

SOME PROBLEMS IN RESEARCH ON MATHEMATICS TEACHING AND LEARNING FROM A SOCIO-CULTURAL APPROACH

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It is not my intention in this paper to argue for a socio-cultural perspective on mathematics education (see Lerman, 1996) but to examine some of the problems that one faces in research from that perspective. The international group for sociocultural research held its second meeting in Geneva earlier this year (1996) and there is a growing body of research from that group and from its members. In the UK in mathematics education I believe that we have little experience (with some notable exceptions, e.g. Solomon 1989; Nunes & Bryant 1996) and my intention here is to open a discussion about the problems of designing and carrying out sociocultural research. By 'socio-cultural' I am referring to theories which argue that social and cultural forces are *constitutive* of human consciousness not merely *causative* (Smith, 1993, p. 128). In particular, but not exclusively, I will refer to the work of Vygotsky and followers when outlining the theoretical issues that sociocultural research attempts to address in mathematics teaching and learning. It is perhaps more appropriate to describe Vygotskian research as historical-cultural rather than socio-cultural in order to emphasise phylogenesis: "The fossilized form is the end of the thread that ties the present to the past" (Vygotsky 1978, p. 64).

1. Dynamic research on learning

Learning is a constantly shifting, unending process. Vygotsky defined the zone of proximal development as the gap between what a child can do on her or his own and what she or he can do with, for example, a teacher. In order to gain a picture of what a child knows one has to take account of this. The problem is complicated by the fact that learning is different at different times and in different forms. The learning activity constitutes the zone of proximal development, the zone is not something pre-existing, attached to each child like a force-field or like a framework (a scaffolding) to lead a child from what she knows to what the teacher wants her to know (Meira & Lerman, forthcoming). Therefore any test or evaluation will provide just a snapshot of part of what children know in that/those context(s).

What is needed is some kind of dynamic research methodology which allows us to look at learning as it takes place and looks towards its future.

2. Situated meanings

Mathematical meanings are situated in practices. Contexts used in the mathematics classroom or in textbooks, or mathematical knowledge (as seen by mathematicians) in outside school social practices, particularly work ones, drawn into the classroom create particular problems for teachers and for research (Boaler, 1996). Further, as Evans's research has shown (1994), contexts call up different practices for

people and meanings can shift along chains of signification, they can break away from where they begin and certainly from what is intended by the teacher. They put what the teacher intends 'at risk'. Thus students can perform differently in different situations. We need to take account of contexts, of transfer into the classroom and from school mathematics to outside practices, and of shifts of meanings, when researching mathematics teaching and learning.

3. Multiple voices

Vygotsky's formulation of human consciousness as appearing first on the social plane and only afterwards on the individual plane roots the individual's consciousness in cultural domains. But these domains are multiple, including gender, ethnicity and class. At different times and in different situations, people will feel themselves to have voice or to be denied voice. At the micro-level of children working together on mathematical tasks, this structures the interactions and knowledge construction of the group (e.g. Brodie, 1995). In research (and in teaching) we would want to enable powerlessness and powerfulness to be articulated and to take account of it.

4. Reflexivity

It is not new to say that the researcher inevitably affects what she or he is studying. Not only can one not be a fly on the wall, chaos theory implies that the fly might cause a storm on the other side of the world! There are yet more levels of reflexivity than this. As a researcher I am trying to understand what learning is, that is I am trying to learn about the situation I am observing, which is a situation in which children are trying to learn mathematics and the teacher is trying to learn about teaching. What is more, the researcher's theoretical assumptions about learning frame the perspective on the process in which she or he is involved.

5. Individual/social dialectic

Vygotsky called one of his books "Language and Thought", emphasising the dialectic of language, which is firstly social, and thought which is the individual's (though no less social in origins). Any learning activity is constituted by the actors and their scripts and particularly the teacher and her or his mathematical script, in the social structure of the classroom. How can research take account of all that? We might usefully say that focusing on the individual foregrounds thought, whereby we must take account of the background, and similarly focusing on the social setting foregrounds language and communication, but we must take account of the individuals.

6. Semiotic mediation of cultural tools

Vygotsky drew on the Marxist notion of material tools transforming the world and people to talk about cultural tools. These too construct the world for people and people are constructed through them, they mediate consciousness. The

transformation is mutual and dialectic. The mediation of cultural tools has been studied through the effects of sign systems (e.g. Luria, 1976; Nunes & Bryant 1996) and the way they structure and regulate thought. Another approach has been to draw on the semiotics of Peirce, together with a theoretical formulation of development from Vygotsky, to build a Developmental Semiotics to study meanings and their growth along lines of increasing sign-sign foregrounding in mathematics (Vile, 1996). The notion of cultural tools emphasises the role of the teacher who represents culture in the classroom, specifically in this instance mathematical culture. We might wish to use long-term studies in order to examine the effect of the mediation of cultural tools.

7. Spontaneous and scientific concepts

It is ironic that Vygotsky's method, offering a view of consciousness as constituted in cultural and social practices, should have opened up the possibility of multiple voices when at his time (post-October revolution) and in his place (Russia) he saw development as being from pre-literate to literate, from backward to advanced culture, as a single line of social progress. It is ironic but it is not surprising, given his method. Interpreting his spontaneous/scientific distinction today, the task for researchers (and, again, for teachers) is to recognise the differences and work with them. Contrary to other formulations, for Vygotsky spontaneous concepts don't die, and are not simply subsumed into more advanced concepts, they are raised to a level of consciousness and scientific concepts made concrete so that they confront each other. An example from teacher education: in an attempt to engage student teachers, in the final year of their course, with their still unchallenged assumptions about the role of the teacher, Crawford & Deer (1993) devised an activity in which the students had to work in groups to develop a programme of mathematics which was centred on the children's environment, rather than a prescribed syllabus. The students found this very hard and experienced: "initial ecstasy, shock of recognition, crisis, realism and commitment" (p. 116). The outcome was at least a recognition by the students of having a wider range of skills upon which to draw and in many cases new-found confidence in their ability to create "a very different learning environment ... from the one that they had experienced themselves" (p. 118). Elsewhere Crawford writes:

The course was designed to create a "zone of proximal development" for student teachers as a way of expanding their knowledge of the dialectic process of teaching and learning through conscious experience of the process. They were engaged in a learning activity. (Crawford, 1994 p. 6)

Another perspective, perhaps complementary, is that of splitting: notions of a half, as in "Your half is bigger than mine" are confronted with the mathematical notion of a half, and these two meanings are separately contextualised. Fischbein's work (1991) similarly points out that intuitions (a 'six' occurs less often than other

numbers when a die is thrown) exist side by side with theoretical mathematical knowledge. Research needs to uncover the spontaneous concepts in examining the learning of scientific (mathematical) concepts.

Research

I have listed and discussed briefly elements that might frame methodology. One wants to incorporate all these, and perhaps other, elements when researching from a socio-cultural perspective. But one can't do it all.

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