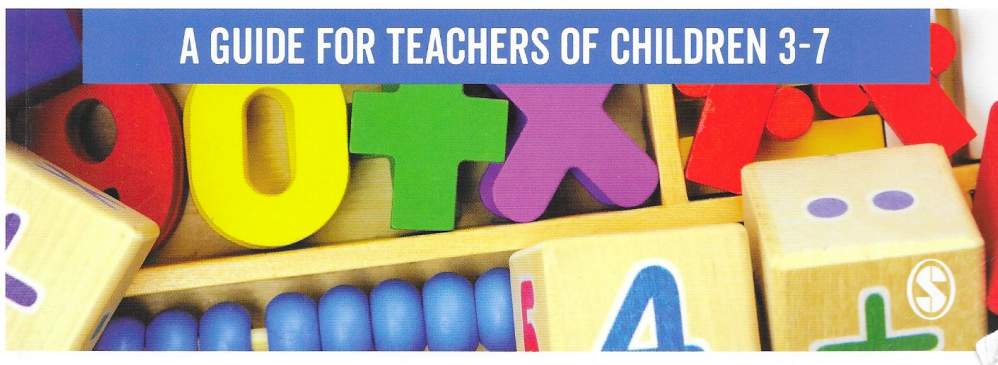




UNDERSTANDING MATHEMATICS FOR YOUNG CHILDREN

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A GUIDE FOR TEACHERS OF CHILDREN 3-7



CONCRETE MATERIALS, SYMBOLS, LANGUAGE AND PICTURES

When children are engaged in mathematical activity, as in the example above, they are involved in manipulating one or more of these four key components of mathematical experience: concrete materials, symbols, language and pictures. These four components will often provide a starting point for generating the variation in experience of mathematical concepts that is essential for developing mastery.

First, they manipulate *concrete materials*. We use this term to refer to any kind of real, physical materials, structured or unstructured, that children might use to help them perform mathematical operations or to enable them to construct mathematical concepts. Examples of concrete materials would be blocks, various sets of objects and toys, rods, counters, fingers and coins.

Second, they manipulate *symbols*: selecting and arranging cards with numerals written on them; making marks representing numbers on pieces of paper and arranging them in various ways; copying exercises from a work card or a textbook; numbering the questions; breaking up numbers into tens and units; writing numerals in boxes; underlining the answer; pressing buttons on their calculator; and so on.

Third, they manipulate *language*: reading instructions from work cards or textbooks; making sentences incorporating specific mathematical words; processing the teacher's instructions; interpreting word problems; saying out loud the words that go with their recording; discussing their choices with the teacher and with other children; and so on. This language will include both formal mathematical words, such as 'subtract two, equals', and less formal language that describes particular actions or observations, such as 'take two away, how many are left?'

Finally, they manipulate *pictures*: drawing various kinds of number strips and number lines, set diagrams, arrow pictures and graphs.

AN EXAMPLE IN A NURSERY CLASS

In a nursery class some children aged 3 to 4 years are propelling themselves around the playground on tricycles. The tricycles are numbered from 1 to 9 (see photograph overleaf). At the end of the time for free play they put the tricycles away in a parking bay, where the numerals from 1 to 9 are written on the paving stones, matching their tricycle to the appropriate numbered position in the bay. There are conversations prompted by the teacher about why a particular tricycle is in the wrong place and which one should go next to which other ones. When all the tricycles are in place, the children check them by counting from 1 to 9, pointing at each tricycle in turn.



We begin to see here how an understanding of elementary mathematical ideas develops, as children begin to make connections between real objects, symbols, language and pictures. The children are making connections between the ordering of the numerical symbols and the ordering of the actual tricycles. The numerals on the paving stones form an elementary picture of part of a number line, providing a visual image to connect with the language of counting. Already the children are beginning to understand what we will call (in Chapter 2) the ordinal aspect of number, by making these simple connections between real objects lined up in order, the picture of the number line, the symbols for numbers and the associated language of counting.

UNDERSTANDING AS MAKING CONNECTIONS

A simple model that enables us to talk about understanding in mathematics is to view the growth of understanding as the building up of cognitive connections. More specifically, when we encounter some new experience there is a sense in which we understand it if we can connect it to previous experiences or, better, to a network of previously connected experiences. In this model we propose that the more strongly connected the experience is, the greater and more secure is our understanding of it. Using this model, the teacher's role in developing understanding, and thereby in promoting mastery, is to help the child to build up connections between new experiences and previous learning. Learning without making connections is what we would call learning by rote.

CONNECTIONS

We find it very difficult to understand operations (the equals, number, network of connections) that we have. Any one of the differences that may

Figure 1.1 S

So, for example, in a playground situation, the language of counting can be able to connect. When 4-year-olds are on a die with counter forward connections, an understanding of the number. These are (see www.nur) activities with symbol 5. The 'five' between the process of filling five. The material enable the children to understand patterns, physical

CONNECTIONS BETWEEN THE FOUR KEY COMPONENTS

We find it very helpful to think of understanding the concepts of number and number operations (that is, number, place value, addition, subtraction, multiplication, division, equals, number patterns and relationships, and so on) as including the building up of a network of cognitive connections between the four types of experience of mathematics that we have identified above: concrete experiences, symbols, language and pictures. Any one of the arrows in Figure 1.1 represents a possible connection between experiences that might form part of the understanding of a mathematical concept.

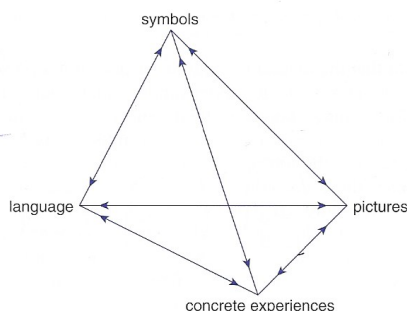


Figure 1.1 Significant connections in understanding number and number operations

So, for example, when a 3-year-old counts out loud as they climb the steps on the playground slide or when they stamp along a line of paving stones, they are connecting the language of number with a concrete and physical experience. Later they will be able to connect this experience and language with the picture of a number strip. When 4-year-olds play a simple board game, they are connecting a number symbol on a die with the name of the numeral and the concrete experience of moving their counter forward that number of places along the board. And so, through these connections, an understanding of number is being developed.

Consider a child just starting to use Numicon plates to explore early ideas of number. These are coloured plates carefully structured to represent numbers in sequence (see www.numicon.com). The shape for 5, as shown in Figure 1.2, is a picture that in activities with the materials is connected with the language 'five' and, eventually, the symbol 5. The shape is seen as having a position in a pattern of shapes, which places 'five' between 'four' and 'six'. The child learns to connect this shape with the physical process of filling the holes in the plate with pegs, while counting one, two, three, four, five. The materials are effective for promoting understanding of number because they enable the child to make such key connections between language, pictures and patterns, physical action and symbols.

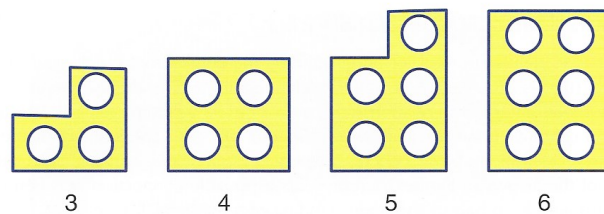


Figure 1.2 Some Numicon shapes for promoting understanding of number

We should make clear that the diagram in Figure 1.1 does not represent all the possible connections that might contribute to understanding mathematical concepts or processes. Particularly for young children, in their learning about number and counting, we could include physical movements, gestures and music – such as the rhythmic patterns in both the words and the music of counting songs and the actions that go with them. Then, of course, there are connections within one of the four categories of experience suggested in Figure 1.1. For example, the learner will make connections between one kind of visual image and another, such as connecting four steps of two on a number line with four rows of two dots; or between formal mathematical language, such as ‘not vertical’, and everyday language, such as ‘tilted’. Our point is simply this: the more connections, the more secure and the more useful the understanding.

PAUSE TO REFLECT ‘BY GEORGE, SHE’S GOT IT!’

These are the words of Professor Higgins in *My Fair Lady* when Eliza shows significant progress in her learning! Think about all the different expressions you might use – or hear other people use – to indicate that you (or they) understand something or do not understand something. For example, you might say things like:

- Oh, I see!
- Now it’s clicked.
- Everything is falling into place.
- Sorry, I don’t get it.
- I’m still in the dark.
- I can’t see the sense in that!

Reflect on what insights these forms of words might give you about the nature of understanding. Do any of the expressions you identify resonate with the connections model of understanding for mathematics that we have introduced in this chapter?