

## **MATHEMATICS EDUCATION - 'A FIELD IN DISARRAY '?: THE STORY OF A SEARCH FOR A METHODOLOGY**

Alf Coles

Kingsfield School, South Gloucestershire and University of Bristol

*In this paper I review some recent reviews of mathematics education research, which seem at first sight to confirm a judgement by Steen (1999) that it 'is a field in disarray'. As a PhD student, looking at competing methodologies there can seem a bewildering complexity from which to choose. It appears that there are relatively few (three to five, depending on authors) theoretical perspectives or paradigms that guide the field, but a plethora of methodologies that can be used with them. One thing I realise would help me, is if authors were explicit about the 'not's' of any approach they use. In this vein I reflect on my own use of enactivist methodology, and its affordances and constraints.*

### **ON RESEARCH METHODOLOGIES**

A mathematics professor (Lynn Steen), asked to review a 1994 ICMI study into the purpose of mathematics education research, concluded: 'it is a field in disarray, a field whose high hopes for a science of education have been overwhelmed by complexity and drowned in a sea of competing theories' (Steen, 1999, p.236).

I am one year in to a PhD study, whilst also part of an on-going collaboration with Laurinda Brown (10 years and counting) which has resulted in many research papers and projects. Our collaboration began with me as subject of Laurinda's research. Although this quickly shifted to co-research, Laurinda obviously came to this work with well thought through ideas about her epistemological stance, theoretical frame and methodology. I found these ideas made sense and helped me develop my practice as teacher and researcher. To some extent, therefore, I have been shielded, until now, from the overwhelming complexity referred to above by Steen. However, the onus, as part of a PhD, to account for every choice I make, has returned my attention to issues of methodology; and overwhelming it is!

To help me get a sense of the range of approaches taken in the field - what I had to choose from, if you like - I embarked on a review of reviews of mathematics education in the Journal for Research into Mathematics Education (JRME) and Educational Studies in Mathematics (ESM); which I take as being the two leading research journals in the field.

In a review of articles in JRME, Schoenfeld (1994) reports that in 1973 almost all articles used a quantitative, statistical methodology. In 1983 one third of articles were not statistical, and by 1993 well over half used non-statistical methods. At the start of the 1980's 'educational researchers found themselves emerging from a methodological straightjacket into a Pandora's box of opportunities and problems' (ibid, p.708).

In a review of papers in ESM (Lerman et al, 2002) it is clear that the range of approaches to tackling problems in mathematics education continued to increase between 1990 and 2001. Lerman et al identified what methodologies researchers used in a sample of ESM papers. They reported on 43 studies in total (p.36) and found among them there were 26 different theoretical perspectives.

Despite the multiplicity of methodologies clearly in circulation, some reviewers have been able to classify all approaches into two or three categories. Lester et al (1979) suggested there is a continuum between experimental (laboratory-type) studies and non-experimental (naturalistic) studies and, at that time, called for more of the latter. This echoes distinctions made many years later e.g.: 'long-term observation and experience' compared to 'specially mounted studies' (Sierpinska et al, 1993, p.277); experimental, and descriptive research (Carnine & Gersten, 2000); research done 'on classrooms rather than *in* classrooms' (English, 2003, p.225).

While, no doubt, these authors would not coincide exactly on how they would classify any particular study, there does seem some broad agreement here between at least two distinct approaches to education research.

Ernest (1997) distinguished three paradigms of research in mathematics education; scientific, interpretative and critical theoretic (p.37), whilst suggesting that the last two categories could be seen together, which would leave a dichotomy between scientific and interpretative/critical paradigms.

So, there seems to be some agreement here, at least; all the reviews I have found contrast a scientific or experimental conception of research ('which locates uncertainty exclusively in the immediate object of inquiry', (Ernest, 1997, p.38)) with an interpretative or critical notion ('which problematize[s] the relationship between the knower and the known', (Ernest, 1997, p.38)). Ernest (1997) gives one way of locating this difference as whether the researcher(s) acknowledge any reflexivity in their study. (I take 'reflexivity' to mean the belief that humans play an active role in creating knowledge or meaning.)

I am pretty comfortable accepting this basic reflexive turn. What counts for me as a perception depends on my history. Such belief places me *out* of Ernest's 'scientific' category, but within the interpretative/critical category I am left with: interactionism, poststructuralism, social constructivism, postmodern constructivism, critical theory, feminist theory, ethnomethodology, auto-ethnography, hermeneutic phenomenology, to name but a few ... where to begin! Steen's (1999) sense of the overwhelming complexity in the field of mathematics education research was perhaps ringing true.

## **WHAT IS A METHODOLOGY?**

It seemed useful, at this point in my search, to explore briefly the wider social science literature on methodology, to see what approaches are commonly used. I first followed up a reference suggested to me on a linguistic ethnography course I attended; Crotty (1998), in writing on the foundations of social science research,

distinguishes four nested elements (p.2) to any study, that inform one another, but which he felt need to be differentiated. The four elements are:

- methods - what procedures I will use for gathering data (e.g., sampling, questionnaire, interview, case study, narrative, conversation analysis)
- methodology - what research process I plan (e.g., ethnography, grounded theory, phenomenological research, action research, discourse analysis)
- theoretical perspective - what philosophical stance grounds this research process (e.g., positivism, interpretivism, critical theory, postmodernism)
- epistemology - what theory of knowledge is embedded in the theoretical perspective (e.g., objectivism, constructionism, subjectivism)

This terminology seemed to fit, broadly, the use of words in mathematics education. While Ernest (1997) uses 'paradigm' as synonymous with 'theoretical perspective', Crotty & he put similar labels in this category. Interestingly, for Ernest, theoretical perspectives entail epistemologies rather than the other way around (as Crotty has it). Lerman et al (2002) call their distinctions methodologies and theoretical fields interchangeably; from their list of fields it seems Crotty and Ernest would call them methodologies. Carnine and Gersten (2000) call both 'descriptive' and 'experimental' types of research design, which I take as synonymous with methodology - making these labels consistent with the other authors' usages.

So, there seems some useful language here. There are a relatively few theoretical perspectives/epistemologies and a plethora of methodologies. There is debate about the issue of 'paradigm commensurability', i.e. whether *any* methodology can be used with *any* theoretical perspective or whether some are incompatible. Again in the wider social science literature, Lincoln and Guba (2000) conceive of a continuum of five paradigms: positivism, post-positivism, critical theory, constructivism, participatory (p.170); each with characteristic methodologies, which are generally compatible with positions close to them. Indeed, the very fact that there are more methodologies than paradigms indicates, at least for the researchers who use them, that many methodologies can be consistent with the same paradigm.

In helping me decide on a theoretical perspective and methodology, what I realised I wanted was a statement of the affordances and constraints of each approach. Researcher reports, e.g. in JRME and ESM, are generally meticulous in laying out the positive reasons why they have chosen certain perspectives but silent about what these approaches leave out. In reflexive spirit, the place to start addressing this issue must be questioning the principles behind research I have been involved in myself.

## **REFLECTING ON MY OWN PREVIOUS RESEARCH**

The principles governing the research Laurinda Brown and I have done come under the heading of enactivism (Varela et al, 1991). One thing my recent journey through mathematics education literature has made me realise is that enactivism has epistemology, theoretical perspective, and methodology, all rolled in to one. I will

attempt to set out what some of these research principles are and, in keeping with the issue raised at the end of the last section, indicate some of the 'not's' of this approach.

## **Methodology**

From an enactivist standpoint, what I perceive is not a pre-given world that I can attempt to gain clearer and clearer access to. I cannot separate myself out from what I perceive due to the fact that my human-ness and my personal history (of acting in my environment) have shaped what, for me, counts as a perception:

'In the enactive approach reality is not a given: it is perceiver-dependent, not because the perceiver 'constructs' it as he or she pleases, but because what counts as a relevant world is not separable from the structure of the perceiver.' (Varela, 1999 p.13)

For enactivist research therefore: 'It can be said that there is no data, only interpretations and interpretations of interpretations.' (Reid, 1996 p.206).

One implication of such a belief is that multiple perspectives need to be taken of any data; usually by more than one researcher interrogating the same data for different purposes. Detailed discussions of data, based around such multiple views, form one of the core activities of enactivist research.

Whilst enactivism is interested in theory building, these are not theories aimed at arriving at the truth of the matter, or aiming to be final and 'best'. They are theories that are 'good enough for' (Reid, 1996, p.206) their users, and they survive for as long as they serve a purpose.

One constraint, for some, of such an approach to the process of data collection is that, beyond a structure for meetings, interviews, observations, etc, little can be pre-determined about the outcomes of enactivist research. There is a continual interaction between theory and data and, as such, what arises, and what needs to be done next, depends on what has just occurred.

## **Theoretical perspective**

The essence of the enactivist world-view is that all living beings are self-organised systems continually engaged in a process of maintaining a relationship with their environment whilst pursuing their own intentions and purposes. Human perception is not the passive receipt of inputs that cause certain effects and result in certain actions (which it is perhaps 'naturally' taken to be). Rather, from an enactivist viewpoint, aspects of the environment relevant to the interests and intentions of a human are pre-selected for conscious attention; there is increasing neurological evidence that this is indeed the case (e.g., see Ellis, 2005, p.2). This approach is consistent with ideas under the label 'embodied cognition'.

The 'not' of the enactivist theoretical perspective is, perhaps, that it does not take an *explicitly* critical stance towards research, if, by critical, is understood: 'the desire not just to understand or to find out, but to engage in social critique and to promote social and institutional change to improve or reform aspects of social life' (Ernest, 1997,

p.16). Institutional change may well be one desired result of enactivist research, but, in my experience, that is not an explicit aim. Linked to this, enactivist research has little to say about power relations e.g., in a classroom; typically choosing instead to focus on the detail of how such relations are displayed.

## **Epistemology**

It may seem, given the foregoing discussion that, from an enactivist standpoint, knowledge is impossible. This is not the case but, what counts as knowledge cannot be separated from my on-going self-organisation and relationship with my environment. From an enactivist standpoint: 'All doing is knowing and all knowing is doing.' (Maturana and Varela, 1998 p.27) or to put it another way, knowledge is effective action and 'is the result of an ongoing interpretation' (Varela, et al, 1991 p.149).

This conception of what constitutes knowledge may seem too 'weak' for some theorists, particularly in its uncoupling of the notion of knowledge from 'truth'. For Maturana, truth can only be assigned after the event. In the moment of perception/action I cannot tell if I am mistaken. Indeed the whole concept of a mistake implies that I held as true something that turned out to be false - i.e. that, 'in the moment', truth or falsehood was not a part of my perception.

Enactivist epistemology also explicitly rejects any 'representational' models or theories of mind and consciousness.

## **HOW DO WE REPORT ON METHODOLOGIES?**

Reflecting on my own research principles makes me realise that I am actually more interested in the detail of what researchers *do* than their theoretical perspective. It seems easy to align oneself to e.g., social constructivism or embodied cognition but what does that mean in practice? I would find it useful to read far more of the detail of how researchers analyse their data, for example. How do we use ourselves when e.g., sitting at the back of a classroom, or listening to an audio recording? I am reminded of Dick Tahta (personal communication) talking once about the 'psycho-analytic turn' in which one becomes more interested in why it is individuals take certain ideas as truth than in the actual truth they are expounding. The question changes from: 'What is true?' to 'What is it in our histories or experiences that make certain ideas, methods or explanations appealing to us?'. It is perhaps unsurprising that I am finding myself increasingly drawn to narrative approaches to research and feel increasingly that accounting for what in our own histories has drawn us to certain ideas, approaches or interests is crucial in being able to interpret each others' work.

Thank you to the participants of the day conference for your discussion of ideas raised in this paper. There does seem a tension between the desire on the one hand for a standard set of approaches and assumptions that might lend our research greater credibility, and on the other hand the sense in which research positions themselves

are part of our personal narratives and so necessarily diverse. I would welcome further feedback or continuing discussion, via [alf.coles@gmail.com](mailto:alf.coles@gmail.com).

## REFERENCES

- Carnine, D. & Gersten, R. (2000) The nature and roles of research in improving achievement in mathematics, *Journal for Research into Mathematics Education*, 31(2), 138-143.
- Crotty, M. (1998) *The foundations of social science research* (London, Sage Publications)
- Ellis, R. (2005) *Curious emotions* (Amsterdam, John Benjamins Publishing)
- English, L. (2003) Reconciling theory, research, and practice: A methods and modeling approach, *Educational Studies in Mathematics*, 54, 225-245.
- Ernest, P. (1997) The epistemological basis of qualitative research in mathematics education: A postmodern perspective, *Journal for Research into Mathematics Education. Monograph*, 9, 22-39+164-177.
- Lerman, S., Xu, G. & Tsatsaroni, A. (2002) Developing theories of mathematics education research: The ESM story, *Educational Studies in Mathematics*, 51, 23-40.
- Lester, F. & Kerr, D. (1979) Some ideas about research methodologies in mathematics education, *Journal for Research into Mathematics Education*, 10(3), 228-232.
- Lincoln, Y. & Guba, E. (2000) Paradigmatic controversies, contradictions, and emerging confluences, in: Denzin, N. & Lincoln, Y. (Eds) *Handbook of qualitative research* (London, Sage Publications)
- Maturana, H. & Varela, F. (1998) *The tree of knowledge* (Boston, Shambala)
- Reid, D. (1996) Enactivism as a methodology, *Proceedings of the Twentieth Annual Conference of the International Group for the Psychology of Mathematics Education*, Valencia, 4, 203-209.
- Schoenfeld, A. (1994) A discourse on methods, *Journal for Research into Mathematics Education*, 25(6), 697-710.
- Sierpiska, A., Kilpatrick, J., Balacheff, N., Howson, G., Sfard, A. & Steinbring, H. (1993) What is research in mathematics education, and what are its results, *Journal for Research in Mathematics Education*, 24(3), 274-278.
- Steen, L. (1999) Theories that gyre and gimble in the wabe, *Journal for Research into Mathematics Education*, 30(3), 235-241.
- Thomson, E. (2007) *Mind in life: Biology, phenomenology, and the science of mind* (Massachusetts, Harvard University Press)
- Varela, F., Thompson, E., Rosch, E. (1991) *The embodied mind: Cognitive science and human experience* (Massachusetts, MIT Press)
- Varela, F. (1999) *Ethical know-how* (Berkeley, Stanford University Press)