Methodological implications for researching mathematical thinking as a socially organised phenomenon

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Aims of the symposium

The project *Teaching and Learning – Mathematical Thinking*[1] has been seeking to develop and integrate theoretical approaches to the study of aspects of school mathematics (reported at MES2, see Carreira *et al.*, 2000). The theoretical approaches we have utilised have in common a focus on the socially organised nature of thinking as it is embedded in social practices. An important part of the project has been the attempt to apply our theoretical concepts to study empirical data. This has raised a number of methodological issues. The aim of this symposium is to share and discuss these issues, considering the methodological implications of adopting a theoretical position that sees mathematical thinking as socially organised.

Rationale

Our work on the project *Teaching and Learning – Mathematical Thinking* has involved bringing together a number of different theoretical perspectives and attempting to apply them to study aspects of school mathematics. This way of working has brought into focus the problem of relationships between theory and methodology. We outline here a number of issues and questions, relevant more broadly to research adopting similar social perspectives.

Identification of the research object

At the beginning of the project, we chose a number of substantive aspects of school mathematics teaching and learning on which to apply the developing theory. In reflecting on the processes of research, the question is raised: how is the research object (e.g. transfer, assessment, emotion, mathematical thinking) identified? The 'problem' is present (that is, it is named) in the field of mathematics education research but it does not actually become a research object until we bring theory to bear on it. We must ask, therefore, what is the role of theory in constructing the object of research.

Given our focus on the social organisation of phenomena in mathematics education, it is only consistent to ask also about the ways in which specific

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practices of research in general, and of mathematics educational studies in particular, influence the construction of the research object and the ways in which the theoretical is linked with the empirical. In addressing this question it may be useful to categorise different kinds of theory, for example, metaphors, conceptual models, or what Maton (2000) calls theories orientated to knowledge or to the knower. This also raises the issue of the relevance of questions about the relationships between participants in research practices and the identification of the research object, that is, questions such as: Who identifies and defines the research object? To what extent is it the researcher's research object and how are other participants in the community (of mathematics education, education, research, etc.) present in its definition? How are the participants and the educational structures affected by the research and how is their voice heard?

We also wish to consider the extent to which the context needs to be taken into account at this and other stages of the research process. What do we need to know about the educational system or, indeed, the national political and social contexts of the practices we study? At the other extreme, what do we need to know about the circumstances and history of individual participants? Answers to these question will be closely related to the theories deployed and the conceptualisation and operationalisation of the research object. Thus, applying a situated approach requires knowledge, or a judgement, about what are the relevant communities of practice, as seen by the researcher and/or the participants. Applying a discursive approach requires knowledge of, or a conjecture about, the discourses at play in the system at the time of the research. Applying a psychoanalytic dimension, say in the study of emotion, makes it desirable to know, or to enquire into, something of the subject's history. The theoretical approach is likely also to affect the production and the analysis of data as well as the identification of the research object.

The selection and production of data

As the project's aims were primarily theoretical, we have not designed and conducted new empirical studies. However, in order to test the viability of our theories – and to help us to develop them – it has been important to engage with empirical data. This data was selected from that which was already available to members of the project team and was originally collected for rather different purposes (see, for example, Morgan, Tsatsaroni & Lerman, forthcoming). We have made use of data produced prior to the theoretical identification of the research object and have had to consider how this may be justified and accounted for.

The general issue here is the extent to which the identification of the research object determines the kinds of data that need to be produced and used. Data are not neutral 'true' records of an absolute reality but are produced through processes of selection and framing. They are thus produced anew with every specific research problem and object of enquiry. The data that we have re-used are thus in some sense changed by being used in different ways. But even

allowing for these processes still leaves some space for the practical issue of what data are appropriate to produce in order to address a specific research question. What are the criteria for appropriateness of data?

Further, recognising the ways in which engagement with the empirical may serve to develop the theoretical, we need to consider how the production of data may play a part in the definition of the research object. Does identification of the research object necessarily precede the selection and production of data?

Most of the questions related to the selection and production of data that we have identified are equally relevant for research undertaken with many different theoretical standpoints. Our assumption that mathematical thinking is a socially organised phenomenon raises particular issues about the production of data. A basic question for us has been: is 'naturalistic' data (to whatever extent it is possible to produce this), gathered while participants are engaged in the social practice of interest to the research, more useful than data produced in, for example, interviews where participants are engaged in the practice of interviewing?

Data analysis

The challenge for our project and for other researchers is to use theory systematically and explicitly to interrogate the empirical in a way that may lead not only to *learning* something about the empirical/social world but also to the refinement and *development* of the theory. We must therefore engage with questions about the relationship between development of theory and learning about the empirical/social world and differences there might be when these questions are considered from different theoretical perspectives.

Few would argue that it is possible to look at data in a way that is not theory-laden. However, this does not mean that methods of analysis should be *completely prescribed* by the theory that is in use at any moment. We may well need some epistemological and/or methodological principles that are *prior* to the theory or theories in use – particularly in a research area such as mathematics education where theories proliferate. This need applies with even more force in a research programme such as ours, where we have consciously put forward and developed four theoretical perspectives. Or could this problem be covered by making reference to good research practices that are characteristic of a 'developed' field of study? The notion of the need for 'systematic' methodological principles is well established. For example, seeking disconfirming as well as confirming cases is accepted by both quantitative and qualitative researchers. Nevertheless, it is interesting to ask how each theoretical perspective conceives of, and addresses, the issue of 'systematicity' (e.g. Bernstein, 2000).

To summarise

We can understand the 'identification' of the research object as involving a three-stage process (although it is possible that, when adopting some theoretical perspectives, the three stages overlap): (i) the *conceptualisation / elaboration* of

the named problem in terms of the theory; (ii) the provisional choice of research strategy(ies) (e.g. primary vs. secondary, structured vs. unstructured, direct vs. indirect, etc.); (iii) the operationalisation of the concepts elaborated using the theory, in the sense of systematically setting down the conditions under which the researcher will recognise in empirically descriptive terms the presence or absence of the research object, or the gradations and quantities of its characteristics (Bernstein, 2000; Moore, 2001).

In the project we have struggled with many of the questions identified above and have become aware of others as we have worked to develop theory and methodology to allow us to study mathematical thinking as a socially organised phenomenon. In the symposium we intend to share some of the outcomes of our struggles. We do not expect to be able to address all the questions outlined above but hope to contribute to methodological debate among mathematics education researchers who are engaging with similar issues.

Structure of the symposium

The symposium will consist of two sessions:

Session 1: We will start by describing and reflecting on some of the specific methodological issues we have encountered during our work in the project *Teaching and Learning – Mathematical Thinking*. The focus of discussion will be on the relationships between theory, the identification of the research object, and the collection of data.

Session 2: This session will address relationships between theory and methodology in a more general way. There will be opportunities to discuss questions related to data analysis and to follow up issues raised by participants.

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