CONSTRUCTING AN UNDERSTANDING OF EARLY NUMBER

Alison Price
School Of Education, Oxford Brookes University

ABSTRACT

An understanding of how children learn the very early stages of mathematics requires us not just to look at the children's understanding but also the interaction that happens in the classroom as they learn. This paper discusses a single teaching session in a Reception classroom and analyses it from a social constructivist theoretical framework. In it I argue that the children can be seen to construct their own mathematical understanding and that knowledge of the social context in which they do so is crucial to our understanding of how they learn.

Introduction

I am currently involved in research into the relationship between the teaching and learning of the early stages of addition in the primary classroom.

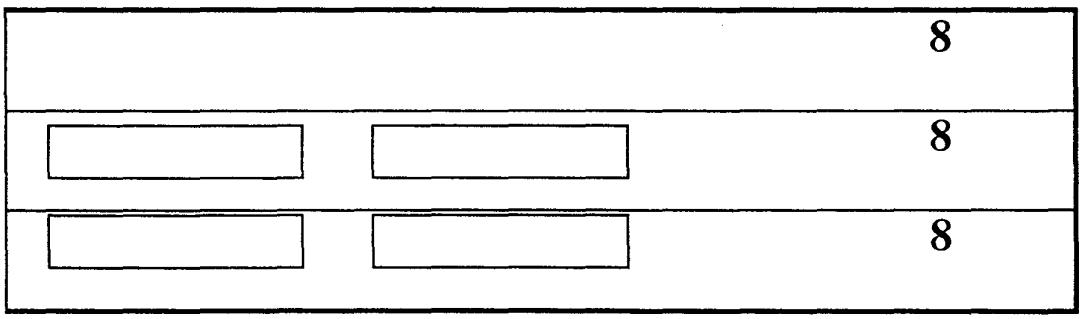
The following data was collected as a result of ethnographic observation in the classroom which consists of notes taken at the time and discussions with the teacher following the lesson.

I want to look here at the transcript of a teaching session from phase one of my data collection and discuss my analysis of what is happening, related to my own theoretical framework.

I am approaching my research from a social constructivist point of view. Because of this, I realise that my own view of social constructivism has been socially constructed and may therefore differ from that of others. I believe that children learn mathematics by constructing their own concepts through practical experiences, through the use of language and through interaction with others. I do not believe that there is a clear implication of this for teaching; there is no one social constructivist model of teaching, through some models may be based on constructivist theories. The actions of some teachers may however be described in these terms.

From this transcript I am attempting to describe the actions of both teacher and of the pupils in terms of such learning theory.

A group of five children were working with the teacher (Beth) in a reception class: Emma (5), Angela (5), Charles (4), Ian (5), Jacob (5). The rest of the class were working around them on other mathematical activities, some of them working with the classroom assistant and others working alone. The children were given a sheet something like:



Teacher- "I want you to choose eight multilink cubes and put them in your top set." Angela and Charles counted out the cubes singly saying the number words as they went; Emma took them one at a time but said nothing; Ian and Jacob put out a handful, counted them and then added the required extra cubes.

The children all understand what was meant by the teacher within the context of the lesson. They had previous experience of such activities and understood the language used by the teacher from their previous experience. They had used the 'multilink cubes' before, could count to 'eight' and understood the idea of a 'set' at least in terms of the box indicated at the top of the sheet.

However they had not done this actual task before so their actions cannot be described in behaviourist terms and the task involves a social understanding of both activity and language.

Teacher- "Can you put some of the eight in this set and some of them in this set?, indicating the appropriate places on the sheet, (the two rectangles on the middle row.)

There was a problem here since more than three bricks would not fit into the set rectangle drawn on the sheet. Angela fixed hers together in a square, Charles tried to squash his in, while the others let then spill out over the lines. All the children placed 4 in each set except Emma who had 3 and 5.

The children are being tightly controlled here in terms of teaching - the teacher specifying what she wanted them to do and where the cubes should be placed - yet the task is open ended in that she does not specify how many of the cubes to place in each set. They used all the eight cubes in the two sets which they were not specifically asked to do. Previous activities carried out with the teacher (making sets with smaller numbers of bricks but using a similar framework) have shown them that this is the social norm within this type of mathematics activity.

Later on the children might be expected to carry out a more open ended task e.g. 'how many different ways can you make eight?' but at this early stage they are not only being given opportunities to construct their understanding of the mathematics but also to construct further understanding of the accepted social aspects of the activity both in language and actions, which will be needed to complete further, more complex tasks.

With regard to the instruction to place the cubes *in* the sets Angela and Charles seem to want to comply literally while the others seem to understand that the lines are there to indicate separateness of the two sets but the placing is not crucial. Here the language used has a specific contextual meaning which differs from its literal use. If asked to place the cubes *in* a physical box (to tidy them away at the end of the session for example) a more literal interpretation if *in* would be expected. At no time did the teacher explain the word *in* had a different meaning in the two contexts, so without a social understanding of task and concept such distinctions would not be possible.

Teacher- "Now I am going to go round the group and everyone can tell me a number story, Jacob."

Jacob- "Four and four ... (hesitated)

Teacher- "altogether make ... "

Jacob- " ... altogether make eight."

lan- "Four and four altogether make eight."

Charles- "Four and four altogether make ten." (sic - not noticed)

Angela- "Four and four altogether make eight."

Emma- "Three and five altogether make eight."

The idea of a number story being an articulation of the calculation in words is again socially accepted in this class, while in other classes the expression 'number story' might mean putting the calculation in a context resulting in, e.g. 'if you had four pounds and got four more for Christmas then you would have eight pounds.'

Jacob is unable to complete his sentence unaided. Beth seems reluctant to complete it for him fully, perhaps because this would not allow him to show his understanding of equivalence. She therefore appears to scaffold the sentence for him by supplying the next expression but allowing him to complete the sentence himself. This not only enables Jacob to show his understanding but gives him a sense of achievement at completing the task.

Teacher- "So, everybody except Emma made 'four and four altogether make eight' and Emma made 'five and three altogether make eight'. Now ... I want you to change your number story now but to a different number story in the bottom sets."

Jacob made 6 and 2 and read it back correctly, Ian made 5 and 3 and read it back, Charles made 5 and 3 and read it as 3 and 5. Beth corrected him, insisting he read it from left to right.

Most of the children understand what was expected of them in terms of 'a different number story'. With Charles, Beth insists that he interpreted in words, the same sentence as he had in front of him with cubes. It was not that the number sentence he gave her (3 and 5 making 8) was mathematically incorrect but that it did not describe his model in the socially accepted way that mathematics, like writing in English, is read from left to right. This can be seen in terms of training or of enculturation. It would be possible to allow children to construct their own mathematical learning and record their maths from right to left. However it would be difficult for them either to communicate it to others or to make sense of other peoples written mathematics. Recorded mathematics is socially determined and we expect children to conform, just as we correct baby-words for their more socially understood equivalents.

Angela still had 4 and 4 since she had merely transposed the cubes to the opposite boxes.

In contrast to the others Angela does not seem to understand what is expected of her. She has constructed her own interpretation of the situation. She did move the cubes around, so that the cubes that had been in the middle left set were now in the bottom right and vice versa, but her emphasis seems to be on the cubes *per se* rather than the mathematics represented by the cubes. Her second model *is* different from the first but does not appear to Beth to represent a different number story.

Teacher- "It's still 4 and 4. Can you break it up and make it different?"

Angela removed one cube from the left hand set and hid it in her hand.

Angela- "Three and four together make eight" (very hesitantly) looked at the extra cube and put it back in the three but this time to make an L shape rather than a square, "Four and four together make eight."

Teacher- Can you change the bricks?" (Angela looks puzzled.) "Have a look at some of the others to see if it will give you a clue".

Angela repeats her procedure of removing one and counting the rest" 1 ,2,3,4,5,6,7." lan- (to teacher) "She needs one more."

Teacher- "Charles, can you help her? Angela, if you have 4 and 3 and it makes seven, how many more do you need?"

Teacher then goes round the table reiterating the number stories from each of the other children. Meanwhile Charles helps Angela to make 6 and 2.

Angela- "Six and two altogether makes eight."

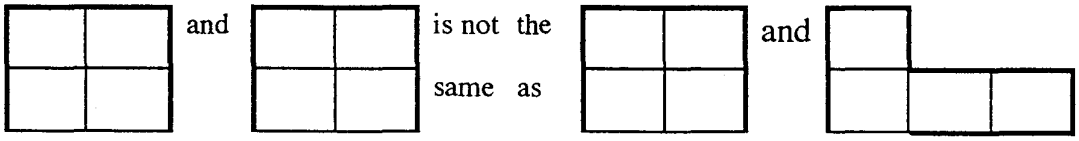
Teacher- "Is that right, have you got eight this time?"

Angela- (counting) "1,2,3,4,5,6,7,8."

It is as if the more that Beth emphasises the numbers the more Angela is concentrating on the cubes. Perhaps the fact that she had fixed the cubes together at the beginning, to form a square that would fit into the box, confused her. She seems to be concentrating more on the form and less on the quantity of cubes present. A casual observer might think that Angela did not understand the mathematics. Perhaps she does not understand that eight can be divided up in some other way to make a different sum. Student teachers often conclude that a child is 'slow' when he or she does not complete a task in the way expected.

Yet in fact Angela did nothing that could not be explained in terms of the language used by the teacher. Beth expected a different number story to be one with different combinations of numbers. But there are situations in which 4 and 4 could be different from 4 and 4. For example if there were four girls in a room and four boys came in it would be a different social situation from there being four boys in the room and four girls coming in. Both would be represented mathematically in the same way yet be socially different.

Also, it can be seen that



and this is even more noticeable when the cubes are different colours.

The processes of stressing and ignoring are key ideas in mathematics and children need time to learn which are the important characteristics and which unimportant in any situation. What Angela is doing here is stressing and ignoring in a different way to that expected by the teacher. That she did understand the mathematics is shown later.

Teacher- "So you've all made two number sums. Now I want you to make pictures of the bricks."
All the children were able to draw bricks in the sets and represent the sums below with numerals and + = signs. Angela did this extremely quickly.
Teacher- "Angela, can you show me any more way of making eight with your cubes?"
Angela- (rearranges cubes instantly and says) "Three and five".

Discussion

The learning that is taking place during this lesson can be described in different ways. The teacher, Beth, is using a model of mathematical teaching developed by Liebeck (1984) and known by the acronym ELPS. This model describes the learning of mathematics as having four elements with increasing levels of abstraction: experience, language, pictures and symbols. It relates to Bruner's three modes of learning - enactive, iconic, and symbolic (Bruner 1%7) - but emphasises the spoken language which is essential especially for young children. So the children are required to do and to talk about the partitioning task then record it in pictures and in symbols. The model is being used consciously by the teacher as she has learnt it during inservice training and believes it to be important for children's learning. However, Beth cannot clearly articulate her theory of learning. In conversation she talks both of the children not having' got it' which might indicate a transmission view, and of the way children don't always learn what you think they are going to - more of a constructivist view.

A behaviourist view of learning could account for the fact that the children comply with the teacher's expectations - they have learnt to do it that way before. It cannot, however, account for Angela's *misunderstanding* except perhaps in terms of deviance, since Angela is neither doing what she has been asked, nor what she can see the others doing. Neither does it explain the fact that the children are able to work with eight bricks in a way that they have previously done only with smaller numbers. The children are showing understanding of a situation in which they have not been before.

A Vygotskian view of learning (1987), the concept of the zone of proximal development and resultant scaffolding of tasks (Wood et al. 1976, Wood 1988), requires a very close relationship and understanding between the child and teacher. This is difficult to do in a class of 38 children and indeed some writers (Bliss et al. 1996) have concluded that scaffolding seldom occurs in classroom settings. However there are times in the classroom where a child shows some clear evidence of his or her thinking or ability and the teacher is able to move them on. Jacob showed that he was able to understand the ideas of a number sentence represented by his model but was unable to fully articulate it. Beth scaffolded his answer by giving just sufficient help to enable him to complete the task which he was unable to do unaided.

A constructivist view goes further in accounting for the children's ability to assimilate this new situation in the light of what they have learnt in previous lessons. It also goes some way to explaining how Angela constructs her own understanding, one that is so different from the others. Children will construct their own concepts in ways that are meaningful to them but cannot necessarily be understood

by those, especially teachers, who would wish it otherwise. What a radical constructivist (von Glasersfeld 1995) view does not explain is what factors might affect the formation of such alternative conceptions. Social constructivism, by adding all the elements of the social context of learning can, I believe, begin to explain some of these.

• Firstly, we have seen how the children's learning was influenced by the social context of the classroom - the children knew what sort of behaviour was expected of them through a process of enculturation and were corrected when their speech or actions did not conform.

• Secondly, we have also seen how alternative interpretations of the language and specific words used can alter a child's understanding of the mathematics, even though the words which caused confusion in this incident were not mathematically complex but words such as 'in' and 'different' used in everyday life. Language is itself a socially accepted construct the complexity of which children, especially young children, are still coming to understand.

• Thirdly, although mathematics is essentially an abstract concept it has to be modelled, to be situated in some way in order to be understood and learnt. This modelling requires physical or situational contexts which, while helping to explain the mathematics, can also confuse the learner with unnecessary 'noise'.

An awareness of these social aspects of learning gives us, as teachers, some insight into the sorts of issues that help children learn but also those that may be confusing children. Attention to these issues may help us to be more aware so as to provide a range of activities and use a range of language that will allow children to develop more easily the socially accepted norms of mathematics as well as the underlying mathematical concepts.

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