Research project: children who get 'stuck' at level 2C in mathematics

Summary of research findings

Introduction and context

National data demonstrates that, without well-targeted intervention, many children who attain level 2C in mathematics at the end of Key Stage 1 are unlikely to progress to a secure level 4 by the time they leave primary school. When children do not reach the national benchmark of level 4 by the end of Key Stage 2, this in turn affects their likelihood of achieving a good GCSE grade in mathematics, which can have a profound impact on their future life choices. This research arose out of concern about the number of children who attain level 2C at the end of Year 2 in primary schools and who consequently appear to make slow progress through Key Stage 2.

The aim of this research was to identify aspects of mathematics that appear to present 'barriers to learning' for children whose progress and attainment has stalled at level 2C at the end of Key Stage 1. It is hoped that teachers and schools can use the findings of this research to plan appropriate intervention to help such children overcome these barriers and make good progress in mathematics over Key Stage 1 and be well-placed to achieve level 4 by the end of Key Stage 2.

For details of the methodology of this research and details of results, see Appendices.

Aspects of mathematics that appear to present 'barriers' to children whose attainment has stalled at level 2C

The results from this research project suggest that those National Curriculum Attainment Targets that present most difficulty to children working at level 2C are:

- AT1 Using and applying mathematics
- AT2 Number and algebra.

Common areas of difficulty found in the research group of children working at level 2C

Understanding and using place value in two-digit numbers

- Almost all children were able to count aloud in tens from 0 to 100, although there was some confusion when distinguishing between the 'ty' and 'teen' numbers. However, many children were unable to apply the counting to practical contexts. For example, once a group of objects had been arranged into groups of 10, almost all children still needed support to help them count how many objects there were altogether.

- Most children were not able to recognise and state that there are 52 objects altogether in a set containing 50 objects that were arranged in five groups of tens alongside another two individual objects.

- In a test question, none of the children working at level 2C could identify that 37 has three tens; this compared with 60% of the children working at level 2B.

Mental calculation involving two-digit numbers

The lack of understanding of place value described above meant that the children were very restricted in terms of their mental calculation strategies.

- The children working at level 2C often resorted to using strategies that involved counting in ones. Where they could count small numbers of objects or fingers, they were generally accurate. Interestingly, in a test question, 100% of the 2C children were able to circle the 11th person in a picture of a queue, as opposed to 57% of the 2B children.

- When asked to handle bigger numbers, the 2C children would continue to use fingers to count in ones; this often led to inaccuracy through their inability to keep track of the count.

- Most children were able to identify the new total when they were asked to add one to a given number; very few children were able to use understanding of place value to say the new total when asked to add 10. This was evident in test questions, where 33% of level 2C children could answer 32 + ? = 43 correctly, compared to 80% of children working at level 2B.

- A small number of level 2C children were beginning to use counting on or back as a strategy, often supported by a number-line image, though again they relied on counting in ones. This helped children to 'see' the numbers; one girl explained that she knew that nine was three more than six because she was picturing the numbers on a number line and was counting between them. A boy worked out how many more counters there were in a set of 42 than in a set of 28 by counting on from 28 to 42. Initially, he included 28 in the count and gave the answer 15 but corrected himself when asked to use a number line to check.

- Children could halve small even numbers, such as eight, by using objects or fingers but could not use place value or partitioning to halve larger numbers. Only 14% of level 2C children could find half of 60 in a test question, compared to 43% of level 2B children.

- Children had very limited understanding of the inverse relationship between addition and subtraction and halving and doubling. Over half of the level 2C children were unable to explain how to 'undo' an addition operation. For example, after adding three objects to an original set of five objects, they were generally not able to say what they would need to do, and the operation they would use, to return the set to its original size. Only one child was able to make an accurate link between a subtraction calculation and a known addition fact.

- Children working at 2C appeared to have little practical understanding of multiplication: one boy, who explained that 'doing tables' was one of his favourite

things in mathematics, was not able to give the total amount of money in a purse that contained three 5p coins.

Solving problems

- Children were generally able to identify when to use addition to solve a problem, particularly where it involved combining groups, but most children struggled to identify how to solve problems involving subtraction.

- Most children were unable to identify a way to work out how many more bricks were in one set than another, even though the bricks were in front of them and they had already counted the bricks in each set. This difficulty in finding 'How many more…?' was also evident in test questions. None of the 2C children was able to identify how many more children had brown eyes than green eyes from a block graph, compared to 57% of 2B children.

- Over half of the children struggled to find the total of a small number of coins in a purse; they found it hard to combine several amounts and did not appreciate the power of starting by counting the value of the 10p coins, using their skill of counting in 10s .

- From analysis of test questions, 2C children struggled to interpret and find methods for more unusual problems; for example, only 44% of 2C children were able to find ways of putting counters into a grid to make two lines of four counters, compared to all 2B children.

Recording methods

- Children could often model simple problems, using equipment or drawings when this was suggested. However, when asked to record what they had done to solve a problem, most children's immediate response was to attempt to write a number sentence. Addition sentences were generally accurately written but, when writing subtraction sentences, many children struggled to write the appropriate numbers in the correct order.

- In their response to test questions, 2C children had much less security than children working at 2B in interpreting and understanding number sentences with missing numbers. For example, only 29% of 2C children correctly completed the equations 3 + … = 8 and … + 5 = 9, compared to 86% of 2B children.

Understanding and using mathematical vocabulary

- Children could generally understand rules, follow instructions and interpret problems that used simple mathematical vocabulary. They found it much more difficult to use appropriate mathematical language to explain their methods, understanding or reasoning. For example, one girl described a rectangle as 'like a square – four sides – a square goes this way,' while another girl tried to explain how she knew that 26 was smaller than 61: 'It is in its twos, 61 is in its sixes.'

Conclusions

Children whose progress was 'stuck' at level 2C in mathematics were severely hampered by their:

- poor understanding of place value for two-digit numbers and an inability to combine groups of tens and units into a single number or partition a number into tens and units
- reliance on naïve counting strategies, usually involving ones and often with fingers or objects, which enabled them to deal with small numbers but not with larger numbers
- limited concept of subtraction, based on a simple model of 'take away', that did not support an understanding of the relationship of subtraction to addition
- difficulty in recording and interpreting number sentences accurately, particularly when they involve subtraction or the finding of missing values
- weak understanding of the structure of multiplication as repeated addition, and its application and links to the process of counting in groups other than ones
- access to a narrow range of mathematics vocabulary and poor understanding and use of mathematical language, restricting their ability to interpret problems, to express their ideas or explain their thinking.

If these children are to progress in mathematics they need to be taught:

- to recognise the value of each digit in a two-digit number, to use this knowledge to partition two-digit numbers, combine tens and units to form a two-digit number and to order two-digit numbers
- how to use and apply their knowledge of counting in tens, to count a large number of objects efficiently and accurately, counting on and back in tens from any two-digit number and finding the total value of a set of coins that includes 10p pieces
- how to use their knowledge of counting in tens and their recall of number facts to begin to calculate efficiently, using one-digit and two-digit numbers
- that subtraction can involve finding the difference between the numbers of objects in two sets or the difference between two numbers, and to recognise how this operation relates to addition
- how to use number sentences to represent practical situations, especially those involving subtraction or multiplication, and how to interpret and solve number sentences that have missing numbers.

In addition, teachers need to model and promote the accurate use of mathematical language to explain ideas and reasoning and to solve problems, providing children with regular and carefully scaffolded opportunities to engage in mathematical dialogue with adults and with their peers.

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In order to plan appropriate interventions to address the above areas of difficulty, schools will find the following resources helpful in planning and assessing learning:

- Overcoming barriers in mathematics – helping children move from level 1 to level 2 DCSF: 00021-2009
- Securing level 2 in mathematics DCSF: 00687-2009BKT-EN
- Supporting children with gaps in their mathematical understanding DCSF: 1168-2005G.

Details of how to obtain or download all of these resources can be found at the National Strategies web area by searching for the title or reference number, at: www.standards.dcsf.gov.uk/nationalstrategies.

Appendices

Appendix 1

Research methodology

The aim of this small research project was to try to identify aspects of mathematics that children working at level 2C find particularly challenging and that may act as 'barriers' that impede some children from making good progress in mathematics, particularly in lower Key Stage 2. In order to do this, two lines of research were followed, as described below.

1. Analysis of data from Year 2 test papers

Results from Year 2 QCA national test papers were analysed for 28 children (some children had taken the 2007 paper while others took the 2009 paper). The children were from three different schools; 16 of the children attained level 2C and 12 children attained level 2B. The overall results of the group who attained level 2C were compared with those of the children who attained level 2B.

Appendix 2 shows a graph comparing the overall attainment of the two groups of children in the following aspects of mathematics: numbers and the number system; calculations; solving problems; handling data; measures; shape and space. In all aspects, the attainment of level 2C children fell well below that of the level 2B children.

Appendix 3 gives descriptions of questions the level 2C children found particularly challenging. In all cases the percentage of children working at level 2C who answered the question correctly was under half of the percentage of children working at level 2B who answered the same question correctly.

2. Attainment sampling of children working at level 2C

The researcher contacted three primary schools and asked them to be involved in the research project. Each school was asked to select two children from Year 2 or Year 3, identified by teachers as 'stuck' at level 2C.

The researcher then visited each school and worked with the identified children on a range of practical and oral activities designed to assess children's attainment against the Assessing Pupils' Progress assessment guidelines for level 2.

The attainment of the sample group of pupils was then collated. See **Appendix 4** for results.

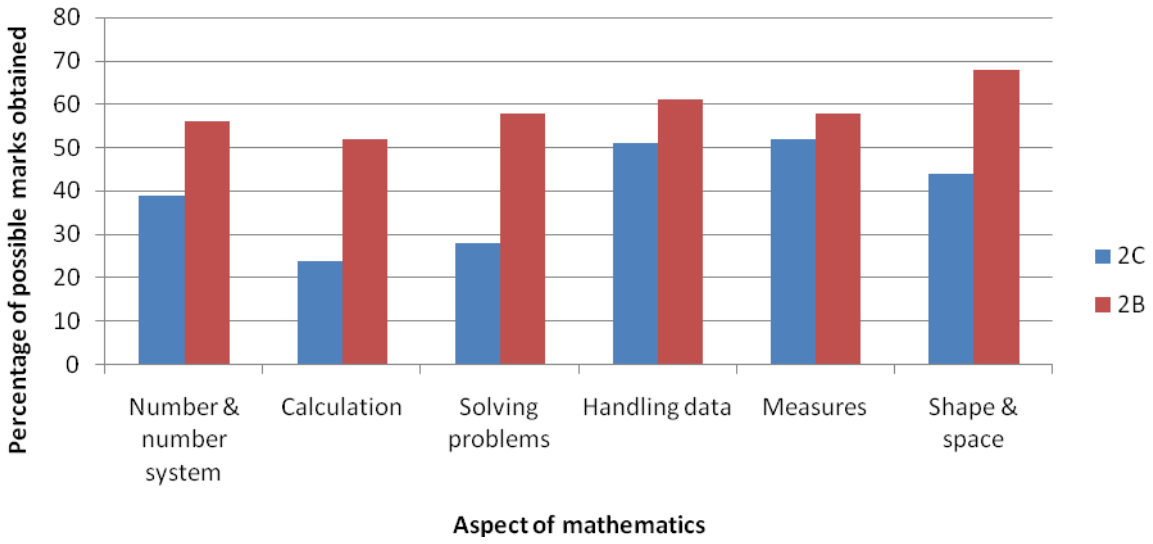
Research outcomes

Results from the above research were carefully analysed. The main aspects of mathematics that appeared to present barriers for children working at level 2C were identified. Details of these have been written up in the *Summary of research findings* – see above.

It is hoped that teachers and schools may be able to use the information from this research project to inform their intervention for children whose attainment in mathematics appears to plateau at level 2C.

Appendix 2

Graph comparing overall attainment of children attaining level 2C with that of children attaining level 2B in different aspect of mathematics



Appendix 3

Descriptions of questions from level 2 Year 2 national test papers where the percentage of children working at level 2C who answered the question correctly was below or equal to half of the percentage of children working at level 2B who answered correctly

Description of question	% of children working at level 2C correct	% of children working at level 2B correct
2007 Year 2 Paper		
Find half of 60	14%	43%
Identify the unit of weight from a list	14%	71%
Work out 7 + 5 + 7	29%	71%
Place + and = symbols to make a number sentence 18...7...11	43%	86%
Write in missing number to make addition sentences correct: 3 + ...= 8 and ... + 5 = 9	29%	86%
Record grey squares on grid given reference, e.g. A5	14%	100%
6 × 2	14%	57%
Word problem involving subtraction: Work out how many children are painting, given that there are 29 children and 5 are not painting.	14%	43%
Interpret a block graph: How many more children have brown eyes than green?	0%	57%
Calculate total number of eggs (with space to show working).	43% & 14%	71% & 71%
Tick two purses with the same amount of money	14%	57%
Sort numbers, using rounding to the nearest ten	14%	29%
24 + 68	0%	29%
Read the scale to record the weight of a bag	29%	71%
Draw the missing line in a pattern where lines go up by 2cm each time	0%	29%
75 – 43	14%	43%
2009 Year 2 Paper		

Find different ways to put counters in the grid to make two lines of four counters	44%	100%
What is 8 less than 28?	11%	60%
32 + ? = 42	33%	80%
Tick the shape which is less than ½ blue	11%	100%
54 + 19	11%	40%
37 has ? tens.	0%	60%
Half of 12 = ? Double 12 = ?	0%	20%
Use 46 and 54 to complete number sentences: 8 + ? = ?, ? + 8 = ?; & ? – ? = 8, ? – 8 = ?	11% & 0%	61% & 40%
Tick two correct properties for a cube.	22%	60%
Ben says 57 – 16 = 14. He is wrong. Show how to work this out.	11% & 0%	20% & 40%
Look at the table. Which object is half the length of the ruler?	11%	60%

Appendix 4

Children working at level 2C – collated data from attainment sample group

APP statements	Few children attained	About half children attained	Most children attained	Notes and examples
• Select the mathematics they use in some classroom activities				• Not assessed specifically
• Discuss their work, using mathematical language, e.g. with support			✔ (but see notes)	• Most children automatically used some of the more common mathematical vocabulary e.g. side, even, tens, in the discussions • Almost all children found it hard to express mathematical ideas in complete sentences, e.g. one girl tried to describe how she knew 26 was smaller than 61: 'It is in its 2s, 61 is in its 6s.' • Most children were able to draw pictures to represent practical situations involving number • Almost all children could record an addition number sentence to represent a practical addition of small numbers • Over half of the children struggled to write a subtraction number sentence accurately, some used the + rather than – symbol, where others were unsure of what numbers to include and in which order, writing for example 5 – 5 = 5 rather than 10 – 5 = 5
• Begin to represent their work, using symbols and simple diagrams, e.g. with support		✔ (but see notes)		
• Explain why an answer is correct, e.g. with support		✔		• About half of children could give simple explanations of their mathematical thinking, e.g. eight is three more than five, I can picture them on a number line
• Predict what comes next in a simple number, shape or spatial sequence and give reasons for their opinions			✔	• All but one of children were able to continue the sequence of even numbers and could explain that they counted in twos; most could also predict the next odd number, explanations included 'One number is missed out.'
• count sets of objects reliably			✔	• All children counted sets of objects accurately, using techniques such as moving

APP statements	Few children attained	About half children attained	Most children attained	Notes and examples
• begin to understand the place value of each digit, use this to order numbers up to 100	✔			objects as they counted • Only one child demonstrated good understanding of place value in two-digit numbers: few children were able to talk about the value of digits; about half of children, once we had counted a large set of objects into groups of 10, were unable to work out that the four groups of ten plus the three left over gave a set of 43 (even after we counted in tens to show that the four tens made 40) • Most (though not all) children could recite the sequence of multiples of ten from 10 to 100, but several could not apply this to count a set of objects grouped into tens without support; one child was unsure of 'ty' and 'teen' numbers, which made their counting confused
• recognise sequences of numbers, including odd and even numbers			✔	• Most children could order three two-digit numbers when given them in written format • See comments above re sequences
• begin to use halves and quarters • relate the concept of half of a small quantity to concept of half of a shape			✔	• Most children were able to find half of a set of objects, by sharing into two equal groups • Not assessed specifically
• use the knowledge that subtraction is the inverse of addition	✔			• None of the children could correctly write a subtraction fact for a linked addition fact; under half of the children were able to explain what they would do to a group of eight objects to turn it back into five objects (after we had added three) • All children were able to find half of a small group of objects practically; about half of the children were able to double a small number; no children were able to relate halving and doubling
• understand halving as a way of 'undoing' doubling and vice versa	✔			

APP statements	Few children attained	About half children attained	Most children attained	Notes and examples
• use mental recall of addition and subtraction facts to 10		✔		• Mixed attainment: some children knew all pairs to 10 where one child only recalled one pair; about half of children were able to recall answers for small addition facts such as 2 + 3 while others used fingers to work out all facts where objects were not already being used • Over half of the children struggled to identify the total amount of money in a purse (32p). All when prompted were able to count in tens to 30 (one explained that the 'ty' meant tens so 30 is 3 tens) but over half were not then able to say that 30p and 2p makes 32p • Almost all children were able to say how much they would have if they were given 1p more from a known amount; few children were able to say how much they would have if given 10p more or less
• use mental calculation strategies to solve number problems, including those involving money and measures	✔ (where the calculation was not easily solved through counting on in ones)			
• choose the appropriate operation when solving addition and subtraction problems		✔		• Children could generally identify how to solve problems that involved simple addition, such as combining two groups, but struggled more with subtraction • Most children struggled to suggest a method for finding how many more bricks were in one handful than another (even though they knew which had more because we had counted each group): one child was able to say that she knew nine was three more than six because 'They are here and here on a number line'; one child was able to say that 32 was seven more than 25 by counting up in his head; others were unable to come up with a method at all
• solve number problems involving money problems and measures	✔			
• record their work in writing		✔ (see notes)		• children recorded addition sentences when asked to write down something to show how they answered a simple addition problem; few children were able to record subtraction sentences

APP statements	Few children attained	About half children attained	Most children attained	Notes and examples
				accurately
• use mathematical names for common 3-D and 2-D shapes • describe their properties, including numbers of sides and corners		✔ (see notes)	✔	• most children could name common 2-D shapes (3-D not assessed), though just under half of children named an oblong as a square • children were generally able to answer questions about properties of common 2-D shapes but struggled actually to describe shapes using mathematical vocabulary, for example, one child described a rectangle as 'like a square – four sides – a square goes this way.'
• describe the position of objects • distinguish between straight and turning movements • recognise right angles in turns	✔		✔	• all children could follow instructions using simple positional language; almost all children could position objects and describe their actions using positional language such as 'on top of' and 'behind'. • Not specifically assessed • Few children could respond appropriately to being asked to turn through a right angle
• understand angle as a measurement of turn • begin to use everyday non-standard and standard units to measure length and mass • begin to use a wider range of measures		✔ (see notes)		• All children turned on the spot when asked to turn through a right angle or a quarter/half turn; almost all were unsure of how far to turn or in which direction • Not specifically assessed • Not specifically assessed
• sort objects and classify them, using more than one criterion • understand vocabulary relating to handling data • collect and sort data to test a simple hypothesis • record results in simple lists, tables, pictograms and block graphs				• Almost all children were able to sort a set of shapes using one given criterion; over half of children struggled to suggest their own criterion to use to sort the shapes; did not assess sorting using more than one criterion • Not assessed • Not assessed • Not assessed
• communicate their findings, using simple				• Not assessed

APP statements	Few children attained	About half children attained	Most children attained	Notes and examples
lists, tables, pictograms and block graphs they have recorded				