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PLUS, AND AND ADD: ADDITION AND ENGLISH ADDITIONAL LANGUAGE LEARNERS OF MATHEMATICS

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The learning of mathematics by additional language learners is an under-researched area within mathematics education. In this paper, an initial exploratory study of an additional language learner in the UK is described. Consideration of the learner's vocabulary of addition shows that during the study, he relies almost exclusively on the word "plus". This raises important questions regarding the learning of mathematics by such students.

Introduction.

Many of the world's children learn mathematics through the medium of an additional language. There has, however, been little research investigating English Additional Language (EAL) [1] learners of mathematics. Where such research has been conducted, it has generally focused on the relationship between language and attainment (see, for example, Clarkson 1992). There seems to have been little work aimed at understanding the *process* of learning and understanding mathematics when the predominant classroom language is not the learner's first language. This paper describes a preliminary study in this field which has the aim of developing the research methods and focus for further research.

Theoretical perspective.

In his work on the relation between thinking and speech, Vygotsky (1962) rejected the idea that "thought and word were isolated, independent elements" (p120), focusing instead on word meaning which he described as "a phenomenon of verbal thought, or meaningful speech - a union of word and thought" (p120). He observed that word meanings change as the child develops as well as with different functions of thought (p124) and that this change reflects a change in the relation of thought to word (p124). Later he addresses the role of language in communication and its relationship to thought:

> ...because thought does not have its automatic counterpart in words, the transition from thought to word leads to meaning. Direct communication between minds is impossible...Communication can be achieved only in a roundabout way. Thought must pass first through meanings and then through words (Vygotsky, 1962: 150).

Thus, an analysis of words and the meanings attached to them in communicative interaction can offer insights into thinking and intellectual development, and so to the learning process.

Developing this line of thinking, Vygotskian social constructivists have stressed "the import of the overall social context of the mathematics classroom as a complex, organised form of life including [amongst several points]...the discourse of school mathematics, both content and modes of communication" (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.

This theoretical position implies that an examination of classroom interaction involving EAL learners will shed some light on the process of learning and understanding mathematics through an additional language. The issues surrounding this area of investigation are complex, not least because an investigation of EAL school learners involves subjects who are at different levels of both intellectual and linguistic development.

Research strategy.

I planned to use Neil Mercer's (e.g. 1991; Edwards and Mercer, 1987) approach to discourse analysis, in order to identify communicative strategies used by a group of EAL learners in the negotiation and construction of mathematical meaning in the classroom. Much of the work on classroom discourse tends to focus on the teacher-pupil dyad or other forms of teacher controlled interaction (Edwards and Westgate, 1987: 41). At this stage I am more interested in student-student rather than student-teacher interaction, since the former, being less heavily cued, will better reflect students' understanding, at least of the language, if not of the mathematics.

The analytical approach that will be adopted is described by Edwards and Westgate (1987): "[the researcher] listens and re-listens to these recordings, and studies their transcripts, until some 'patterning' is discerned which can be checked by further scrutiny of the data (p105)". This paper reports a preliminary stage in this process.

The study.

During the spring of 1998 I visited the lessons of a small mathematics 'extraction' class in a Bristol (UK) secondary school. The class aims to support the lowest attaining students in Year 7. Recently, classwork has focused on basic arithmetic. Several of the students, though not all, use English as an additional language.

The weekly class follows a pattern favoured by the class teacher. The 1 hour lesson begins with 20 - 25 minutes of oral work. For the rest of the lesson, the teacher provides a worksheet for the students to work on. Students tend to sit separately and work alone. Mathematical interaction between students occurs infrequently. Exchanges are usually social or organisational in nature - asking what to do, or for a pencil, for example.

As I am interested in student-student interaction, the preliminary study did not involve recording students during their usual classroom activity. Instead, pairs of students were withdrawn and recorded as they worked together on a task for approximately 10 minutes. On the day of the recording, six students were in attendance and so three pairs were recorded, three EAL and three monolingual students. The tasks, which were related to students' recent work on arithmetic, were selected and prepared with the aim of being achievable, of a format new to the students (to avoid routinised discussion), and capable of promoting mathematical discussion. The task design also has the merit that it contains no explicit linguistic cues. Each task item was in the form of a 6 block 'pyramid' (figure 1a), in which the numbers in two lower level blocks are added to give the number in the block above. Figure 1b shows a completed pyramid, and figure 1c a more complex item.

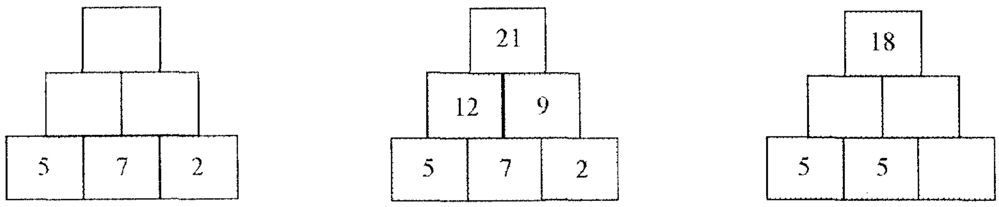

Figure 1a **Figure 1b** **Figure 1c**

Figure 1: Examples of addition pyramids (MA, 1994: 12-13)

Before beginning the task, the pyramids were explained to the students using two example pyramids. They were then presented with the task sheet and left to complete the sheet unsupported in order to maximise interaction and to allow them to work unguided by the presence of an adult. I, as researcher, was present in the room, seated out of the line of sight of the participants so as not to act as an unwitting audience, though still available to be consulted if necessary. The students were tape-recorded working in pairs which were selected by the teacher in consultation with the class. Transcripts were produced from the tape recordings.

In this paper, I shall focus on one pair of students, who shall be known as L and V. Both students are at the end of Year 7 (12 years old). V has grown up in the UK and is seen as low achieving by his usual class teacher who has nominated him to take part in the extraction class. The teacher of the extraction class feels that he is achieving more highly within the group than the other participants. L arrived in the UK from Nigeria, approximately 6 months before this study. In Nigeria, English is officially used only from the later stages of primary school. Pidgin serves as a means of day-to-day communication in a linguistically diverse nation. Thus although L is familiar with English his proficiency is still developing. The day of the pyramids task was only the second time he had attended the extraction class, having been only recently nominated by his mathematics teacher.

Looking at the interaction.

During my explanation of the pyramids using the practice examples (unfortunately this was not tape-recorded) L did not seem very clear about the activity. When replicating the task for himself, he said 'times' and was clearly multiplying. I explained again and made explicit that he had to add - I used the words 'add' and

'and'. At one point he used the word 'plus' which I then picked up on, as he obviously understood this to mean *addition* rather than the words I had been using. There is evidence in the transcript, as well as on subsequent recordings, that L mixes up the words 'times' and 'plus'.

The following section of dialogue [2] between L and V took place at the start of the recording, while they were working on the pyramid shown in Figures 1a and 1b.

1	V:	...five six seven/ eight nine//
2	L:	**V**/ tha's/ once seven times five/ seven
3		[plus five (&)
4	V:	[no
5	L:	(&) **add**/ yeah/ seven plus five
6	V:	right seven/ eight nine ten eleven **twelve**/ tw-
7		twelve there/ seven [eight nine
8	L:	[seven times seven plus
9		two
10	V:	's nine/ twelve plus [nine/
11	L:	[nine/
12	V:	twelve plus nine/ **twelve**/ thirteen fourteen
13		fifteen sixteen seventeen (*whispers*)
14	L:	elev-/ twenty **one**
15	V:	twenty one
16	L:	's right

At the beginning of the extract (lines 2-3) L first says "times" before correcting himself to say "plus". He seems to be in the process of establishing the word which corresponds to the idea of *addition*. He emphasises his correction in line 5, using and stressing the alternative word "add", perhaps in response to V's expression of disagreement (line 4), before once again using "plus". V shows that L's intention has been understood by carrying out the addition by counting on from 7. Later (line 8), L again says "times" before correcting to "plus", while V is simultaneously completing the addition. For the final addition in the pyramid, V begins to articulate the required calculation (line 10) and L joins in after the operation ("plus") has been stated by V.

While L's use of vocabulary seems to be unstable, he appears to be comfortable with the idea of *addition*, apparently carrying out the calculation $12 + 9$ by efficiently using $2 + 9$ as a stepping stone (line 16), while V uses the more laborious method of counting on from 12 (line 14-15).

In fact L's vocabulary of addition, seems to rely on the word 'plus', at least on this occasion. This is revealed by a simple count of the words used during the task by the two participants to refer to addition, as shown in the table below.

Word used	L	V
plus	9	5
add	1	7
and	0	4
times	3	0
Total	**13**	**16**

L uses 'plus' almost exclusively, using 'add' only in the excerpt shown above, to emphasise what he meant. Perhaps his vocabulary is forced to extend only when communicative imperative demands. V, by contrast, uses three alternative words interchangeably.

Discussion.

This is an interesting finding which raises a number of questions. Why are there at least three ways of referring to addition in English? Are there any differences between them? L is using just one word to talk about addition, which he sometimes confuses with 'times'. Does this restriction of his vocabulary affect his ability to communicate effectively in the mathematics classroom? The confusion of 'times' and 'plus' do not seem to reflect a deeper confusion of the concepts involved and so could reflect a stage of his linguistic development in mathematics.

Why does L use 'plus' as his word for *addition* rather than one of the available alternatives? An examination of transcripts of the two other pairs who completed the pyramid activity shows a general preference for 'add'. Three out of the six students involved used it exclusively and two others generally preferred it to 'plus', 'and' or 'onto'. In fact, the only student other than L to use 'plus' was V, perhaps prompted by hearing L use it. This could imply that in the culture of the class, or possibly of the school, the preferred word for *addition* is 'add'. Perhaps L, who is new to the class and a recent arrival in the UK and in the school, has carried the word with him from elsewhere. If this were the case, how would it affect L's mathematical learning?

One word for *addition* would appear to be entirely sufficient for L to communicate the idea when necessary. Communication, however, also involves interpreting others' contributions, and a question therefore arises about the effect of L's vocabulary on his understanding of 'incoming' language. Certainly, during my initial explanation of the pyramids, he did not appear to respond to my use of 'and' or 'add', although once he had understood the requirements of the task, he responded appropriately to these words when they were used by his partner. This seems to be an example of context providing meaning and so assisting linguistic understanding.

Where to now?

The above analysis suggests that there may be differences in the vocabulary of EAL and monolingual learners of mathematics. This could be explored in more depth by firstly collecting more data on EAL learners' vocabularies in unprompted use as well as on the vocabulary used by teachers and students in this and other mathematics classes. Secondly, it could be profitable to examine EAL learners' understanding of different lexical items in a more directed way, through structured interviews, for example. Collecting information from both 'natural' classroom settings and more controlled situations would initiate a useful dialogue between the two sets of resulting data, which should lead to a deeper understanding of this complex area.

Most usefully, however, this study reveals limitations in the theoretical perspective. In particular, although Vygotsky's position focuses on word meaning and its role in communication, it does not address the way in which meaning is constituted by language in communicative interaction. In developing the framework, therefore, this is an area which must be explored.

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. 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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