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THE MATHEMATICS OF MONEY AT KEY STAGE ONE (5 – 7 YEAR-OLDS)

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There is an assumption that early number knowledge will directly support the learning of money. Here we consider one situation Key Stage One children experience, that of paired number bonds and its value in dealing with simple money equivalence and addition. An analysis of this situation will illustrate where positive and negative transfer might be taking place.

INTRODUCTION

Whilst knowledge of number is considered to be generally supportive when working with money it is possible that there are elements which interfere with or cannot be transferred to money situations. The aspect of money selected for examination is one normally met by Key Stage 1 school children, the addition of two or more values. These observations are based upon experience of working with young children underpinned by other teacher's reports on the behaviour of children when dealing with money sums and coinage.

ADDING THE VALUES OF TWO COINS

In the National Numeracy Strategy (DfEE 1999) for Year One, one of the Key Objectives is 'know by heart: all pairs of numbers with a total of 10' (p6). Children are usually involved in discovering the composition of a number, often referred to as 'finding stories of..'. A story of 5 being 0 + 5, 1 + 4, 2 + 3, 3 + 2, 4 + 1, 5 + 0. This is then linked to the addition, so the story of 10 would give all the possible permutations of two numbers which total ten. These paired number bonds are of significant importance in the performing of mental calculations and algorithms. The expectation that children at Key Stage 1 of the National Curriculum (DfEE 1999) is that children will, 'develop rapid recall of number facts, know addition and subtraction facts to 10 and use these to derive facts with totals of 20'.

It is accepted that this number bond knowledge will transfer to a money situation. So knowing 5p + 4p uses the number bond of 5 + 4. Here we do have transferable knowledge. However it is common when working with money to use real or plastic coins as supporting apparatus. If we look at all the paired number bonds to ten and compare them with the equivalent coin pairs (see figure 1) there are actually only six matches.

Number	number bonds	two coin equivalence
2/2p	1 + 1	1p + 1p
3/3p	1 + 2	1p + 2p

4/4p	1 + 3	
	2 + 2	2p + 2p
5/5p	1 + 4	
	2 + 3	
6/6p	1 + 5	1p + 5p
	2 + 4	
	3 + 3	
7/7p	1 + 6	
	2 + 5	2p + 5p
	3 + 4	
8/8p	1 + 7	
	2 + 6	
	3 + 5	
	4 + 4	
9/9p	1 + 8	
	2 + 7	
	3 + 6	
	4 +6	
10/10p	1 + 9	
	2 + 8	
	3 + 7	
	4 + 6	
	5 + 5	5p + 5p

Figure 1. Correlation between paired number bonds and money bonds

[In this table commutativity has been assumed, the addition of zero has been omitted]

The paired number bond knowledge used for money calculations is not of significant importance when using coinage. Money equivalence relies more upon combinations greater than paired numbers as can be seen from the following figure which shows the combinations that can be made using standard coins to create a value of 10p.

1p, 1p, 1p, 1p, 1p, 1p, 1p, 1p, 1p, 1p

1p, 1p, 1p, 1p, 1p, 1p, 1p, 1p, 2p

1p, 1p, 1p, 1p, 1p, 1p, 2p, 2p

1p, 1p, 1p, 1p, 2p, 2p, 2p

1p, 1p, 2p, 2p, 2p, 2p

2p + 2p + 2p + 2p + 2p

5p + 5p

5p + 1p + 1p + 1p + 1p + 1p

5p + 1p + 1p + 1p + 2p

5p + 1p + 2p + 2p

10p

Figure 2. Coin compilation up to 10p

Here we find that it is not the combining of pairs of numbers but the ability to deal with sets of more than two numbers which is required. The 'story of 10' (or other number) follows a pattern (9+1, 8 +2, etc.) and can be found using pairs of numbers. The 'story of 10p' does not follow one pattern and the sets consist mainly of combining more than two amounts. This makes dealing with money addition a more sophisticated task than that of number when using actual coins.

When we consider further these combinations of coins and children's learning patterns reported by teachers we find there is probably a sequence of realisation here:

a)	10p =	10p
b)	10p =	1p + 1p + 1p + 1p + 1p + 1p + 1p + 1p + 1p + 1p (ones)
c)	10p =	5p + 5p(doubles)
d)	10p =	2p + 2p + 2p + 2p + 2p(coins the same)
e)	10p =	1p, 1p, 1p, 1p, 1p, 1p, 1p, 1p, 2p
		1p, 1p, 1p, 1p, 1p, 1p, 2p, 2p
		1p, 1p, 1p, 1p, 2p, 2p, 2p
		1p, 1p, 2p, 2p, 2p, 2p (mixed coinage using 1p/2p coins)
f)	10p =	5p + 1p + 1p + 1p + 1p + 1p
		5p + 1p + 1p + 1p + 2p
		5p + 1p + 2p + 2p (mixed coinage including 5p coin)

Figure 3. A possible sequence of development in using coins to make 10p

a) the direct match - acceptance that one 10p coin is equal to another identical 10p coin is a matching exercise where the logical idea of sameness is readily understood.

b) follows the rules of one-to-one ordinal counting used in number and the exchange of ten 1p pieces parallels that of ten ones to a ten when using place value materials

c) the association with the number bond, counting in 5s and the attraction of sameness found in doubling

d) the connection between the 2p coin and counting in 2s

e) replacing two, 1p coins for a 2p piece

f) replacing three (or more) coins for a 5p piece or selecting a larger amount and 'counting on'

ADDING THE VALUES OF TWO OR MORE COINS

When children start to add numerical amounts such as 5 + 4 they are probably going to use some form of apparatus to support a counting strategy. This could be cubes, counters, fingers or a number line. One approach is to establish the two quantities and then 'count all'. With the number line, and maybe the fingers, the first number (5) will be established and then a 'count on' strategy used. As children progress in their number knowledge they will get to know that the number fact 5 + 4 always generates an answer of 9.

If a child is presented with 5p + 4p and uses any of the above 'number' strategies they will probably succeed in totalling the amounts but if they use the coins which would be appropriate 'money' apparatus, a new situation is presented. If the child selects a 5p and four 1p coins to work with the model remains the same as the number examples and a 'count on' strategy can be used. However if the 5p + 4p is represented by the coins 5p + 2p + 2p this does not fit either counting strategy model. There are now three numbers to add. The previous common experience in number at Key Stage 1has been to add two numbers though the National Numeracy Strategy (1999, p 26) introduces adding three numbers as an outcome for Year 1 pupils.

If the number bond knowledge is not transferred children will probably employ a 'counting on' strategy but will compensate for the hidden one-to-one correspondence by touching the 2p coins twice ('touch counting'). Orally they will either count the 5p or count on from the 5p saying '5, 6/7, 8/9'.

Alternatively one might wish children to use the bonds they know in a two stage sum. This could be;

$$(5 + 2) + 2 \text{ or, } (2 + 2) + 5$$

This might be done with the coins or in the head with the image of the coins or in pure number with the sum extracted from the coin structure. A calculation such as 14p + 3p illustrates this more dramatically. Getting out the coins to support working out could lead a child into (10 + 2 + 2) + (2 + 1). This is good practice in totalling coins but not the quickest way to a solution. It appears easier to keep the calculation un-situated (in the abstract number domain). Which apparatus should the child be electing to use if they cannot calculate the sum, number apparatus or coins? This appears to be a case where supporting with apparatus (coins) is not necessarily going to make the calculation easier. Using coins in this situation will give practice towards totalling any collection of coins, which is undoubtedly a longer term aim. In the light of these considerations take a numerical approach to the following and then treat it as a practical task using coins as a further illustration of this point.

$$10p + 1p + 50p + 2p + 5p + 20p$$

CONCLUSION

One might argue that children need to experience adding coins from an early stage because this is an essential skill required for working with money in 'real life'. Alongside this argument it is essential to realise that paired number bonds are limited in their support of many money addition situations. In reality most practical money situations use multiple number bonds even when presented as two value additions.

REFERENCES

DfEE (1999) The National Numeracy Strategy London:HMSO

DfEE (1995) Key Stages 1 and 2 of the National Curriculum London:HMSO