Language Difficulties in Mathematics

DEFINITION

The particular language difficulties inherent in mathematics that are discussed in this entry relate to vocabulary, syntax, abstract and natural language, miscues in word problems, and the predominance of structure over content.

EXPLANATION AND DISCUSSION

The importance of language in learning mathematics cannot be overstated. We understand mathematical ideas by making connections between language, symbols, pictures and real-life situations (Haylock and Cockburn, 2003: 1–19). Mathematical concepts to be understood and used have to be associated with a word or a phrase. In a summary of research into the development of mathematical ideas in young children, Perry and Dockett (2002: 101) conclude that 'without sufficient language to communicate the ideas being developed, children will be at a loss to interact with their peers and their teachers and therefore will have their mathematical development seriously curtailed'. Because of the significance of language in learning mathematics, it is important that teachers are aware of the particular difficulties and complexities of the way language is used in this subject. Five categories of these are discussed below.

Vocabulary

The difficulties associated with the technical vocabulary of mathematics include the following.

1. Mathematics uses a number of technical words that are not usually met or used by primary school pupils outside mathematics lessons. Examples might include 'parallelogram' and 'multiplication'. Such words are not being reinforced in everyday usage and are therefore

not being given greater meaning through employment in a range of contexts. The existence of a discrete set of mathematical terminology also encourages pupils to perceive mathematics as being something that happens in school that is unrelated to their everyday lives outside school.

2. There are words that are used in everyday English, which have different or much more specific meanings in mathematics. For example, in relation to subtraction the 'difference between 8 and 13' is not that one has one digit and the other has two digits. Other familiar examples would include: 'volume' (in everyday English used mainly for levels of sound); and 'right' as used in 'right angle' (not the opposite of a left angle!). Mathematics uses 'odd' to refer to every other counting number, which is hardly consistent with the everyday use of the word (see Pimm, 1987: 89). Clearly, primary school teachers have to anticipate possible confusions when using such words as these.
3. Words in mathematics are characteristically used with precise meanings. But in ordinary everyday English, many mathematical words are misused or used with a degree of sloppiness, which can be a barrier to pupils' understanding of mathematical concepts. 'Sugar cubes' are usually cuboids, but not all of them are actually cubes. Adults do not mean a time interval of one second when they say, 'Just a second!' The phrase 'a fraction of the cost' uses the word 'fraction' imprecisely to mean 'a small part of'. And the word 'half' is often used to mean one of two parts not necessarily equal. Moreover, many teachers themselves use mathematical language carelessly, such as confusing 'amount' with 'number', or using 'sum' to refer to a calculation other than an addition.

Syntax

We provide here two examples of the difficulties of syntax that occur frequently for pupils trying to make sense of mathematical statements.

1. The first difficulty relates to the subtle uses of prepositions in a number of the basic statements we make in mathematics. Consider, for example, the differences in meaning between: (a) 'divide 25 by 10' and 'divide 25 into 10'; (b) 'reduce this price by £20' and 'reduce this price to £20'; (c) 'share twelve between three' and 'share twelve with three'. Teachers also need to be aware of ambiguities associated with

prepositions in some mathematical statements, such as: 'what is 10 divided into 5?' (2 or 0.5?); and 'how much is 5 more than 3?' (2 or 8?).

2. Teachers should also recognize the syntactical complexity of many of the statements they make and the questions they pose in mathematics. Consider, for example, this question: 'Which number between 25 and 30 cannot be divided equally by either 2 or 3?' To grasp this, the pupil not only has to hold in their mind a number of pieces of detailed information, but also has to relate these together in the precise way implied by the complex syntax of the sentence. It is a hugely demanding task, but not untypical of what is demanded of primary school pupils doing mathematics.

ABSTRACT AND NATURAL LANGUAGE

Pupils need to learn correct, formal mathematical language. So, for example, the collection of symbols '37 – 14 = 23' is read formally as 'thirty-seven subtract fourteen equals twenty-three'. This is a purely abstract statement, dealing with concepts expressed in abstract language. However, if these symbols were a model of some real-life situation there would also be the natural language that describes the situation, such as: 'If I have 37p and I spend 14p, then I have 23p left.' Giving time to establishing the connections between the formal abstract language that goes with the symbols and the natural language that describes the concrete situations modelled by the symbols is a major part of the agenda for primary teachers of mathematics. Boero et al. (2002: 243), in a review of research in this area, stress the importance of natural language as 'a mediator between mental processes, specific symbolic expressions, and logical organizations in mathematical activities'. However, a major difficulty is that pupils have to learn to connect the same formal, abstract language and the associated symbols with the natural language associated with a range of very different real-life situations. So, the same symbols used above could be associated with the language of taking away, or making comparisons, or finding how much more is needed, and so on, in a range of contexts, such as sets of objects, money, length, time, mass and capacity (Haylock and Cockburn, 2003: 46–58).

Miscues in word problems

One of the major language difficulties in mathematics is the way in which pupils will sometimes respond incorrectly to verbal cues in word problems. For example, in a word problem that requires a subtraction but which contains the word 'more', the word 'more', because it is naturally associated with addition, will act as a miscue and prompt pupils to add the numbers in the problem. For example, 25 would be a common answer given by 8-year-olds to this question: 'John has now collected 18 tokens. That's 7 more than he had last week. How many tokens did he have last week?'

The predominance of structure over content

'Meg has saved up £18.80 towards buying the complete *The Lord of the Rings* DVD set, which costs £26.50. How much more does she need?' To some primary school pupils, the most intriguing aspects of this question are likely to be in the narrative content (Pimm, 1987: 12–14), promoting responses such as, 'She could get them cheaper in .... '. But in a mathematics context, the content has to be disregarded in favour of the underlying structure, from which must emerge the subtraction calculation, 26.50 – 18.80. The structure of the sentence has to be predominant over the narrative content. This rather artificial way of responding to language is a distinctive requirement in dealing with word problems in mathematics. But then, when it comes to interpreting the result of the calculation (such as the 7.7 obtained when 26.50 – 18.80 is entered on a calculator) recognition of the original narrative content of the problem becomes essential again.

PRACTICAL EXAMPLES

Two practical suggestions for focusing on mathematical language are given below.

Stories for calculations

One of the best ways of gaining insights into children's understanding of mathematical ideas is to analyse their use of natural language to write stories for calculations written in symbols. For example, given the division 12 ÷ 3, one pupil wrote: 'Tim had 12 cakes he shared them out with 3 of his friends' (Haylock and Cockburn, 2003: 79). The use of the preposition 'with' here reveals a misunderstanding of the notion of sharing in the context of division. Another pupil wrote this story for the subtraction, 12 – 3: 'There were 12 soldiers, 3 were ill, how many were not ill?' (Haylock and Cockburn, 2003: 48). This use of the word 'not' reveals a good understanding of the connection between subtraction and the complement of a set.

Language patterns

Because of the syntactical complexity of many mathematical statements primary school teachers should spend time helping pupils to master significant language patterns, particularly those involving subtle uses of prepositions. For example, a key language pattern associated with division is used here: '24 shared equally between six is four each.' Special emphasis should be placed on the patterns of statements using the language of comparison (Haylock and Cockburn, 2003: 50–2), which are particularly complex for many pupils. For example, the structure of the statement '12 is 3 more than 9' would be encountered in a number of contexts such as:

- the £12 CD costs £3 more than the £9 CD;
- the 12 kg box is 3 kg heavier than the 9 kg box;
- the 12 cm strip is 3 cm longer than the 9 cm strip.

These statements should always be accompanied by the equivalent language patterns using the lesser quantity as the subject:

- the £9 CD costs £3 less than the £12 CD;
- the 9 kg box is 3 kg lighter than the 12 kg box;
- the 9 cm strip is 3 cm shorter than the 12 cm strip.

FURTHER READING

Wigley's chapter, 'Approaching number through language' (in Thompson, 1997), deals with some of the language aspects of young children learning to count. A key text on language in mathematics is Pimm (1987). Verschaffel and De Corte provide a comprehensive review and discussion of children's responses to arithmetic word problems (chapter 4, in Nunes and Bryant, 1997). Those interested in how to help pupils whose poor language skills impinge on their learning of mathematics should refer to Grauberg (1998).