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SOME ERRORS CHILDREN MAKE IN MULTIPLYING

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(UNDER THE DIRECTION OF DR LESLEY BOOTH)

One of the basic skills which children learn in primary school mathematics is whole-number multiplication. Beginning with the multiplication 'number-facts', such as $3 \times 6 = 18$, $5 \times 7 = 35$ and so on, children soon move on to 2 or 3 digit numbers multiplied by single-digit numbers (e.g. 28×5 or 372×6), and then to multiplication by 2-digit numbers (e.g. 28×13). By the time children reach Primary 4 (Normal), it is hoped that they have achieved some facility in these skills.

However, some children make errors in this kind of computation. Sometimes, of course, these errors are the result of 'carelessness'; but often they are the result of particular kinds of misunderstanding. Correcting the errors, therefore, will require that the misunderstandings upon which the errors are based are first corrected.

What kinds of misunderstandings cause the errors which children make in doing multiplication? A study carried out in five Singapore primary schools towards the end of 1985 helped to throw some light on this question. In this study, a simple test of children's ability to compute various products was given to a total of 170 children from nine classes drawn from the Primary 4 grade of five schools. The test (which is given in full in the appendix), included items ranging from 7×0 , through items like 9×6 , 35×4 , 304×2 and 143×5 , to such items as 13×12 , 39×30 , and 45×34 .

The results showed that all the items involving multiplication by a single-digit number were very well answered, with 95 percent and more of the children getting each of these items correct. This shows that there was very little 'carelessness' in answering these questions, and that the children seem to know their basic multiplication facts very well. However, the items involving multiplication by a 2-digit number were less well answered.

Approximately 30 percent of the children computed 13×12 , 14×20 and 39×30 incorrectly, and 35 percent produced an incorrect answer for 45×34 . Clearly, there were some particular problems with computing these kinds of products which did not occur in the case of the simpler multiplications by single-digit numbers.

Consequently, a selection of the children who got these problems wrong were interviewed, in order to try and find out what kinds of error they were making, and why. In all, a total of 15 children from the five schools were interviewed. From these interviews, several different kinds of error were identified.

- (1) *Zero error.* Some children use the correct multiplication process, but multiply by zero incorrectly, for example:

$$\begin{array}{r} 14 \\ \times 20 \\ \hline 14 \\ 280 \\ \hline 294 \end{array}$$

Explanation: The child says, "Multiply by zero. Nought times 4 is 4, nought times 1 is 1."

- (2) *Multiplying tens and units separately.* Some children do 2-digit multiplications by finding the product of the units digits, and then the product of the tens digits (some children do the same thing but find the product of the *tens* first), for example:

$$\begin{array}{r} 39 \\ \times 30 \\ \hline 90 \end{array}$$

Explanation: The child says, "Multiply 9 by zero: 9 times zero is zero. Now multiply 3 by 3: 3 times 3 is 9".

If renaming is involved, they may do the renaming correctly, for example:

$$\begin{array}{r} 245 \\ \times 34 \\ \hline 140 \end{array}$$

Explanation: The child says, "Do 4 times 5 is 20. Put down '0', carry the '2'. Then 3 times 4 is 12, plus the '2' is 14."

- (3) *Place-value errors.* These were the most common errors, together with the multiplication of tens and units separately (which also, of course, reveals a lack of understanding of place value). Two different kinds of place-value errors were found. In the first kind, children did not know how to rename

numbers when a product was 10 or more (this error can also be made when multiplying by single-digit numbers, of course):

$\begin{array}{r} 45 \\ \times 34 \\ \hline 1620 \\ 12150 \end{array}$	<p>Explanation: The child says, "4 times 5 is 20 (writes '20'). 4 times 4 is 16 (writes '16')." The child does the same thing when multiplying by the 3 tens.</p>
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In the second type of place-value error (made by about 10 percent of the children), the initial zero was omitted when multiplying by the tens digit:

$\begin{array}{r} 13 \\ \times 12 \\ \hline 26 \\ 13 \\ \hline 39 \end{array}$	<p>Explanation: The child multiplies by the 2 units correctly, then says, "Now do 1 times 3 is 3, put down 3, 1 times 1 is 1, put the 1 next."</p>
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Alternatively, the zero was remembered, but put in the wrong place:

$\begin{array}{r} 14 \\ \times 20 \\ \hline 00 \\ 028 \\ \hline 28 \end{array}$	<p>Explanation: The child multiplies by the unit zero correctly, then says, "2 times 4 is 8 (puts down '8'), 2 times 1 is 2 (puts down '2'), and then put down the zero."</p>
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In the last example, it would seem that the child had tried to learn the algorithm, but because of her lack of understanding of the significance of the position of the '2' in the tens' place, she had become confused as to exactly where one 'puts down the zero'. Other examples of confusion with the algorithm procedure were also found.

- (4) *Confused algorithms.* Other children appear to have made an attempt at learning the multiplication algorithm, but because of their lack of understanding of the process, become somewhat muddled in carrying it out:

$\begin{array}{r} 13 \\ \times 12 \\ \hline 26 \\ 330 \\ \hline 356 \end{array}$	<p>Explanation: The child multiplies by the 2 units correctly, then says, "Put down a zero because you're multiplying by ten. Now do 1 times 3 is 3, put down 3 (multiplies the '1' of the 12 by the '3' of the 13). Then 1 times 3 is 3 (multiplies the '1' of the 13 by the '3' of the 13)."</p>
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$$\begin{array}{r} 14 \\ \times 20 \\ \hline 00 \\ 84 \\ \hline 840 \end{array}$$

Explanation: The child multiplies by the unit zero correctly, then says, "Multiply the tens, so 1 times 4 is 4 (multiplies the '1' of the 14 by the '4' of the 14), put it down underneath. Then 2 times 4 is 8 (multiplies the '2' of the 20 by the '4' of the 14)."

$$\begin{array}{r} 239 \\ \times 30 \\ \hline 00 \\ 2970 \end{array}$$

Explanation: The child multiplies by the unit zero correctly, and says, "Put down a zero then multiply by the 3. 3 times 9 is 27, put down 7, carry the '2'. 3 three's are 9 (puts down 9). Then carry down the '2'."

From a consideration of the errors made, two observations were apparent. Firstly, in each of the above cases the children had developed a systematic approach for handling the computations, which they then used consistently on all problems of the same type. Consequently, it is unlikely that merely re-showing them the correct procedure will have any effect. They must first 'unlearn' the procedure they are currently using. One way of helping them to do this may be to first convince them that the answers they are getting *are* wrong. This can be done quite simply by asking them to perform the same multiplications on a calculator. Once convinced of this fact, the children are likely to be much more prepared to give up their current methods.

Secondly, with the exception of the 'multiplying by zero' error, all of the errors can be seen to reveal a lack of understanding of place-value and its significance in such computations. Consequently, before the children can start to learn the correct multiplication procedure, they will need to clarify their ideas about place-value. This may require going back to 'concrete' or practical activities on grouping in tens and units, and particularly to the idea that '34' can be written as '30 + 4', and vice-versa. Again, once the child has started to re-learn the multiplication algorithm, a calculator can be very useful in enabling the child to check each partial product as he or she computes it, for example:

$$\begin{array}{r} 45 \\ \times 34 \\ \hline \text{x4} \quad 180 \quad (\text{check with calculator}) \\ \text{x30} \quad 1350 \quad (\text{check with calculator}) \\ \hline 1530 \end{array}$$

The study has also shown, of course, that examining children's errors in mathematics, and asking the children to describe how they got these wrong answers, can provide the teacher with valuable information concerning the nature of the errors, and hence the ways in which the errors might be corrected.

APPENDIX

MATHEMATICS TEST 1 MULTIPLICATION OF WHOLE NUMBERS

Name: _____ School: _____

Age: _____ Class: _____

Date: _____

Please show all your working:

- A
1. $7 \times 0 =$
 2. $2 \times 4 =$
 3. $9 \times 6 =$
 4. $12 \times 4 =$
 5. $35 \times 2 =$
 6. $10 \times 9 =$

B 7. 8
 x 7

8. 43
 x 2

9. 35
 x 4

10. 240
 x 2

11. 304
 x 2

12. 240
 x 3

13. 207
 x 4

14. 421
 x 2

15. 329
 x 3

16. 462
 x 2

17. 485
 x 2

18. 143
 x 5

19. 13
 x 12

20. 45
 x 34

21. 14
 x 20

22. 39
 x 30

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