

## **“GIVE ME A NUMBER THAT IS LESS THAN 9”: MAKING SENSE OF MATHEMATICS IN AN ADDITIONAL LANGUAGE**

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*There seems to have been little work aimed at understanding the process of learning mathematics when the predominant classroom language is not the learner's first language. This paper reports an exploratory study using the concepts of paradigmatic and syntagmatic axes of language to analyse interaction recorded while two English Additional Language learners sorted mathematical words. There is evidence that these learners may learn mathematical language in syntagms.*

### **Introduction.**

An investigation of the process of English Additional Language (EAL) [1] students learning mathematics involves several dimensions of complexity, including the learner's level of intellectual and linguistic development as well as cultural-linguistic differences which may affect students' ways of knowing (e.g. Lakoff and Johnson, 1980). In particular, EAL students' interpretations of mathematical language encountered in school are likely to be affected by previous experiences of mathematical ideas in considerably different linguistic, social and cultural environments.

The work of Vygotsky (1962) offers a framework within which at least some of these factors are addressed, in particular because it is explicitly based on word meaning. Vygotsky saw word meanings as the link between thinking and speech: they are “a phenomenon of verbal thought, or meaningful speech - a union of word and thought” (p120) and derive from “the transition from thought to word” (p150). By studying the meanings attached to words in communicative interaction, therefore, it is possible to gain insights into thinking and intellectual development. Thus although “direct communication between minds is impossible” (p150), studying the learning process can be attempted. Work in mathematics education based on the Vygotskian perspective has widened Vygotsky's focus by acknowledging the importance of social and cultural context, including the discourse of school mathematics (e.g. Ernest, 1994: 310). This is compatible with the notion that mathematical meaning is constructed through social interaction, particularly negotiation (Voigt, 1998), including the negotiation of word meanings.

### **An earlier study.**

Taking this theoretical position as a starting point implied that an examination of interaction involving EAL learners in school mathematics would shed some light on the process of learning and understanding mathematics through an additional language. As an initial exploratory study, therefore, 3 EAL/non-EAL pairs of students were recorded while they worked on an addition task together (described in Barwell, 1999). Analysis of the students' interaction during this activity revealed that one of the EAL

students, called L, strongly preferred the word 'plus' in contrast to his non-EAL partner who used 'plus', 'and' and 'add'. This paper will focus on the following question raised by this finding and its implications:

- How might EAL students interpret mathematical words in the classroom? What contexts or previous experiences might they associate with particular words in making sense of classroom language?

The preliminary study also revealed limitations in the Vygotskian perspective. In particular, although word-meaning is used as the unit of analysis, there is no framework with which to analyse the word meanings used by students in their interaction. In this paper, this is addressed by using Saussure's (1974) concepts of paradigmatic and syntagmatic axes of language, as developed by Luria (1981).

### **Saussure.**

Saussure appears to have had a broadly similar view of the relationship between thinking and speech to Vygotsky. Vygotsky (1962) saw word meanings as "a union of word and thought" (p120) while for Saussure (1974): "Linguistics...works in the borderland where the elements of sound and thought combine" (p113).

An important aspect of Saussure's (1974) development of linguistic theory was the idea that the elements of language operate through their contrastive or oppositional relationship with other elements: "in language there are only differences" (p120). Thus the important aspect of the sounds of the phonemes of language is that they are distinguishable from other phonemes. For example, in the word 'perfect', an important quality of /p/, is that it does not, to speakers of English, sound like /f/. There are languages in which these two sounds are not distinguishable and so they carry the same phonetic value.

The nature of these linguistic relations can be seen to take two forms. To avoid confusion, I will refer to them as *syntagmatic* and *paradigmatic* in line with Luria's (1981) terminology. Saussure (1974) described these forms as follows:

*Syntagms:* In discourse...words acquire relations based in the linear nature of language because they are chained together. This rules out the possibility of pronouncing two elements simultaneously...In the syntagm a term acquires its value only because it stands in opposition to everything that precedes or follows it, or to both (Saussure, 1974: 123).

*Paradigms:* Outside discourse, words acquire relations of a different kind. Those that have something in common are associated in the memory, resulting in groups marked by diverse relations (Saussure, 1974: 123).

Linguistic elements do not fall exclusively into one category or the other, but have both forms of relation simultaneously. This can be shown by adapting an example of de Saussure's (p133): the lexical value of *twenty-three* derives both from a paradigmatic opposition with *twenty-four*, *twenty-two* and other number words, as well as from the

syntagmatic relationship between its lexical components, *twenty* and *three*. These concepts can also be applied to word meanings.

### **Luria.**

This framework was further developed by Luria (1981) who was strongly influenced by Vygotsky (Wertsch, 1981). For Luria the paradigmatic oppositions of word meanings derive from the hierarchical relationship between concepts:

The word “dog”...is part of a hierarchically organised system of meanings. Together with “cat”, it is related to domestic animals which are contrasted with wild animals. Together with wild animals, domestic animals enter the hierarchy of animals in general, as opposed to plants, etc (Luria, 1981: 226-7).

At this point the influence of Vygotsky is clear. Luria has developed a connection between the paradigmatic structure of language and Vygotsky’s (1962) description of the psychological structure of ‘scientific concepts’. Indeed for Vygotsky, the function of education is to encourage the construction of a hierarchy of such concepts, in which lower levels of the hierarchy are subsumed into higher levels (p115).

### **A card-sort activity.**

In order to investigate the questions raised by the preliminary study, a further study was conducted in the form of a card-sorting activity, inspired by Berenson and Vidakovic (1996). Two Year 7 EAL students, L and G, were chosen from the three who took part in the initial study. Both students were identified by their mathematics teachers as being ‘held back’ by their EAL status. L had recently arrived in the school from Nigeria. G arrived in the UK from Somalia during upper primary school. Both students attend a small weekly mathematics ‘extraction’ class which aims to support the lowest attaining students in Year 7.

In the activity, the two students were presented with a set of cards on which were printed words relating to addition and asked to sort them into groups of words which ‘go together’. They were video-recorded as they did this. The words were obtained from the recordings of the pyramids activity, observation of lessons and language support resources, such as posters, used in the class (see note [2] for a list of the words). It was hoped that the students would jointly construct groups of words, through a process of negotiation which would require at least implicit discussion of word meanings. Unfortunately a number of factors meant that the activity did not run as intended. For example, the students were not used to working together and they were put off by the camera. As a result, they tended to respond individually, rather than discussing together, and needed more prompting through questioning than was intended. Nevertheless, during the 15 minutes recorded, some interesting exchanges took place. A number of these are discussed below, with one possible interpretation presented. At this stage, such a discussion aims to bring out issues for further investigation.

### Words which go together.

The following exchange took place 12 minutes into the activity, when I asked about the card LESS THAN (upper case denotes words appearing on one of the cards), which had not been explicitly considered until that point (see note [3] for transcription conventions):

- 133 RB: G/ you were looking at LESS THAN  
(*omission*)
- 134 G: give me a number that is LESS THAN  
135 hundred
- 136 RB: so is there anything like LESS THAN here?  
...
- 141 G: yeah here it is MORE THAN
- 142 RB: are you going to put them together?
- 143 L: [no
- 144 G: [yes/ cos like the opposite/ MORE THAN  
LESS THAN// so like MORE THAN means  
give me a number that is MORE THAN/  
nine/ and LESS THAN means/ give me a  
number that is LESS THAN nine

G's explanation (line 144) could be a textbook example of paradigmatic opposition, in which LESS THAN and MORE THAN derive meaning through being opposites, as G is well aware. It is interesting, however, that G makes sense of both expressions as syntagmas: he does not separate the components 'less' and 'more' from 'than'. Furthermore, he also makes sense of the expressions themselves in syntagmatic terms, as part of the phrase 'give me a number that is ... nine', a structure that also occurs in line 134. This form of words is surely an example of 'teacher-talk', an expression which seems to come from the discourse of classroom mathematics. This suggests that for G, the mathematical connotations of MORE THAN and LESS THAN only have meaning in terms of the discourse of the mathematics lessons in which they are used. The card sort activity is arguably also located within this discourse, (which I will call school-mathematical discourse), so G's form of words does not necessarily show other possible interpretations or uses of MORE THAN or LESS THAN as they are used in other discourses, such as, for example, shopping, money or the playground.

L also uses syntagmatic association to make sense of words within school-mathematical discourse. Twice he asks me for the meaning of COMBINE (which I do not give) before suddenly and energetically associating it with ALTOGETHER:

- 115 L: yeah yeah I know/ I know/ COMBINE  
116 something together.

He did not appear to search the cards before making this connection, suggesting that for L, COMBINE eventually brought to mind the syntagm 'combine together'. He then looks for the card ALTOGETHER which for L is perhaps synonymous with 'together'.

Certainly he uses ALTOGETHER in the same way on another occasion, this time syntagmatically associating it as ‘together’ with ADD:

91	L:	...ADD together	<i>looking at ALTOGETHER</i>
92		that goes here	<i>placing ADD with ALTOGETHER</i>
93		it’s <b>ADD</b> together	<i>pushes them together to emphasise ‘together’.</i>

Such association is not necessarily an aid to making sense of mathematical language, however. L makes another syntagmatic association in considering the word INCREASE:

101	RB:	what about// INCREASE?/ you didn’t decide	
102		where to put INCREASE.	
103	L:	there	<i>points at G’s group.</i>
104	RB:	ok/ is there a reason?	
105	L:	coz like/ if you have a radio// you can	
106		increase the volume (...)	

In this case L has associated INCREASE in a syntagm from outside school-mathematical discourse, “increase the volume”. There could be a number of reasons for this. Perhaps L does not recognise INCREASE as a school-mathematical word, in which case he is unlikely to make associations within that discourse. This raises an interesting question about what it is that cues interpretations to be made within a particular discourse. Perhaps, for example, L might have made a more school-mathematical interpretation of INCREASE if it had been part of a syntagm like ‘increase by’ (in a following interview G refers to “times and divide by”) or if a paradigmatically related word such as ‘decrease’ had also been included.

### Summary and further questions.

The evidence provided by the extremely small-scale study described here is clearly limited. Nevertheless, some tentative conclusions can be drawn although they only apply to the students’ participation in the card sort activity. It is not possible to ascertain to what extent such conclusions are specific to EAL learners, rather than being more general language issues which might apply equally to many monolingual learners of mathematics. Within these limits, some progress has been made in exploring the questions addressed. There do seem to be indications of how L and G interpret words in terms of their previous experience of school mathematics or their experiences outside of school. Mathematical words frequently seem to be understood in syntagmas, or expressions of several words, rather than in isolation. This observation raises questions about the fondness for formal definitions in school mathematics. The extraction class teacher, for example, said in an ensuing interview that she often included questions about word meanings in the oral section which formed the first 20 minutes of her lessons.

Finally, a number of hypotheses and further questions have emerged from this analysis, suggesting foci for further investigation. 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? During the discussion following presentation of this work at Warwick, it was suggested that EAL learners might find it easier to understand formal mathematical vocabulary, since they might be less distracted by meanings derived from common usage. Like all learners, however, EAL learners may still acquire non-mathematical connotations of mathematical vocabulary, as G's use of INCREASE suggests. Monolingual learners have a lifetime to become sensitive to the subtleties of meaning, connotation and the different discourses in which they occur. EAL learners, particularly those who arrive after the start of schooling, must take time to develop this sensitivity, yet they do learn.

### Notes.

1. English additional language or EAL refers to any learner in an English medium learning environment for whom English is not the first language and for whom English is not developed to the level of a native speaker. Since this study is set in an English secondary school, native English speakers will be described simply as monolingual.
2. The cards were: ADDITION, ALTOGETHER, AND, EQUALS, LESS THAN, MORE THAN, TOTAL, ANSWER, COMBINE, ADD, ONTO, MAKE, SIGN, +, SUM, PLUS.
3. Transcription conventions: bold indicates emphasis, / is a pause < 2 secs, // is a pause > 2 secs, (...) indicates indecipherable speech, ? is for questions, ( ) for where transcription is uncertain. [ for overlapping speech, italics for commentary. RB is Richard Barwell.

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