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SOME THOUGHTS ON CHILDREN'S USE OF LANGUAGE IN MATHEMATICS

The language which children hear from their teachers in mathematics lessons is laden with special mathematical vocabulary, and with words and phrases particularly characteristic of mathematics lessons - words like 'assume', 'multiple', and 'represent'. These words and phrases, together with the special meanings assigned to them in Mathematics, are referred to as 'the speech register of school mathematics'. Mathematical language is said to be in the 'transactional' style, since it is geared to conveying information as concisely and unambiguously as possible. To what extent do children use the transactional style, and the speech register of mathematics when they really want to communicate mathematical ideas? (This is different from trying to say what one thinks the teacher wants one to say...) And how does their use of this language, or their failure to use it, as the case may be, affect their mathematical thinking?

To explore these questions I devised a game which involved children in justifying their mathematical conclusions to their peers. Most of the language which I quote in what follows comes from recordings of groups of twelve-year-olds

playing this game. The game was based on a board as illustrated in Fig 1. This board was the 'whole' for the purpose of the game. The children's task was to choose from pieces of cardboard such as illustrated in Fig 2 that piece which corresponded to a specified fraction of the whole, and to justify their choice.

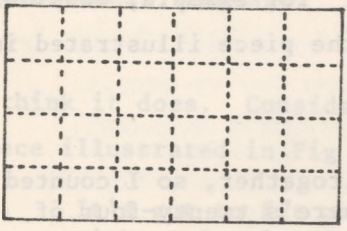


FIG.1 : THE 'WHOLE'

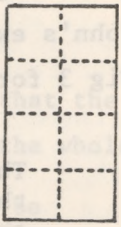


FIG.2 : ONE OF THE GAME PIECES ($\frac{8}{24}$ of the whole)

The most striking feature of the recordings is that these children, in their first year of secondary school, virtually never used the transactional style of mathematics. Rather their language was in the 'heuristic style', ie groping towards expression, with language characterised by hesitations, pauses, repetitions and false starts; for example, consider Amanda's explanation for why she chose the piece illustrated in Fig 3 for $\frac{3}{12}$ of the whole.

> Three twelfths is two...well one twelfth is two squares, right...and three twelfths...if you multiply, well if you get...two twelfths is two squares, so that's one twelfth, and that's two twelfths and that's three twelfths.

This extract also exemplifies the way children tended to resort to haptic language, ie simply saying what they were doing, rather than communicating the mathematical reasoning underlying the problem; for example, consider John's explanation for choosing the piece illustrated in Fig 3 for $\frac{6}{24}$ of the whole:

> That's one, six of them altogether, so I counted those squares there, so there's twenty-four of them so that's six twenty-fourths.

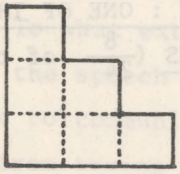


FIG.3

The only technical terms of mathematics used with any frequency by the children were 'square', 'divide', and 'multiply'. I made a fairly close comparison between the language I used when talking to the children about

the situation in the game, to that which they used. Whereas I tended to use conventional expressions such as 'We must think of cutting the whole into twelve like pieces' or 'Twelve pieces would fit in', the children used predominantly 'neutral' terms, such as 'There are twelve pieces'. (There weren't twelve pieces...) Well does it make any difference if the children don't use the conventional language?

I think it does. Consider Keith trying to argue that the piece illustrated in Fig 2 is not two eighths of the whole:

> It's got to fit on two times. It's got to be eight thingy's hasn't it. So it would be...

He never finds his way through this one. I suggest that his inability to crystallise the two stages of reasoning involved is in part due to the fact that he cannot find appropriate language to distinguish between the two ideas.

The language which teachers use in mathematics lessons had some effect on what the children said and thought. I did not once use the phrase 'goes in twelve times' when discussing finding a fraction of the whole in the game. The children used this expression in 21% of such statements. This expression has echoes of the language of number. I wonder if pressure from teachers on children to use the language of mathematics causes them to regurgitate the language of mathematics which they have

heard most often - namely the language of number? There are incidents where the use of such language clearly prevents the child from coming to grips with the situation. Consider Alan trying to find one twelfth of the whole:

> Twelfth you get one half...would be one half 'cause twelve goes into twenty-four two..there's none of them pieces is half of that.

I suggest that he would have got further if he'd thought about concretely sharing the whole among twelve people. On a similar theme, how's this for persuasive argument: Nichola is justifying her choice of the piece illustrated in Fig 4 for three-eighteenths of the oblong:

> Yeah I know it's only eighteen pieces, and if it's only eighteen pieces, six will go into eighteen three times, won't it?

The other children found this piece of reasoning inarguable, despite their initial doubts.

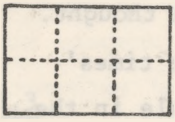


FIG.4

And then there is the irresistable jingle of 'cancelling' - 'Three's into three go once; three's into eighteen go six' , so $\frac{3}{18} = \frac{1}{6}$. Malcolm consistently 'cancels' like this:

> Three's into eighteen go six ($\frac{3'}{18_6}$) and sixes into eighteen go three ($\frac{1'}{18_3}$) So ...

And this is how Jason finds three eighths of the whole:

> See what eight divided by twenty-four is three, and three goes on to the top, and then you go eights into twenty-four...no that's wrong...um...three's into twenty-four go eight so you put that on the bottom.

Not surprisingly this reasoning did not make him feel confident enough to select the appropriate game-piece. The template for cancelling seems to have entirely ensnared Jason's attempt to solve this problem. I suspect that rhythmical laguage patterns have a tremendous appeal for children, and that if they learn such a language pattern before they have developed a deep relational understanding of the associated concept, then the language pattern can entirely obfuscate their thinking.

Even language which is acceptable within the speech register of mathematics can on occasion lead to confusion. The teachers of these children used the phrases 'cancel down', and 'lowest terms', in connection with equivalent fractions.

James says:

> What if it's a smaller fraction...say it's eight twenty-fourths, and yet you can bring it down to a smaller fraction. Can you disagree then?

The language of cancelling reinforces James' misconception that one third of the oblong would not in fact have the same area as eight twenty-fourths of the same oblong.

I hesitate to end by stating conclusions; the recordings of the children raised more questions than they answered. Rather I state my personal thoughts after considering what the children said. Firstly, where the children do use the language of mathematics, it is far too much like a meaningless jingle, and far too tenuously related to insight into the situation at hand; so I feel wary of putting pressure on children to use the language of mathematics. Indeed the language of the mathematics register may have complex and unpredictable effects on the child's thinking. This leads me to feel all the more convinced of the necessity to constantly LISTEN to what the child says; communication of meaning is a two-way process. But the most striking feature of the recordings is that far too many of the children seem to have missed out on an opportunity to develop, as an integral part of their tools of communication, language which would aid their thinking about the mathematics of the situation given. So I have come to believe in the importance of

encouraging the child to talk about the mathematical situation, so that he can make meaning from it, and, in developing the language to cope with the situation, crystallise his thoughts about the situation.

I doubt that there is a more apt conclusion than the sentiment which Anne expressed about the game:

> Like in maths you have your own mind to things, and then if you're wrong other people have got different things - opinions like, so that they can tell you if they think you're wrong and they can like prove it to you, which teachers can't do. Like they don't sometimes like show you how things - say it was three twety-fourths they wouldn't like show you how it's done like so it makes you more confident when you do your sums again.

I think I know what she means.

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