroom. *NALDIC Occasional Paper 14.* Watford: NALDIC Publications Group.
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- Barwell, R. (1997) Maths teaching in Hunza. *Mathematics Teaching* 161, 20-22.

## Appendix I

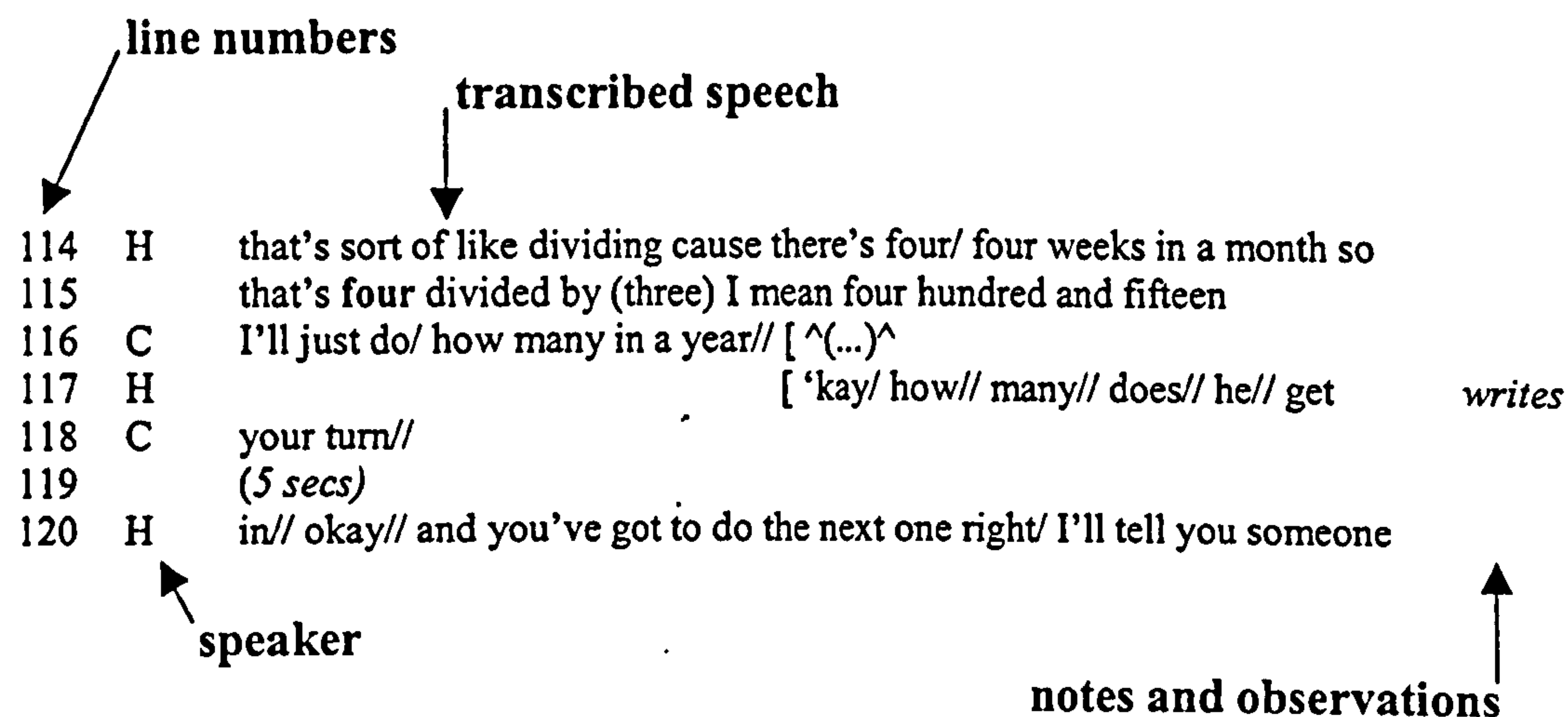
### Notes on the presentation of data used in this dissertation

This appendix contains explanatory notes on the following topics relating to the collection and presentation of data for this dissertation:

- transcription format
- transcription conventions
- transcript labelling system
- use of names
- summary of audio recordings of students working on the word problem task

#### Transcription format

The transcripts used in this dissertation are set out in four columns. The first column on the left contains line numbers. The second column indicates the speaker, shown at the beginning of each turn. Students are represented by the first letter of their pseudonym (see section on use of names, below). I am represented by RB. The third column contains transcribed speech and indications of other details such as sniffs, sneezes and pauses. Such details are given in italics in parentheses. The fourth column gives occasional notes or observations, such as when students are writing or using a calculator. This format is illustrated in the following extract from the transcript provided in Appendix II:



## Transcription conventions

The following conventions have been used to represent spoken interaction between students in this dissertation:

/ indicates a short pause less than 2 seconds (see above extract, line 116).

// indicates a long pause more than 2 seconds (see above extract, line 117).

Parentheses ( ) enclose speech where transcription is uncertain, perhaps because of background noise, two students speaking at once or mumbling (see above extract, line 115).

Ellipsis contained in parentheses (...) indicates speech which cannot be deciphered, even approximately. This may occur when two students speak at once, where students mumble or speak too far away from the microphone (see above extract, line 116).

**Bold type** indicates emphasis (see above extract, line 115).

A question mark ? indicates the use of question intonation. They do *not* indicate words which grammatically appear to be questions.

These little circumflex marks ^ ^ are used to enclose whispered or very quiet speech (see above extract, line 115).

Vertically aligned square brackets [ indicate where two or more participants speak concurrently (see above extract, lines 116 and 117).

An ampersand & indicates where a speaker's turn continues on a lower line in the transcript.

An equals sign = indicates where a speaker runs two words together.

Italic capital letters indicate letter sounds used in spelling out words, for example. *T* indicates 'tee'.

## **Transcript labelling system**

Each transcript prepared as part of the study reported in this dissertation is given a unique label, for example:

*1B/2C&H: 11/7/00*

These labels represent the following information:

1B indicates the cycle in which the recording was made. Four cycles were completed. Cycle 1A was the first cycle which took place in the summer term of 2000 before a target series of lessons. Cycle 1B was the second cycle which took place after the same target series of lessons. Hence A indicates 'before', B indicates 'after'. Subsequent cycles were only conducted after targeted series of lessons. Hence Cycle 2B was conducted after a series of lessons in autumn term 2000, and Cycle 3B was conducted after another series of lessons in summer term 2001.

Following the cycle is an indication of the number of the recording in a given cycle. Hence 1B/2 is the second recording in Cycle 1B. The first recording made in Cycle 1A is labelled 1A/0 as it was initially run as a trial and only later incorporated into the labelling system described here.

Letters indicate the students participating in the recording. Hence 1B/2C&H involves Cynthia and Helena. A table is showing which students took part in which recordings is given in the section 'summary of audio recordings' below.

Finally, following a colon, the date of the recording is shown. Hence the transcript 1B/2C&H: 11/7/00 comes from a recording made on 11 July 2000.

## **Use of names**

All names (apart from mine) have been changed to preserve the anonymity of the participants. Students have been given pseudonyms. Students' full names frequently arise in the recordings and have been transcribed using the pseudonyms. The class teacher is referred to as 'T' or 'Miss T'. Other teachers are referred to as numbered Ts, such as T1 or T2. Place names have also been changed.



## Summary of audio recordings of students working on the word problem task

IN the tables below, EAL students are shown in bold type.

<p><u>Cycle 1A</u></p> <p>1A/0C&amp;H: 21/5/00          1A/1S&amp;R: 19/6/00          1A/2F&amp;P: 20/6/00          1A/3E&amp;V: 20/6/00          1A/4C,D&amp;J: 21/6/00          1A/5S&amp;H: 21/6/00</p> <p><u>Cycle 1B</u></p> <p>1B/1S&amp;R: 11/7/00          1B/2C&amp;H: 11/7/00          1B/3F&amp;P: 12/7/00          1B/4S&amp;H: 12/7/00          1B/5E&amp;VA: 13/7/00          1B/6C,D&amp;J: 13/7/00</p>	<p><u>Year 5 (1999/2000)</u></p> <p><b>Cynthia &amp; Helena</b>  <b>Safia &amp; Rahim</b>  <b>Farida &amp; Parveen</b>          Eleanor &amp; Vicky  <b>Cynthia, Daniel &amp; Joanne</b>  <b>Safia &amp; Helena</b></p> <p><b>Safia &amp; Rahim</b>  <b>Cynthia &amp; Helena</b>  <b>Farida &amp; Parveen</b>  <b>Safia &amp; Helena</b>          Eleanor &amp; Vicky  <b>Cynthia, Daniel &amp; Joanne</b></p>
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<p><u>Cycle 2</u></p> <p>2B/1Z&amp;A: 30/11/00          2B/2S&amp;B: 4/12/00          2B/3C&amp;J: 4/12/00          2B/4T&amp;V: 5/12/00          2B/5A&amp;J: 5/12/00          2B/6Z&amp;C: 6/12/00          2B/7S&amp;T: 7/12/00          2B/8V&amp;B: 7/12/00</p>	<p><u>Year 5 2000-2001</u></p> <p><b>Zeb &amp; Afzal</b>  <b>Shaheen &amp; Benjamin</b>          Courtney &amp; Jackson  <b>Tahira &amp; Verity</b>  <b>Afzal &amp; Jackson</b>  <b>Zeb &amp; Courtney</b>  <b>Shaheen &amp; Tahira</b>  <b>Verity &amp; Benjamin</b></p>
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<u>Cycle 3</u>	<u>Year 5 2000-2001</u>
3B/1T&V: 11/6/01	Tahira & Verity
3B/2S&B: 11/6/01	Shaheen & Benjamin
3B/3Z&C: 13/6/01	Zeb & Courtney
3B/4V&B: 18/6/01	Verity & Benjamin
3B/5S&T: 22/6/01	Shaheen & Tahira
3B/6A&J: 22/6/01	Afzal & Jackson
3B/7C&J: 25/6/01	Courney & Jackson
3B/8Z&A: 9/7/01	Zeb & Afzal

## Appendix II

### Transcript of Cynthia and Helena

The following transcript represents the interaction between Cynthia and Helena on the first occasion they were asked to work together. It was also the first occasion either student had been recorded working on the word problem task, although I had earlier used the tape recorder in the students' classroom.

This recording was made in a central area just outside the classroom. The space is kitted out as a computer laboratory but as it was not in use, I made a space at a table for the students to work at. I sat a little way away from them while they worked, out of their line of sight so as not to disturb them, but present should they need assistance

For this recording, I asked the two students to make up some word problems involving addition. I provided them with a sheet of plain paper and two pencils. Transcription conventions are shown in Appendix I.

- 
- RB now you've seen my tape-recorder before haven't you  
C yep  
RB so I can remember things/ so what I want you to do is think about/ erm/  
5 sometimes/ when Miss T/ erm/ gives you some word problems to do?  
d'you remember/ word problems?// so maybe some/ some word problems  
about/ erm/ for/ adding/ sums/ adding up/ does that make sense?//  
sometimes Miss T asks you to make your own questions/ yeah?  
H yeah  
10 RB so some=what I'd like you to do/ is write me/ um/ five/ word problems/  
for doing/ addition/ d'you think you can do that for me?// is that okay?/  
but I want you to do them together/ okay?/ so just between you/ five  
word problems  
H okay  
15 C on each page?  
RB no/ jus-just on one page/ but there's some spare paper if you want to/ t-  
to/ I dunno to/ think/ or/ anything you might want to write/ does that  
make sense?/ I'll just be sitting over here with Yakub [ if you need &  
? [ okay  
20 RB me/ but otherwise I'll just leave you to get on with [ it/ is that okay?/&  
? [ yep  
RB great/ so you can work together  
C I can't=  
H d'you remember it?  
25 C no
- Yakub  
working  
outside  
alone*
- RB  
withdraws*

H it's/ a word problem is when you know miss writes on/ maths/ when she writes/ a paragraph on the board/ or/ you copy the sentence on the board/ and and and it says/ um/ Mike had something or (Jane) had something you know like that?

30 C no

H well that means/ right say like/ Natalie had/ Natalie went and bought something/ and then/ you know? when miss says that?

C I can't remember/

H for instance// Natalie went to the shops/ she bought three things/ for fifty

35 p.

C oh I know now I remember/ the l-/ um/ the/ we=like/ th-the um um *v animated*  
som'ing/ som'ing// um// I know what d'you mean but I can't explain

H yeah?

C yeah yeah yeah

40 H and she and she right at the end of the paragraph she writes/ how many/  
[ things did she buy or [ what did she have like that [ and/ mister said &

C [ h- [ yeah yeah yeah [ yeah yeah yeah

H that/ mister/ says we have to write/ [ five

C [ five

45 H alright/ [ adding adding ones

C [ yeah you first/ you first

H okay then/ I'll show you// give me a name

C name/ um// (...)

H no

50 C Gemma then any

H Daniel then *Daniel is in*

C yeah brilliant *their class*

H ^don't tell Daniel though/ [ cause he'll get really mad (with) me^

C [ 'kay

55 ? (...)

H Daniel um *writes*

C Daniel um

H went to the shop

C n-no can/ umm/ um write that/ Daniel work/ n-no/ Daniel/ w=um/

60 Daniel/ well if he work/ (...) he have/ he have/ hundred pound/ and how  
many/ in/ the month/ (for example) like easy one

H but you've got to use it in addin'/ addin'/ addition/

C oh yeah

H so you say Daniel/ yeah it's kind of like a addition thing isn't it/ because/

65 Daniel went to work/ he had hundred pound/ a month?

C um/ a week

H oh that's ^(okay then)^ a hundred pounds a week/ how many/ how many  
um/ how ma=how much money do he have in a month

C yep

70 H (okay then)

C Daniel work

H Daniel work/ has a job?

C no Daniel has a job/ no no/ Daniel work/ one week/ a hundred pound

H no wait/ Daniel has a job/ he worked one/ [ week/ he has a hundred &

75 C [ week

H pounds/ how many/ how many what?/ how many

C oh like that like that like that/ um/ like that like that/ Daniel work/ um/  
no/ Daniel/ no/

H [ work  
 80 C [ have a job/ um no/ Daniel have a job/ one month he have err/ um/ umm/  
 four thousand three hundred and forty pound how many in a week  
  
 H tha's that's kind of hard for people though/ well not hard for most people  
 but  
 85 C it's okay  
 H okay// Daniel/ [ Daniel has a job/ he gets paid *writes*  
 C [ has a job  
 he got/ uh he get/ he got/ four hundred and fifteen pound in a week  
 H what?  
 90 C four hundred and fifteen pound in a week  
 H paid/ how much?  
 C four hundred fifteen/ pound on a week/ no/ on a month  
 H 'kay/ four hundred fifteen pound  
 C in a week/ no no/ in a month  
 95 H in *writes*  
 C month  
 H a  
 C month  
 H month  
 100 C how many in a week/ no oh yeah/ how many in a week  
 H (...) okay then/ how many/ how many/ how much money does he get/ in a  
 year/  
 C in a week  
 H a week?  
 105 C no that's (...)  
 H no cause/ you said in a month/  
 C yeah/ no/ I said/ [ no/ I said/ Daniel has a job he gets paid four &  
 H [ how many  
 C hundred and fifteen pound in a month/ how many in a week  
 110 H how much he gets  
 C yeah/ how-how much he get/ on one week  
 H that's dividing innit  
 C oh yes that's divide/  
 H that's sort of like dividing cause there's four/ four weeks in a month so  
 115 that's four divided by (three) I mean four hundred and fifteen  
 C I'll just do/ how many in a year// [ ^(...)^  
 H [ 'kay/ how// many// does// he// get *writes*  
 C your turn//  
 (5 secs)  
 120 H in// okay// and you've got to do the next one right/ I'll tell you someone  
 C yep  
 H another name could be// Michael?  
 C no/ um/ Sophie?  
 H no/ not everybody in the class  
 125 C ah/ Megan// [ (...)  
 H [ could be  
 C how do you spell Megan?  
 H M  
 C M  
 130 H E  
 C E

H G  
 C G  
 H AN  
 135 C AN/ Megan// and then  
 H Megan/ um/ goes to a shop five time/ no/ [ five times a week  
 C [ oh writes  
 Megan go// to/  
 H goes  
 140 C goes  
 H er just put a S/  
 C E S E S/ goes/ squash/ goes to the shop/ five times a week  
 H double E// two Es// week// um/ she buys  
 C she buy  
 145 H err  
 C um  
 H she bought  
 C she bought  
 H no she/ ^what's the past tense^/ she buys  
 150 C no she bought  
 H yeah/ go on/ she buys  
 C she buy/  
 H she/ bought/ I think bought [ she bought (...)  
 C [ I buy a book  
 155 H but she always goes to the shop five times a week/ after school// so she  
 buys  
 C she buy=she buy  
 H U  
 C oh/ oh/ [ B U Y  
 160 H [ Y// S  
 C ah S/  
 H three things  
 C three things/ at the week  
 H three things which cost/  
 165 C (...) three think think/  
 H three things/ three items  
 C three  
 H I T E M just write items/ three/ items/ three products  
 C how/ how d'y-/  
 170 H I T E M  
 C I/ T/ E/ M/ writes  
 H S  
 C S  
 H three items/ one costing seventy five p.  
 175 C one//  
 H (cost)  
 C cost  
 H C O  
 C C O  
 180 H S  
 C S  
 H T/ I N G?/ costing  
 C four pound fifty

H uh?/ seventy five p.  
 185 C s-seventy five p.  
 H yeah// another one costing  
 C 'nother one  
 H another item costing/ twenty seven/ can I write some  
 C yeah (you can write)//  
 190 (5 secs)  
 H cost// another one costing// costing/ twenty seven/ and one/ and//  
 C costing  
 H how much money?  
 C and one cost/ one pound// a [ pound  
 195 H [ pound  
 C yeah=a pound  
 H one/ pound/  
 C how many together  
 H how much  
 200 C 's together/  
 H how much money does she spend/ um/  
 C together/ ah/ how much does she spend together  
 H how much did you spend in three weeks  
 C three weeks/ 'kay/ no/ one month  
 205 H no  
 C yeah  
 H yeah alright [ (that's not hard)/ it's not hard actually/ just (...)  
 C [ that's not hard (...)  
 H alright then just/ how much does she buy/ three weeks  
 210 C no months  
 H it's [ five times a week  
 C [ months  
 H 's like/ it's three weeks/ tha's fifteen days/  
 C okay/  
 215 H fifteen times everything y'know  
 C okay writes  
 (5 secs)  
 H in/ three/ weeks// okay/ next one  
 C next one  
 220 H now tha's/ tha's the one about months/ I think that we gotta do/ one  
 week  
 C yes/ this got years and months  
 H tha's got months [ that's got years/ tha's got/ week  
 C [ that's got years/ tha's got week/ and month/ not just  
 225 week  
 H how much does she spend  
 C (...)  
 H how much does she spend/ yeah?/ how much does she spend  
 C how much//  
 230 H okay then  
 C um/ I don't think we// [ ah  
 H [ Jake and Jack  
 C no no/ um/ so wha's the one/ ah/ um um um um um um / can't remember/  
 um  
 235 H Hannah  
 C Hannah

H Catharine  
 C no/ Gemma/ no/ ah/ um  
 H Keith and  
 240 C Betty  
 H Betty and/ Wilma  
 C no Betty and Pettie/ no Peter  
 H Betty and Peter/ played with/  
 C oh my aunty's (...)  
 245 H um/um/ I know  
 C (...)  
 H um// I know/ Betty and Peter make a painting/ they/ no tha's (*inaud*)  
 C oh Miss mi-mister/ do we must to use add? *to RB*  
 H do we must to use add  
 250 RB add yeah I'd like you to do about addition is that alright?  
 C ahm?  
 H can we do them all different  
 C can we do different?  
 H add multiply times take away//  
 255 RB okay/ yeah  
 C yeah/ that's good/ okay like that (...)  
 H let's do division then  
 C no=yeah/ I do division/  
 H Betty and/ Betty and/  
 260 C hey look my sister/ [ what's she doing/ 's Sanjoop's sister/ um (...) &  
 H [ Mary  
 C not like that/ um  
 H okay  
 C no n-no/ um/ at year five/ each class have thirty two/ um/ one class need  
 265 forty book/ how many/ no not like that// um change a book/ can you think  
 of one  
 H I know um/ what what did you say those names Peter and Betty/ make a  
 cake  
 C Peter does that  
 270 H Pe-/ *P E*  
 C Pe-p-p *P E T T*/ no  
 H *P E T E R*  
 C *P E / P E T / E R*/ Peter  
 H beter *rhymes w.*  
 275 C beter/ that not say Peter/ [ Peter *Peter*  
 H *P* [ *P*  
 C Peter/ beginning with *P*// Peter/ and/ Betty/ *P E E T T E R*/ Betty like that  
*P E T T E R*/ I don't think so *P E T T E R*/  
 H *P E T E R*  
 280 C [ *P / E / T*/ well *P E T*  
 H [ *E / T*  
 yeah/ *E R*  
 C *E R*  
 H Betty and Peter  
 285 C Betty and Peter/ yeah/  
 H to make a cake/ they need to divide it  
 C to make/ wait=wait/ to make/ a cake  
 H show/ um/ Betty and Peter



C to make a cake/  
 290 H made a cake  
 C make a cake/ make/ a cake/ yeah that's right  
 H make/ cross out to  
 C what/ make  
 H Betty and Peter make a cake/ a cake// they need to divide it into  
 295 C they  
 H they need to  
 C need  
 H to divide it up  
 C into three// what time is it/ has you got a watch/ I lost my watch  
 300 H divide it up/ [ into//  
 C [ what time  
 (5 secs)  
 H three/ pieces// pieces//  
 C twenty to two  
 305 H into three pieces/ draw/ draw  
 C oh twenty to twelve  
 H quick because we need two more to do/ they need to divide it up into  
 three pieces/ um// draw how they do this  
 C um Peter and Betty make a cake/ they need/ to/ divide/ it/ up/  
 310 H into  
 C in three pieces/ no four pieces  
 H three/ it's harder/ and they'll be (depressed)  
 C four pieces/ three pieces/  
 H draw how/ they/ need/ to/ draw how/ they need to do this  
 315 C um/ like that/ make a cake to need to divide to up to three pieces/ and/  
 that um/ Peter eats something and Betty eats something and how many  
 left  
 H okay then/ what  
 C like that/ um/ Peter eats two/ no/ eats one and a half/ and Pet-no/ Peter  
 320 H eats/ one and Betty eats half and how many  
 H ^how many's that^// they divide it up into three pieces/ um/ full stop/ if  
 Peter/ eats// P'ter eats/ eats// um/ I know Peter eats  
 C um/ like Peter eats/ one/ and a half/ and a half/ what P-Peter eats/ look  
 look/ this is/ one two three innit/ Peter eats one  
 325 H I know what your saying/ [ cause  
 C [ and that half/ look/ this is the half/ and that  
 half/ like that/ he eat this much// half then half  
 H yeah I know one and a half/ one and a half 's three  
 C [ yeah one and a half then half  
 330 H [ so// Peter eats um/ two pieces  
 C two pieces/ no/ just  
 H Peter eats one third  
 C one third/ um//  
 H um/ and/ I don't know/ I know/ P-Peter eats/ one two pieces/ what/ is/ I  
 335 H don't know  
 C no Peter eats one pieces/ and Betty eats half pieces  
 H no/ Peter eats two pieces and Bet-/ no Peter eats one piece/ and Betty eats  
 one piece what's/ how much/ is left  
 C left that's easy  
 340 H I know

*writing*

C I'll just let it like that  
 H yeah  
 C yeah/ Peter eat one pieces// oh like that like that Peter eat one pieces/ um/  
 345 is/ two/ oh/ no like/ Peter eat two one pieces and Betty eat no um how  
 many Betty eats no/ I can't explain it/ oh just like that  
 H um/ Betty// you did Peter and Peter/ look/ Peter/ [ Peter there  
 C [ um/ Peter Peter  
 H there  
 C Peter Betty  
 350 H yeah alright cross out (that one anyway)// Betty/ that's not how you spell  
 Betty  
 C there's wrong/  
 H only cause it's not a capital  
 C I think it's/ [ P no  
 355 H [ that's Peter and beter  
 C Peter P E/ no P E/ P E T T/ E/ Y/ miss? how d'you spell/ Betty? *to RB*  
 RB Betty?  
 C yeah  
 RB B E  
 360 C B E  
 RB [ B E T T Y  
 C [ B E/ T/ [ T Y  
 H [ oh Y/ oh yeah I meant to E T T Y//  
 C pieces and how many left//  
 365 (5 secs)  
 H four/ (...)  
 C um/ um/ like/ um/ ^Alison^ *Alison &*  
 H do Emily/ yeah Emily and Alison *Emily are*  
 C Alison and Emily/ no no/ you know/ um/ Al-Alison had wha- she had *both in Y5*  
 370 pocket money in a week/ no/ yeah like that like that  
 H I know  
 C Alison Alison had pocket money=no/ Alison had/ Alison one month/ no/  
 have/ no/ Alison have/ one/ one month/ Alison one month have/ um/ fifty  
 pound pocket money/ and/ how many in a week/ no that's easy  
 375 H I know/ um Alison/ has five pound/ pocket money in a week/ Emily has  
 C five  
 H two pound/ no two pound  
 C [ no wait wait wait  
 H [ Alison five a week [ how much a week does Alison have/ yeah  
 380 C [ um wait wait wait/ what's  
 yeah/ yes wait/ Alison have five pound and  
 H pocket money a week  
 C pock/ [ pock  
 H [ pocket/  
 385 C P O K [ no C  
 H [ C K E T  
 C E T  
 H pocket money  
 C E T/ E T/ okay C C K E T pocket [ money  
 390 H [ money  
 C M O N E pocket money Emily has  
 H two pounds  
 C how/ it's pocket money a week

H a week yeah/  
 395 C a week/ Emily *EM* [ how d'you spell it  
 H [ *ILY*  
 C *I/L/Y*  
 H not *R/L*  
 C *L/ oh/ EMILY/*  
 400 H Emily has/  
 C wait wait I'll put the has on  
 H two pound/ sixty/ one  
 C two/ two pound sixty one/ pock-pocket money a week/ pocket money  
 H a week/ how much more does/ Alison have  
 405 C okay/ how much  
 H more  
 C how much [ more  
 H [ more/ does Alison have  
 C does  
 410 H *DOE*  
 C *DOES/* does  
 H Alison have  
 C Alison have/  
 H Alison  
 415 C Alison have

*RB intervenes to stop their work and they return to the class*

## Appendix III

### Students' word problems

The following word problems were written by students in transcripts referred to in this dissertation. The problems are reproducing using the students' original spelling and line breaks and are listed in chronological order, by cycle.

#### Cycle 1A

##### Cynthia and Helena (1A/0C&H: 21/5/00)

Daniel has a job he gets pay  
£415 in a month. How much money  
does he get in a yaer?

Megan goes to the 5 time a week, she  
buys 3 items. 1 costing £0.75p, another  
costing £0.27, and one cost £1.00. How  
much does she spend in 3 weeks

Peter and Beter make a cake,  
They divid it up into 30 pieces.  
Peter eats 1 piece and Betty eats 1 piece.  
How much is left?

Annette has £5 pocket money a week,  
Jade has £2.61 pocket money a week.  
How many mone does Annette have?

##### Safia and Rahim (1A/1S&R: 19/6/00)

100 peple go to the shop and bi  
crisp = 50p      whats is the  
coca = 50p      total

100 peple go to the shop to bye crisps and  
coke it costs 50p  
crisps = £1  
coke = £1

**Farida and Parveen (1A/2F&P: 20/6/00)**

If you have 20 sweet and you gave  
away 8 how many have you leaft?=  
=

If you have 4 paper and you had two partns  
eath what shaell we do with the paper?=  
=

If you have 5 childre and 20 Book  
how many can you give the Book?=  
=

If we have 58 peiln and we find 68 peiln  
How many or together?=  
=

If you have 200 pound and we gave  
68 pound gave someone ease and  
how much you have left?=  
=

**Cynthia, Daniel and Joanne (1A/4C,D&J: 21/6/00)**

If you hade £2.50 and bought 4 packet  
of crisps that was 59p how much would  
you have left and how much did you  
spend?  
=

Daniel He get £5.00 pocket money in  
One week. Howe much pocketmoney He  
He got in one years?  
=

Cynthia had £3.00 and bought 9 sweet  
that is 50p how much would Cynthia  
have left and spend  
=

If you had two handbags and  
somone have you 68 more how many  
would you have?  
=

**Safia and Helena (1A/5S&H: 21/6/00)**

Leanne wnet to a Rock'n'Roll  
concert, it cost £11.50 for one person  
and there was 12,163 people there when  
the show started and the doors were closed.  
How much money did the concert Raise  
altogether?  
=

Paul&Chris went to macdonals they bought  
72,999 £3 meals and 1000 apple pie wich  
cost £1 how much money did they spend?

## Cycle 1B

### Safia and Rahim (1B/1S&R: 11/7/00)

4 M+ Then you press on/c Then you press MRC baton Then you  
press M- Then you press on/c Then you press  
MRC and it is gone

Chris whant to the shop and brot 2 crips  
wich cost £4 each and bort 5 drinks wich  
cost £10 each  
What is the total

300 people were at the beach and 1,000 people  
were at Ikea what is the total

### Cynthia and Helena (1B/2C&H: 11/7/00)

Helena had £30 Pocket money in 1 week  
everyday she buys 4 packet of chrisps each  
costing 45p. How much does she spend in 1 day, How  
much does she spend in 1 week and How much does she have  
left?

Cynthia had £30, she buys a music jewellery box,  
costing £15 and she buys a ring costing £12.99  
How much does she spend altogether and How  
much does she have left?

### Safia and Helena (1B/4S&H: 12/7/00)

If I have 25p and I spend  
10p how many money wolud I left?=  
=

If I have £6.00 I spend 45p for  
crips 60p choclate £1 for drind and  
£3.00 for bateres How mush  
do I left=  
=

I had 30p and I spend 20p How many would I left?

If I have 6000 pound and  
I spend 1000 for bed pound and  
£950 cooker and £995 for  
machine. How much do I spend  
How do I left

I need a bed and it was  
1000 and I had 10000 How money

If I have 6 window and I  
desk and 5 chair How  
many is all together

### **Eleanor and Vicky (1B/5E&V: 13/7/00)**

3 children have £1 each 2 of them  
buy A drink costing 30p work out on the calcuater  
how mach they have alltogether

11 children have £5.60 and go to the shop 5 of them  
spend £.65 how much do they sped all together

2 cildren go to the supermarkit with £25  
and them buy washing up liquid costing 45p sopepob  
20 packits of crisp 1:50p 1 bottle of ginger beer 5 bottle  
of oginge sode costing 50p each. And  
ham burgers cosing 2.50

### **Cynthia, Daniel and Joanne (1B/6C,D&J: 13/7/00)**

Daniel had £50 pocket money in one weeks  
everyday he buy 10 pack of poke'mon stick each cost 30p and he  
buy 2 pack of poke'mon card each cost £2.50.  
How mcuh is us in 1 day, How much He us  
in 1 week and How much He left?

Daniel has £50 he buy £30 birthday  
person and How many he left?

If you have  
680 sweets tiy gave away 1 how much we [?]  
have left

If Cynthia have 900  
sweets and she gave away 200  
sweets to her mum how many she left

## **Cycle 2**

### **Zeb and Afzal (2B/1Z&A: 30/11/00)**

205 eggs 125 eggs brakes how many left

10 buses and one bus tackes 50 people and there are 252 people how  
many left

cheese 5,000p an p. 1000 how  
many left

**Courtney and Jackson (2B/3C&J: 4/12/00)**

200 bikes in the shop 50 people  
came and tool two whats the  
answer

There are a houndred and eighty  
brains in the morgue four monsters  
came and eat 44 each how much is  
left

There are five houndred dinosours  
nine dinosours dies and a houndred  
stay alive share this by 5

**Tahira and Verity (2B/4T&V: 5/12/00)**

If you had 12 sweets and there were  
six people how many sweets  
do they get each?

If there were 100 sweets and there were 50 people  
How many sweets can you divide out 50 by same  
people?

If there were 8 people on the bus and  
2 people came up and that will be 10 people on the  
bus How many can you divide?

**Afzal and Jackson (2B/5A&J: 5/12/00)**

There was fifty people in the  
swimming pool twenty  
five come out how much is  
left?

if there are 100 people and 50 go  
away how left?

If there are 50,000 water guns in  
Woolworths 25,000 get sold  
how much is left

If you got 100 eggs  
and 50 breks how  
many left?



**Zeb and Courtney (2B/6Z&C: 6/12/00)**

There are 100 cars in the town's car park  
there are  
4 floors how many cars on each floor?

If there are 10 flowers in each house and there are 2 houses  
how many flowers all together?

I have 150 cars in my business [?]  
group these in to 3 groups to see if you can

I have 2,000 polite cars, and I share in to 10 pieces  
how much with each piece get?

**Shaheen and Tahira (2B/7S&T: 7/12/00)**

If 15 people went to the bus stop and  
they went in the bus and 2 people left  
How many people are in the bus?

If there were 9 bottles of gallons and 12 ml are in  
the 9 bottles of gallons How many mls are there together

If 50 people were going on a trip and 5  
people were left behind in school How many  
are going to the trip?

If 28 people were going to a trip to the pantomime  
and 2 extra people joined the people. How many  
people are there together?

**Verity and Benjamin (2B/8V&B: 7/12/00)**

It was Christmas Eve and 20 people came to the  
Christmas party and there was a big cake how many  
pieces they get each?

There are five million people and there is one servant  
how many servants do they need each?

There are six children and they baked 3 biscuits  
how many is it

There are 100 children and 25 children get left behind and every single  
one of the children brought half of their pocket money how much [?]  
would it come up to?

## Cycle 3

### Afzal and Jackson (3B/6A&J: 22/6/01)

If it takes  $2\frac{1}{2}$  hours to get to London from Bristol  
How many hours would it take to walk?

1 letter have it and have it again and have it again?

If it takes half 1 hour long walk to school from western court  
how long from Ludlow close