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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
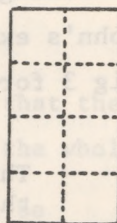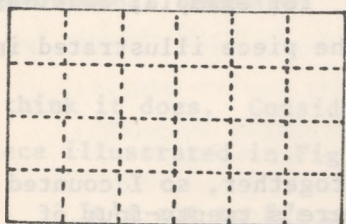the whole, and to justify their choice.

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, vir-
tually 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
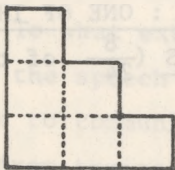> them so that's six twenty-fourths.

<u>FIG.3</u>

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

10

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,
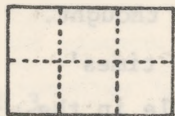despite their initial doubts.

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 ($\frac{\cancel{3}^{1}}{\cancel{18}_{6}}$) and sixes
into eighteen go three ($\frac{\cancel{6}^{1}}{\cancel{18}_{3}}$) 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 regis-
ter 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.

References

JAMES, N. 1980. 'Towards thinking mathematically, Part 1
      - What is a fraction?' in KARPLUS, 1980.

KARPLUS, R. (Ed.) Proceedings of the fourth international
      conference for the psychology of mathematics
      education. International group for the
      ·psychology of mathematics education.

MORROW, M.L. 1981. A case study of the language usage in
      teaching twelve year olds the topic of fractions.
      Unpublished M.Sc dissertation.