Chapter 9
Discursive Demands and Equity in Second Language Mathematics Classrooms

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Second language learners of mathematics face a double challenge: they must learn the language of the classroom and, at the same time, they must learn something of the mathematics that is presented, discussed and conceptualised in that same language. Second language learners include students from linguistic minority backgrounds whose home languages are not well-represented or recognised in wider society. Such learners are bilingual or, more often, multilingual, although their level of proficiency in any one language, or in some combination of languages, varies according to the situation and with what is being discussed.

A variety of terms or labels have been used to describe such students: for the most part, such terms originate in government policy. They include:

- learners who are Limited English Proficient (LEP) – in the U.S.A.;
- English language learners (ELLs) – more recently in the U.S.A. and Canada;
- learners of English as a second language (ESL) – in Canada and the U.S.A.;
- learners of English as an additional language (EAL) – in the U.K.;
- learners from non-English-speaking backgrounds (NESB) – in Australia.

These terms all come from countries that are portrayed as English-speaking and it may therefore seem unsurprising that they all take English as the reference language. However, these terms are descriptions of *learners*, not medical conditions. As such, they all index a deficit view of bilingualism or multilingualism, since they all highlight the value of English and leave students' 'other' languages largely invisible or inaudible.

Researchers have often argued for the use of alternative formulations, particularly 'bilingual learners', although such usage is complicated by the politicisation of bilingual education programs in parts of the U.S.A. (see, for example, Leung 2005).

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B. Herbel-Eisenmann et al. (eds.), *Equity in Discourse for Mathematics Education: Theories, Practices, and Policies*, Mathematics Education Library 55,
DOI 10.1007/978-94-007-2813-4_9, © Springer Science+Business Media B.V. 2012

In this chapter, I examine the challenges facing second language learners in mathematics classrooms. To avoid the kind of deficit assumptions already alluded to, I draw on a social, discursive perspective that sees second language learners' participation in mathematics classroom interaction as jointly achieved. In what follows, I set out the idea of *discursive demands* arising in mathematics classroom interaction. This notion is illustrated with data from a mathematics lesson in a multilingual classroom in London, U.K.

At primary school level, the teaching of mathematics in England is guided by the government's *Primary National Strategy*, as represented by a framework document and many other publications. References to the needs of EAL learners are widespread (often appearing alongside guidance on special educational needs) and are generally framed in terms of a metaphor of 'access' (Barwell 2004). The following statement, for example, is typical; similar statements appear in several parts of the framework:

> Children learning EAL must be supported to access curriculum content while also developing cognitive and academic language within whole-class, group and independent contexts. [...] it is critical to maintain a level of cognitive challenge consistent with that of the rest of the class. Children who are or have become conversationally fluent will continue to require explicit attention to the development of the academic language associated with the subject and of specific aspects within the subject. Planning should identify the language demands of the objectives and associated activities. Making sure that EAL learners know and can use the language demanded by the curriculum content of the unit or lesson then becomes an additional objective. To identify the language demands, teachers and practitioners will need to consider the language children will need to understand in order to access an activity. (DfES 2006, p. 14)

The access metaphor that is apparent in this statement constructs language as a kind of portal, through which students somehow must pass in order to enter a subject like mathematics. As I have written elsewhere (Barwell 2005a), this metaphor has several problematic aspects:

> First, language is separate from content, with the implication that if students can learn the language, learning the [curriculum] content will be straightforward. Indeed, it could also imply that language should be learnt *before* content. The idea that language is a part of content and vice versa is to some extent obscured. Secondly, therefore, the view of language as a portal renders language transparent, obscuring its role in the construction of a subject. Thirdly, both language and content are portrayed in rather static terms, external to the learner, obscuring the subjective experience and variable use of both language and subjects like mathematics. Finally, by obscuring the variability of language and content, their relationship with social, power-suffused relationships and structures is also obscured. Thus, for example, the political dimensions of language and the often authoritarian nature of school curricula are hidden. (p. 144)

The access metaphor is, therefore, problematic in its portrayal of both mathematics *and* language. This portrayal, furthermore, has implications for equity in relation to second language learners of mathematics. By downplaying the role of language in the construction of mathematics, an impression is created that mathematics is the one subject in which second language learners will have few problems – something that is certainly not the case for many such learners. And the presentation of both

English and mathematics as rather static entities serves to underplay the diverse conceptions or experiences of English and of mathematics that second language learners may bring.

The above DfES EAL statement also refers to the idea of 'language demands', which is, in turn, derived from a distinction between academic and conversational language based on the work of Cummins (e.g. 2000). This work is discussed below. At this stage, I will simply observe that, in the statement, language demands are related to access. Hence, it is recognised that a subject like mathematics involves some specific forms of language, but these forms are construed as part of the portal; they act, perhaps, as keys with which to open the portal that leads to mathematics.

Notwithstanding the problems relating to this access metaphor, it is worth asking what the nature of language demands might be in mathematics. Government documents tend to emphasise vocabulary (e.g. DfES 2000), although there is some recognition of other aspects of mathematical language (DfES 2002). Nevertheless, language demands in mathematics tend to be understood as clearly specialised vocabulary, grammar or syntax: language demands, then, at least in U.K. policy documents, are about the language system. Much less attention is given to the demands of mathematics classroom discourse – the broader ways of using language in talking about and writing about mathematics (see, for example, Barwell 2005b). The aim of this chapter is to introduce and illustrate the idea of 'discursive demands' as a way of thinking about some aspects of the double challenge faced by second language learners of mathematics. This idea combines concepts from bilingual education, particularly the work of Cummins, with a discursive perspective on mathematical thinking that foregrounds the situated, socially organised nature of cognitive processes like thinking, knowing or remembering. These ideas are discussed in the sections that follow.

1 Conversational and Academic Language Proficiency

Cummins' work (e.g. 2000) has been influential in shaping the direction of research in bilingual education, as well as in informing the development of pedagogic practices that are effective in supporting the school learning of bilingual students. One construct, in particular, has become widely used: the distinction between academic and conversational language, sometimes also referred to as Cognitive Academic Language Proficiency (CALP) and Basic Interpersonal Communicative Skills (BICS). This distinction initially emerged in research that sought to understand why apparently fluent bilingual school students were under-performing in tests (Cummins 2000, p. 58).

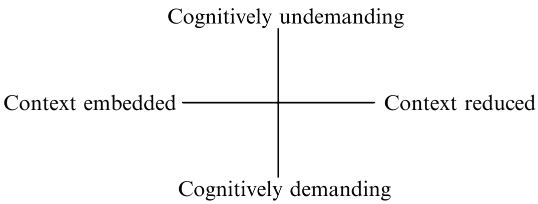
Cummins argued that a single construct of global language proficiency is insufficient to explain such students' under-performance. In effect, language proficiency is domain specific and, indeed, context specific. In particular, students may have a level of proficiency that allows them to participate fully in everyday conversation, while not having developed a similar level of proficiency in the academic language of subjects such as mathematics. Indeed, this point applies to all students to some degree:

> native-speakers of any language come to school at age five or so virtually fully competent users of their language. They have acquired the core grammar of their language and many of the sociolinguistic rules for using it appropriately in familiar social contexts. Yet, schools spend another 12 years (and considerable public funds) attempting to extend this basic linguistic repertoire into more specialised domains and functions of language. CALP or academic language proficiency […] reflects the registers of language that children acquire in school and which they need to use effectively if they are to progress successfully through the grades. For example, knowing the conventions of different genres of writing (e.g. science reports, persuasive writing, etc.) and developing the ability to use these forms of expression effectively are essential for academic success. (p. 59)

It is notable that, for Cummins, academic language proficiency is closely tied to the language of schooling. That is, the construct 'academic language proficiency' is specific to the particular situation of schooling. Subsequent research (e.g. Thomas and Collier 1997) has confirmed the validity of Cummins' distinction and has demonstrated that second language learners take several more years to develop academic language proficiency, as compared with conversational language proficiency. A basic equity issue is immediately apparent, in that second language learners may be assumed to be 'fluent' in the classroom language – and treated as such – when they would, in fact, benefit from support in the development of academic language proficiency in subjects like mathematics.

Cummins (2000, pp. 67–68) goes on to refine the notion of academic language proficiency to take account of two different issues: situational aspects of language use and related cognitive aspects. To do so, he defines two inter-related continua. The first continuum extends from context-embedded to context-reduced communication. In context-embedded communication, interaction is supported by a wide range of situational or interpersonal cues. In a face-to-face discussion, for example, participants may draw on facial expressions, gestures, nods of the head and so on to make meaning, indicate comprehension, ask for clarification and generally communicate. In context-reduced situations, by contrast, the role of situation or interpersonal cues is greatly diminished, as, for example, in a formal written examination. Context-embedded interaction is typical of a great deal of everyday talk outside of school. Much of the interaction encountered *within* school is to a greater or lesser extent context reduced. Consider, for example, listening to a teacher's explanation, presenting a solution to a mathematics problem, writing out such a solution or taking a test.

Cummins' second continuum concerns the cognitive demands of interaction. Cognitively demanding interaction requires "active cognitive involvement" (p. 68), such as, for example, recalling and using new vocabulary or working with an unfamiliar genre or grammatical structure. Interaction becomes less demanding as it becomes, in effect, more automatic. He presents these two continua within a single framework.



The two dimensions are highly interdependent. Face-to-face talk, for example, relies on a high degree of context in the form of gestures, facial expressions and the presence of many of the objects of discussion. Such context supports meaning-making and so tends to reduce the cognitive demands of the interaction. Some interaction involves more reduced contexts. Giving a presentation, for example, involves less direct interaction, so is more context reduced than is face-to-face interaction. A reduced context tends to lead to more cognitively demanding interaction – giving a presentation makes greater cognitive demands to produce appropriate language. Of course, what is cognitively demanding for one student can be relatively undemanding for another. In some sense, therefore, the framework can be seen as relative to the individual. Nevertheless, it allows for some broad general observations to be made. In particular, academic language tends to be both cognitively demanding and context reduced.

Cummins' ideas provide a valuable, though rather broad, framework with which to understand some key issues facing second language learners in school, as well as to inform teaching. While these ideas clearly recognise interaction as central to learning, they do not allow an examination of the detailed nature of this interaction. The framework is not designed with such a purpose in mind. Interaction between students or between teachers and students is also central to equity. It is therefore valuable to consider how the specific demands of interaction in mathematics are implicated in the participation of second language learners.

2 Discursive Demands: Theoretical Perspective

U.K. policy uses the term 'language demands', drawing explicitly on Cummins' notion of academic language proficiency. Both policy and to some extent Cummins tend to see these demands largely in terms of the language system, focusing on vocabulary, text genres, grammar, and so on. Research on bilingualism or second language learners in mathematics classrooms initially had a similar focus (e.g. Austin and Howson 1979). In recent years, however, researchers have emphasised how issues of vocabulary and grammar are only one, perhaps more salient, feature of learning mathematics in bilingual or second-language settings. Research by Khisty (1995), Moschkovich (2002, 2008) and Setati (2005a), as well as my own (e.g. Barwell 2009), all highlight broader discursive aspects of bilingual, multilingual or second language mathematics classrooms, including the use of multiple languages; the role of students' everyday language; the interpretation of graphs, tables and diagrams; the construction of students' relationships with each other; and political tensions surrounding language use. What this work suggests is that situated language use – i.e. discourse – in mathematics classrooms is as significant as the formal linguistic features of the mathematics register in second language learners' participation in and engagement with school mathematics. I propose to refer to these kinds of demands on second language learners as *discursive demands*.

The perspective I will use to examine the discursive demands of mathematics classroom interaction draws on discursive psychology (Edwards 1997, 2006; Edwards and Potter 1992; Wetherell 2007) and related ideas in conversation analysis (Sacks 1992). From this perspective, cognition, including mathematical thinking or language learning, is seen as situated, jointly produced, contingent and organised by the structures of interaction. Mathematical cognition (i.e. thinking, knowing, understanding, etc.) is constructed by participants through their interaction. What a student knows in mathematics is not simply a stable mental state, waiting to be produced at the appropriate moment. What a student knows is constructed through her or his participation in mathematics classroom interaction.

Discursive psychology, then, is less concerned with what students are 'really' thinking, in preference for a focus on how what students are thinking is portrayed and discursively constructed. The discursive construction of cognition depends upon some basic features of interaction, such as choice of words, descriptions and the structure of the talk itself. Indeed, the socially organised structure of talk is seen as more significant in meaning-making and the construction of cognition than the semantic content of the words used. For this chapter, I will focus on the following specific structures found in everyday talk: the role of turn taking and adjacency pairs; sequentiality; repairs; and recipient design.

Spoken interaction is typically structured in turns, with the *turn-taking* structure both enabling and organising interpretation. A common feature of turn-taking is the occurrence of two-part structures, such as question–answer, greeting–greeting or invitation–acceptance. These two-part exchanges are called *adjacency pairs*. The second part of an adjacency pair normatively appears directly after the first, hence the term 'adjacency'. In some circumstances, however, the second part may appear some turns later, often with other pairs nested in between, as in the following example, used by Sacks (1992, vol. 2, p. 529; see also Silverman 1998, p. 106):

A: Can I borrow your car?
B: When?
A: This afternoon
B: For how long?
A: A couple of hours
B: Okay.

In this exchange, the first and last turns in the extract form an adjacency pair, with two question–answer pairs inserted in between. An important feature of adjacency pairs is that once the first part has been deployed, it is difficult for the addressee to avoid completing the pair with the appropriate second part. Indeed, any response will be interpreted in the light of the adjacency pair structure. Even if, for example, B were silent after A's question, that silence would still be heard as a response – a possible refusal, for example. While the second part of the adjacency pair can be put off, as in the above example, it must generally be completed in some way. It is in this sense that interaction is fundamentally *sequential*.

This principle is about more than the basic sense of interaction unfolding over time; the sequentiality of talk is a part of its structure: a question requires an answer; a request requires an acceptance. Responses to first pair parts are interpreted in the light of the adjacency pair structure. Equally, and reflexively, the responses serve to construct the nature of the interlocutor's understanding of the first pair part. Where these understandings are at odds some kind of renegotiation arises, a process known as *repair*.

The purpose of repair sequences is to re-establish a shared sense of understanding, although 'understanding' here refers only to the explicit interpretations made available in participants' utterances, rather than any internal mental state. The principle of *recipient design* is simply that utterances are audibly shaped to suit whomever is listening. A sense of this is apparent in the above extract. Although no information is provided about A or B, the nature of their exchange suggests that they are well acquainted. The phrasing of the opening question 'can I borrow your car?' is familiar. There is no preliminary introduction of the topic and no reason is given. It might even be deduced that A has borrowed B's car before. Such inferences are possible because of the basic principle of recipient design. A's question is designed for someone he or she knows well; in this way, it also constructs the interlocutor as such a person. The subsequent turns in the extract are similarly designed. Recipient design is accomplished by various means, including choice of words, forms of address or by varying the amount of information given. (For summaries of the preceding ideas, see Silverman 1998, pp. 101–109; ten Have 1999, pp. 18–25.)

Conversation analysis is a form of micro-sociology that seeks to understand how social life is organised by participants. Discursive psychology draws on the assumptions and analytic tools of conversation analysis as a starting point for the examination of the social organisation of cognition. Basic structures of interaction, such as turn-taking, adjacency pairs and recipient design serve to shape the content of talk, including, for example, mathematical thinking or knowing. Such social structures are distinct from those of languages like English, although clearly they rely on specific linguistic structures. Hence, I will define discursive demands as the forms of interaction arising in classrooms through which second language learners, along with their interlocutors, jointly produce both cognition and context. In the next sections, I discuss excerpts from interaction involving a second language learner of mathematics during a single mathematics lesson. My purpose is to explore what kind of discursive demands might arise for second language learners of mathematics.

3 Discursive Demands in a Mathematics Classroom

K is a refugee Kosovan student. He joined his school in London, U.K., at the start of Reception (equivalent to senior kindergarten). There were 26 students in the class, including EAL learners from Kosovan, Bengali and both anglophone and francophone African backgrounds. K was assessed by the school as EAL stage 1 (new to English) in November. His teacher estimated that he was probably stage 2 (becoming familiar with English) at the time I visited his class. Such an assessment suggests that he was developing a reasonable level of conversational proficiency in English at that time. His parents were reported as being supportive, though K's mother did not speak much English. K had Albanian language books on English and mathematics. The teacher felt he had a good memory, citing spelling as an example, characterising his memory as "very visual". The teacher reported that K relied on guessing, often not listening to instructions before embarking on a course of action. The teacher believed K was working at a relatively high level in mathematics, but was concerned that he could not show what he knew. In school tests, he scored higher in English than in mathematics.

The lesson discussed in this chapter focused on halving and doubling. K was recorded throughout the lesson using an individual microphone. The lesson began with the students sitting together on a carpeted area responding to the teacher's introductory questions. Later, the teacher moved on to a problem-like scenario about two children who have various items, one child having double or half the amount of the other. One problem, for example, stated that one child had four cars and the other had double. The task was to work out how many wheels there would be for each of the two children involved. The teacher introduced the use of multi-link cubes formed into rods to support thinking about halving. Following the whole-class discussion, the students worked in pre-assigned groups on worksheets. K's worksheet included similar problems to those discussed earlier, including questions about cars and wheels. Another teacher (T2) joined the class for part of the lesson and supported individual students, including K, with their work.

Whole-class discussion in a lively year 1 (Reception) mathematics class is fast and furious, with many speakers often competing for attention and frequent side sequences in which students interact with each other. An utterance like 'I know', for example, can be seen as primarily a bid for the floor (i.e. the right to speak) rather than a definitive statement by a student about her or his mathematical thinking. For a student like K, the discussion presents a number of discursive demands, of which I will highlight three: multiple speaker interaction; frequent repair sequences; 'raising the stakes'. I will describe these demands in more detail and illustrate them with selected excerpts from the transcript – although the densely interwoven nature of these various strands throughout the lesson mean that what is presented is necessarily a simplification.

3.1 Multiple Speaker Interaction

The whole-class discussion in the lesson is characterised by rapid turn-taking exchanges involving multiple speakers. The teacher is generally the participant who nominates who may speak next and so manages the interaction. She also has rights to interrupt other speakers. Of course, there are many interruptions and speakings out of turn from the students, but these are deemed not legitimate, as indicated by such utterances being explicitly refused or ignored. In some cases, for example, the teacher tells students that she did not accept their response because they did not put up their hand and wait to be nominated. K must find a way to make sense of and participate in this kind of interaction.

In the sequence below, the teacher has introduced two characters, Charlie and Ben, whom the children have come across before. In reading the sequence, consider how it looks from the perspective of K, sat in the middle of the carpet, surrounded by his peers, with the teacher standing in front of them next to a small whiteboard on an easel. (Transcript conventions are explained at the end in Note 1.)

T	Ben/ we've got Charlie and we've got Ben/ **now** Charlie is **six** years old
K?	[I'm six!
T	[should have/ should've called him K shouldn't I today/ but he's six years old/ and **Ben/** is **half/**[as old
S	[seven
T	no don't shout out/
S	^I know^
T	he's **half/** as old/[as Charlie
S	[one
T	^so quietly/[tell the person [next to you^
S	[he's six [
S	[three
T	Charlie's six &
K?	I'm six!
S	[I'm six
T	& [and Ben is **half** his age/ you're on the right lines R/ how can you use your [fingers to help you
K	[it's three
T	he's **half** his age
K	seven
Ss	six/ six
S	two two two
S	three/ three
T	so if we've got six that's how many years/ old/ Charlie is/ so how old is Ben
Ss	three/
Ss	I know I know/
T	I'm looking for someone putting their hand up really quietly/ K
K	um/ three

T three/ how did you work it out?
K um/ [I just I just [I just thinked/ I just **thinked**
S [(I went like [this)
S [(…) [
T [no let him talk
what did you think?
K in my head **and** in my hands
T can you show me how did you think in your hands//
K then I just do **that**
T did you shall I show you what R did?

The teacher introduces the information that "Charlie is **six** years old" (lines 240–241), prefaced with an emphasised "**now**" to draw attention to it and an additional emphasis on six. This kind of presentation is typical of opening framings – it seeks to establish a starting point for subsequent discussion, in this case of a mathematical problem. K however, jumps in with 'I'm six!' (line 242), making relevant the fact that it is his birthday. The teacher acknowledges his contribution but shifts attention back to the mathematics problem she is still explaining. She repeats the information "six years old" and then adds new information that "**Ben/** is **half/** as old" (line 244). The emphases and pauses mark the shift from Charlie to Ben, as well as attending to the topically important information 'half'. There follows a variety of responses, both public and more private, with the teacher restating some of the information and managing the interaction in different ways.

Utterances that could be heard as mathematical solutions include seven, one, three, six and two. It is possible that some of these utterances are repeating information given by the teacher; for a student like K, however, what I want to highlight is the multiple responses in play, responses that he potentially needs to filter and evaluate. Furthermore, an exchange in the middle of the sequence illustrates another aspect of the demands related to multiple speakers: the neat adjacency pair structure, while still relevant, becomes somewhat problematic.

T Charlie's six &
K? I'm six!
S [I'm six
T & [and Ben is **half** his age/ you're on the right lines R/ how can you use your [fingers to help you
K [it's three
T he's **half** his age
K seven

While the teacher is, in effect, restating the problem, and appears to be addressing the student R, K is clearly responding to what she is saying. In particular, he says, apparently correctly, "it's three" (line 258), overlapping with the teacher. The teacher's next utterance is a repetition "he's **half** his age" (line 259), after which K says "seven". The adjacency pair principle means that, from K's perspective, the teachers repetition "he's **half** his age" can be heard as a response to his suggestion "it's three". Such a response, in classroom interaction, implies that the student's suggestion is incorrect. Alternatively, K might see that the teacher is directing "he's **half** his age" to someone else. Again, however, K might hear this as implying his own suggestion is incorrect. It may be, therefore, that K changes his answer, since the information he receives from the teacher, whether directed at him or not, seems to suggest his answer "it's three" is not correct. The point here is that the presence of multiple speakers makes it more difficult for K (or anyone else) to discern which utterances should be heard as relevant to their own contributions.

In the last part of the sequence shown above, K is nominated by the teacher and once more offers the response "three". The teacher accepts his response rather neutrally and initiates a question–answer adjacency pair:

T three/ how did you work it out?
K um/ [I just I just [I just thinked/ I just **thinked**

K's response to the teacher's question is 'troubled', meaning that it begins with a pause, and involves multiple repetitions. The nature of his response suggests that the question is in some (social, interactional) sense difficult to respond to. As with my earlier remark about the nature of 'I know', a statement like 'I thinked' can be seen as being more concerned with coming up with *some* kind of suitable account for where his answer came from, rather than being a specific description of a mental process. His struggle is compounded by several students' overlapping attempts to insert their own accounts in response to the teacher's question. While the teacher maintains her attention on K, eliciting the expanded account "in my head **and** in my hands" (line 276), the multiple speakers once again add to the discursive demands faced by K.

3.2 *Frequent Repair Sequences*

The phenomenon of repair is defined by ten Have (1999) as "organized ways of dealing with various kinds of trouble in the interaction's progress, such as problems of (mis-)hearing or understanding" (p. 116). He goes on to point out that repair is always initiated, for example, by responses like 'what did you say?' or 'I can't hear you' (see also Sacks, 1992, vol. 1, pp. 6–7). Repair sequences are likely to be common in classroom interaction. The following sequence arises after the teacher has asked the class how many wheels three cars would have. After various responses, one student, Rasool, makes an energetic contribution. Again, while reading the sequence, consider how it might seem from K's perspective:

Ras twelve twelve twelve! /[twelve/ twelve twelve/ twelve
T [you've got it on **two** cars
(*gasps*)/ how did you do that?
Ras ['cause/

S oh oh/ I counted
Ras I counted in my (…)
T um Hakim I think you need to listen to Rasool/['cause I &
S [it's twelve
T & didn't get it as quick as Hakim did
Ras counted on my fingers
T right stand up show us/ stand up/ right how did you count on your fingers to get to twelve
Ras because four add four makes t-t-twelve
T oh does it
S no eight
S eight
T four add four makes **eight**/ so how many cars would that be
S eight
K? eight/ nine/
T one car has four
K? twelve!
S four more!
T four more would be?
S eight
K eight
S twelve!
T how many cars?
S miss T
S because I
T not how **many** four cars
Ss three!
T no
Ss eight!/ twelve
T that's one car/
S two
T quickly Zia
S I'm thinking in my head
T someone's just said it/ Jane/
Jan eight
T no it wouldn't be eight cars
S four
T right we've got three cars here/ how many wheels have we got on there?
Ss four
T four
Ss four
T so how many wheels have we got altogether?
Ss [eight
Ss [four
T how many cars?
Ss [eight

Ss [two
T how many **cars**?
Ss two
T two cars/ eight wheels
N I'm thinking in my head
T well you're very clever/ sit down/ three cars/ how many wheels?
N? twelve
S I can do all of those
T (*gasps*)// very **very** clever

In essence, the majority of this sequence is concerned with repair of Rasool's statement that "four add four makes t-t-twelve" (line 334). The need for repair is triggered by the teacher's response "oh does it" (line 335). The repair sequence, however, which continues for some time (until line 381) includes several embedded repair sequences. Rasool's initial explanation is, it turns out, problematic in two different ways. First, 'twelve' is not a suitable result for 'four add four'; second, and consequently, Rasool's explanation is not a satisfactory response to the teacher's question. The first form of trouble is solved immediately, with two different students supplying the solution 'eight', confirmed by the teacher. What then follows is a jointly produced repair of the second form of trouble – how to explain why 12 is the correct answer to the problem.

The repair begins with a question from the teacher: "so how many cars would that be?" (line 338). The sequence unfolds with a series of prompts and sub-questions from the teacher and a variety of mostly numerical responses from the students. Shared understanding is only re-established when the teacher asks, "how many wheels have we got on there?" (line 363) and receives the response 'four' which she accepts. It is only at this point that a degree of trouble has been resolved. This resolution seems to arise from the establishment of a joint focus of attention on a single car. The teacher's subsequent question, "so how many wheels have we got altogether?", confirms her interpretation of the students' preceding responses ("four") as referring to a single car. Her next question shifts attention to the number of cars (line 371) and, receiving as she does at least two different responses, a further repair is necessary. She restates the question with emphasis on "cars" (line 374). From here, a suitable explanation is completed in the form of a question–answer pair (lines 378–379).

It is apparent, then, that this sequence involves a good deal of trouble and repair, mostly initiated by the teacher's non-acceptance of some of the responses she hears from the students. Furthermore, these repair sequences are often layered, with sub-sequences repairing local trouble as part of larger-scale trouble arising from the request for an explanation for why there are 12 wheels on 3 cars. The structure is clearly rather complex and accounts for the sense that the discussion is not easy to follow. For K, then, keeping track of what is being repaired, including the different levels of embeddedness, represents another form of discursive demand.

3.3 Raising the Stakes

The last form of discursive demand I will highlight arises directly from the adjacency pair structure of interaction between two people. Specifically, the use of repeated questions raises the stakes for K. In the following extract, T2 is working with K and Steven, reviewing K's written responses on part of a worksheet.

	T2	so you must write thirty two wheels/ and you too you've got to (…)// cross out your twelve/ how many does eight cars have/ how many wheels// thirty-two okay/
	K	I'm trying my second one//
680	Ste	now you can do your **own** one//
	T2	okay **now**/ four cars// d'you know what you've done look here// 'kay it's eight cars and it should be **double** eight and you've **halved** it/ you've made half of eight and it must be **double** eight/ what's double eight?
685	K	umm=
	T2	=eight plus eight
	K	two
	T2	eight and eight together
	K	seven!
690	T2	what's eight/ and another eight/
	Ste	I know
	T2	eight plus eight
	K	two!
	T2	[no
695	Ste	[sixteen
	T2	sixteen
	K	oh
	T2	so it should be sixteen cars/ /woah now you have to work out/ one and a six/

T2 indicates that K has mis-interpreted the question on the worksheet, saying that K has halved a number of cars, when the task is to double the quantity, thus triggering a repair sequence. She formulates this point twice, emphasising the words 'double' and 'halved'. She concludes with the question 'what's double eight?', which is contextualised by the preceding formulations. She has moved from interpreting the task to a direct question. By asking a question, the first part of an adjacency pair, she creates an opening for K to contribute, although the nature of the question also indicates the kind of responses that might be given: a number is expectable. K's response is 'umm', an utterance that allows him to take up his allotted turn, whilst buying some time. His turn is cut off, however, by T2, who reformulates 'double eight' as 'eight plus eight'. Such reformulations can be seen as guiding students, glossing previous utterances to provide a range of interpretations for the student to work with. They might also be seen as supporting the student in engaging with the language of the task, in this case by relating a mathematical term 'double' to an operation 'plus'. T2's glossing also serves to raise the stakes for K. Having been offered two formulations, 'double eight' and 'eight plus eight', there is a greater obligation on K to come up with a suitable response to complete the pair. This obligation, I should emphasise, comes from the interaction, rather than any intention on the part of the teacher.

It is a feature of talk that the more information that is provided with a question, the harder it is not to respond. K does provide a response: ‘two’. This response is generically suitable: it is a number. K has taken the turn for which T2 has nominated him, and rather than giving a non-committal ‘umm’, a response which was marked as unsuitable by the teacher’s swift intervention, K offers something generically appropriate which completes the pair. T2 again indicates this response is not suitable, however, by again reformulating, this time saying ‘eight and eight together’. The stakes continue to rise. K offers another generically appropriate but mathematically unsuitable response, this time as an exclamation, ‘seven!’ Again T2 indicates unsuitability by reformulating, “what’s eight/ and another eight” (line 690). This time Stephen takes the open slot, saying, “I know” (line 691). He indicates that the question is answerable and that, given the opportunity, he would be able to give a suitable response. The effect is to raise the stakes again. Not only is T2 reformulating the question, but Stephen claims to know the solution, implying K should too. T2 returns to an earlier reformulation ‘eight plus eight’ and K gives the same response he offered on the first occasion it was used: ‘two!’ Both T2 and Stephen break the pattern of the preceding turns. T2 now explicitly evaluates K’s latest (re-) offering, “no” (line 694). Stephen, overlapping, takes up the opportunity created by his previous turn, to give a response of his own, “sixteen” (line 695). This response is accepted by T2 through her repetition, “sixteen” (line 696). K accepts this closure, “oh”. Finally, the teacher recontextualises Stephen’s solution within the problem on the worksheet, by referring to ‘sixteen cars’.

Looking at the sequence as a whole, then, there are two features that place discursive demands on K. First, the interaction is structured by the question–answer format. Second, the sequence of reformulations, coupled with the adjacency pair structure, raises the stakes through the exchange. It is difficult for K not to respond, or to take too much time to respond, since the teacher’s questions expect answers. But the reformulations make it increasingly difficult for K to be wrong, hence raising the stakes.

4 Discursive Demands, Second Language Learning and Equity

I have described three forms of discursive demand that arise in the mathematical interactions in which K participates. The participation of multiple speakers in whole-class discussion is demanding, since it results in fast and furious exchanges in which several voices must be followed at once. It also results in ambiguity around the suitability or not of K’s own contributions. Is the teacher rejecting his comment or has she simply not heard it? Is her comment directed at him or at someone else? The frequent repair sequences, including embedded repairs, are demanding since, again, they must be tracked through sometimes lengthy exchanges. And these exchanges, of course, also feature multiple participants. Finally, in one-to-one interaction, extended question–answer sequences with reformulations of the questions can raise the stakes for K.

These *discursive* demands are different from *linguistic* demands as commonly understood. The linguistic demands of the lesson include the multiple formulations for 'double' and 'half', as well as the relating of these terms to various representations, including written symbols, cubes and cars. They also include the syntax of words like 'double' or 'half' – and note the contrast between 'double four' and 'half *of* eight'. The discursive demands I have discussed, however, arise from K's *participation* in mathematical discussion. While turn-taking, adjacency pairs and repair sequences are basic features of all spoken interaction, they are nevertheless relevant demands in K's participation in school mathematics. Any account of the potential challenges that K faces as he learns mathematics while also learning English cannot solely focus on the linguistic demands, important though they are.

How might the different forms of discursive demand described in this chapter interact with K's position as a learner of EAL? My first observation is that K is clearly able to participate in the question–answer pattern common throughout the lesson. He takes up turns when he is nominated, both in whole-class and one-to-one interaction. Indeed, the teacher's feeling that K is prone to 'guessing' can be seen as arising in response to this pattern. It may be less demanding to provide a 'guess' than to ask for more information or to find some other way out of the pattern, particularly when the teacher's reformulations raise the stakes or when other students are competing for the floor. Furthermore, K's responses are generically appropriate – they are numbers, for example – indicating more specific familiarity with the norms of mathematics classroom talk.

My second observation is that the range of formulations of 'double' and to some extent 'half', both in the whole-class discussion and in the one-to-one discussion, provide potentially valuable linguistic input, offering a range of ways of talking about this concept. In this particular sequence, K does not always appear to respond to these reformulations, but it may be that over time, he will become familiar with a number of ways of talking about 'double' and relate the concept to other arithmetic structures, including addition. It is noticeable, however, that throughout the lesson, K rarely uses the term 'double' himself. The occasions when he does so are in the form of repetitions. If meaningful production is an important part of the acquisition process (Swain 2000), however, whilst hearing various glosses for a term like 'double' is an important contribution to K's learning of the language of mathematics, supported opportunities to use such terms himself would also be beneficial.

At the start of this chapter, I argued that curriculum discourse concerning language and mathematics is based on an 'access' metaphor, which frames language as a portal through which students *get to* mathematics. From this perspective, K's task is fairly straightforward. To be able to learn mathematics, he needs to learn English in general and mathematical English in particular. He needs to learn words like 'double', 'half' and 'add' so that he can get to the underlying concepts.

The idea of discursive demands does not fit well with this model. Many of the demands faced by K will not be alleviated by somehow learning the word 'double'. It is not clear to me that he *could* learn what 'double' means *without* participating in the kind of complex, often challenging, interactions described in this chapter. These discursive demands are, in some respects, *prior* to the requirements to learn to use specific words like ‘double’.

K’s guessing, for example, can be seen as arising from the interactional patterns found in the mathematics classroom as much as from his arithmetic proficiency. The question–answer structure in the last extract in particular constructs K as guessing rather than as thinking or working out a solution. In the first sequence, K constructs himself as thinking ‘in his head and in his hands’, but the challenge of accounting for that thinking means that his thinking is not expanded into an acceptable explanation. In this sense, both exchanges may be seen as discursively demanding, despite being, in Cummins’ terms, fairly context embedded. Furthermore, the use of reformulations, cubes, cars, and so on ostensibly serve to reduce the level of cognitive demand – although multiple glosses of ‘double’ might have the opposite effect. My point, however, is that while at the level of formal mathematical language K’s task is to work out what doubling is and to do some himself, discursively there are other significant demands that arise from the structure of talk. If students like K are to be offered effective support in their learning of mathematics, this point should not be overlooked.

Note

1. Transcript conventions: Bold indicates emphasis. / is a pause <2 secs. // is a pause >2 secs. (…) indicates untranscribable. ? is for question intonation. ( ) for where transcription is uncertain. [for concurrent speech. ^ ^ encloses whispered or very quiet speech. = for latching (no gap between words). Italic capital letters indicate letter sounds: & indicates where turns continue on another line.