The Connective Model

Understanding mathematics involves identifying and understanding connections between mathematical ideas. Haylock and Cockburn (1989) suggested that effective learning in mathematics takes place when the learner makes cognitive connections. Teaching and learning of mathematics should therefore focus on making such connections. The connective model helps to make explicit the connections between different mathematical representations: symbols, mathematically structured images, language and contexts.

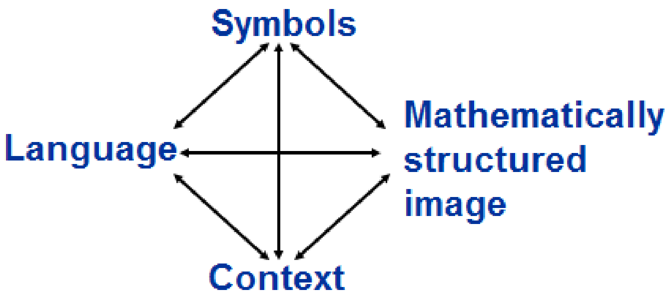

Figure1.1 The connective model of learning mathematics (adapted by the Babcock LDP Primary Mathematics Team from Haylock and Cockburn 1989)

Haylock and Cockburn suggest that it is in making connections between their experiences of these different elements that children's learning is more deeply embedded and their understanding broadened and deepened.

For example:

- A class might be looking at how to reduce their school's impact on the environment and decide to focus on how the pupils travel to school. This provides the context and purpose for the mathematics.

- The pupils examine the data that has been collected, which shows the number of pupils who walk, cycle or travel by car, bus or taxi, and talk about what they notice and what they would like to change; this will involve both mathematical and contextual language, being used a part of purposeful talk.

- A question arises about the total number of pupils who travel in a vehicle that uses fuel compared to the number of pupils who travel in a sustainable way. This provides an opportunity for the pupils to look at the most efficient way to add the numbers, using what they know and understand.

- A mathematical image might be used to support understanding of a method; for example, understanding that for 165 + 25 it is easy to partition the second number and use the known facts 5 + 5 = 10 and 7 + 2 = 9 (for 70 + 20 = 90). The image might also be used by a pupil to support their explanation of their method, allowing others to access their thinking.

- Images for addition include: base 10, number lines, bead strings and place-value counters. The focus should be on using the image to support understanding, not 'to do' the maths. Counting in ones should be avoided and decisions about which resources to have available should be made by the teacher and depend on them being fit for purpose. Decisions about which resources to use to support explanations should be made by the pupils.

- The symbols might record the steps taken or the calculation undertaken (165 + 5 + 20 = 190 or 165 + 5 = 170, 170 + 20 = 190 or 165 + 25 = 190) and the pupils should be able to explain the symbols in relation to the maths in the context, which will involve revisiting relevant language.

It is important to understand the role of classroom talk in relation to this model. It would be easy to assume that talk sits within the *language* aspect of the model. But this is the very specific mathematical language and vocabulary used in connection with the experiences the children are having. The role of talk is to help the children make ***the connections themselves***. This talk can take the form of teacher questioning, demanding children make connections, children questioning concerning connections not seen, talk between children, and explanation of points of view etc. The verbal accompaniment to the children's experiences is what allows them to frame their understanding.

There is evidence from brain research that shows that connecting different representations of mathematics leads to more powerful learning. When students work with symbols, such as numbers, they are using a different area of the brain than when they work with visual and spatial information, such as an array of dots. Joonkoo Park & Elizabeth Brannon (2013) found that mathematics learning and performance was optimized when the two areas of the brain were communicating. Additionally, they found that training students through visual representations improved students' maths performance significantly, even on numerical questions, and that visual training helped the students more than numerical training.

Reference:

Derek Haylock and Anne Cockburn (1989), Understanding Early Years Mathematics, pp 2-4.