TEACHING DEVELOPMENT THROUGH CLASSROOM RESEARCH
AND ITS RELATIONS WITH/TO "DESIGN RESEARCH"

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Design Research is a term being used to describe forms of research that 'design' classroom activity to enhance learning and study its evolution and outcomes. I have become interested in how design research contributes to teacher learning through teachers' involvement in the research process. This short paper explores, at a very elementary level, potential relationships between design research and research into mathematics teaching that has resulted in developments in teaching and knowledge about teaching.

I believe that, in mathematics education, we have two main research aims:

1   To enhance *knowledge* in the field:
     knowledge about mathematics, learning mathematics, teaching mathematics, doing research in learning mathematics …

2   To enhance *practice* in the field:
     to enable *better* learning and teaching of mathematics, *better* researching …

In a special issue of Educational Researcher devoted to papers on design research, The Design-Based Research Collective (2003) write

> Educational researchers, policymakers, and practitioners agree that educational research is often divorced from the problems and issues of everyday practice – a split that creates a need for new research approaches that speak directly to the problems of practice … and lead to "usable knowledge" (p. 5)

This portrayal of the US educational scene accords with an accusation addressed to educational researchers in the UK by David Hargreaves in his 1996 TTA lecture. This suggested that educational research in the UK was having little impact on schools, classrooms, teaching and learning, and that a new agenda was required to bridge the 'gap' between research and practice. The authors in the special issue propose *design research* as a means of addressing these issues. Kelly (2003) talks of "an emerging research dialect" contrasting with dialects of *confirmation* or *description,* with, respectively, 'grammars' of randomized testing or ethnographic description, involving

> attempts to support arguments constructed around the results of active innovation and intervention in classrooms. The operative grammar, which draws upon models from design and engineering, is generative and transformative. It is directed primarily at understanding learning and teaching processes when the researcher is active as an educator. (p. 3)

In an editorial of the Journal of Mathematics Teacher Education (2003), Terry Wood and Betsy Berry suggest a characterization for design research:

- First, a physical or theoretical artifact or product is created.

    - For the researcher/teacher educator the product being developed and tested is the professional development model itself.

    - For the teacher, the product that they design and study is specific to their students and might be an assessment tool or strategy or implementation guideline for a particular mathematics lesson, and so forth.

- Second, the product is tested, implemented, reflected upon and revised through cycles of iterations. The model is dynamic and emergent as the process progresses.

- Third, multiple models and theories are called upon in the design and revision of the products.

- Fourth, design research of this nature is situated soundly in the contextual setting of the mathematics teachers' day-to-day environment, but results should be shareable and generalizeable across a broader scope.

- Fifth, the teacher educator/researcher is an interventionist rather than a participant observer in a collaborative, reflective relationship with the teacher(s) as the professional development model evolves and is tested and revised.

Before saying more about design research, I will sidestep to consider research with which I have been associated for some years and concepts and issues with which I am concerned as a mathematics educator.

Co-learning

Over the years, as practitioner (teacher educator) and researcher, I have come to see the concept of co-learning as central to improving teaching and the corresponding enhancement of learning. Its importance is captured in the following words from Wagner (1997)

> In a co-learning agreement, researchers and practitioners are both participants in processes of education and systems of schooling. Both are engaged in action and reflection. By working together, each might learn something about the world of the other. Of equal importance, however, each may learn something more about his or her own world and its connections to institutions and schooling. (p 16)

I will mention briefly a number of research studies in which teaching and its development have been the focus of research and in which teaching has been seen to develop. Although co-learning was not an explicit concept in the earlier studies, I see them all as examples of co-learning for all participants, leading to developments in teaching and learning.

1   An ethnographic study of mathematics teachers' investigative teaching approaches leading to a theoretical construct, the teaching triad (Jaworski, 1994). Teachers indicated that the researcher's questions – seeking to know more about teachers' thinking and motivation for planned activities and classroom decisions – led to their deep engagement with issues of practice and in changes to practice. Evidence came both from interviews and observations of teaching.

2   The Mathematics Teacher Enquiry Project – a study of teaching development resulting from teachers' own classroom research (Jaworski,1998). Here teachers were invited to ask and explore their own questions relating to issues in learning and teaching mathematics. Research showed that teachers' enquiry, in collaboration with other researchers, led to enhanced thinking and developments in teaching.

3   Collaboration between teachers and researchers to study the use of the teaching triad as a developmental tool, while using the triad to analyse teaching (Potari and Jaworski, 2002), led to deeper understandings of the teaching triad as tool for teaching development as well as for analyzing and understanding teaching complexity.

4   A study (still in progress) of teachers engaged in BPRS research and the learning of teachers and researchers through HEI mentoring relationships led to developing understandings of the contribution teacher research can make to teaching development and the value of research relationships across school/HEI boundaries1.

In these studies, 'design' was *implicit* to some extent: for example, in [2] and [4], teachers designed their own enquiry through questions about learning and teaching that were refined at successive stages. In [3], research might be seen as designed to explore the use of the teaching triad as a tool for research and development. However, none of the studies were set up or carried out, as design studies in the sense of Wood and Berry's characterization above. Of central importance in these studies is that the research itself was a tool in teacher and teaching development; that as a result of teachers' engagement, knowledge grew and teaching developed. A framework to analyze these processes is in progress (Jaworski, in press). I am interested in how the concept of 'design' might enhance growth of knowledge in teaching, and hence developments in mathematics teaching and learning.

Some examples of Design Research

Cobb, Confrey, diSessa, Lehrer and Schauble (2003) offer some examples of design 'experiments':

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[1] BPRS: Best Practice Research Scholarships, awarded to teacher applicants by the UK government Department for Education and Skills (DfES). HEI – Higher Education Institution: typically a university department of education.

- One-on-one (teacher-experimenter and student) design experiments in which a research team conducts a series of teaching sessions with a small number of students … to create a small-scale version of a learning ecology so that it can be studied in depth and detail … .

- Classroom experiments in which a research team collaborates with a teacher (who might be a research team member) to assume responsibility for instruction … .

- Preservice development experiments in which a research team helps organise and study the education of prospective teachers … .

- In-service teacher development studies in which researchers collaborate with teachers to support the development of a professional community … .

- School and school district restructuring experiments in which a research team collaborates with teachers, school administrators and other stakeholders to support organisational change … . (p. 9)

They draw attention to their use of a metaphor of 'ecology' to capture the complexity of teaching and learning situations:

> Design experiments ideally result in greater understanding of a *learning ecology* – a complex interacting system involving multiple elements of different types and levels – by designing its elements and by anticipating how these elements function together to support learning. Design experiments therefore, constitute a means of addressing the complexity that is the hallmark of educational settings.
>
> Elements of a learning ecology typically include the tasks or problems that students are asked to solve, the kinds of discourse that are encouraged, the norms of participation that are established, the tools and related material means provided, and the practical means by which classroom teachers can orchestrate relations among these elements. We use the metaphor of an ecology to emphasize that designed contexts are conceptualized as interacting systems rather than as either a collection of activities or a list of separate factors influencing learning. (p. 9)

In Potari & Jaworski, 2002, we claimed to address *complexity* in teaching development through our use of the teaching triad as an analytical and developmental tool. The learning interactions between researchers (including teachers and educators) and their relationships to classroom learning, might be characterized similarly in terms of *a learning ecology*.

Some issues and tensions

My reading of the articles on design research points towards two factors, which I recognize that, for the moment, I might be treating naively. The first is that design seems to be focused on promoting learning; where mathematics education is concerned, this is mainly the learning of mathematics, although it may involve learning to teach mathematics in a pre-service or in-service programme. The second is that although in most cases teachers are involved in the research (as partners rather than as pupils) it is not clear what levels of ownership are involved. If the research is

'owned' by university researchers who design experiments or innovations according to their own questions and issues, how do teachers develop their own commitments and involvements and with what implications for future practice? Cobb et al. write

> A number of research groups working in a domain such as geometry or statistics might collectively develop a design theory that is concerned with the students' learning of key disciplinary ideas in that domain. (p.9)

> Design studies are typically test-beds for innovation. The intent is to investigate the possibilities for educational improvement by bringing about new forms of learning in order to study them. (p.10)

In what ways would teachers be involved in such groups and such innovation — and how would teachers' learning relate to future work with students on the key ideas? How might the theories developed be realised more widely in practice? There seems to be lack of clarity regarding theory:

> … like other methodologies, design experiments are crucibles for the generation and testing of theory (p.9)

> … the research team frames certain aspects of the envisioned learning and of the means of supporting it as paradigm cases of a broader class of phenomena (p. 10)

> Rather than grand theories of learning [such as constructivism] that may be difficult to project onto particular circumstances, design experiments tend to emphasize an intermediate theoretical scope … that is located between a narrow account of a specific system (e.g., a particular school district, a particular classroom) and a broad account that does not orient design to particular contingencies (p.11)

We might ask how theories informing the design of an experiment relate to those generated in and through the experiment and indeed those involved in processes of testing and evaluation of experiments. The necessity of locating an experiment in a specific context might be seen as problematic in terms of generating theory that is more widely applicable. Seeing the specific as paradigmatic of the general involves a problematic circularity of reasoning. A number of tensions can be seen from these considerations:

- Tension between the particular case/setting and a general paradigm
- Tension between learners and learning in the particular case/setting and more general applicability of the emergent theory
- Tension between the development and use of the design/ innovation/tool etc. by researchers and teachers in the research context and teachers' ownership and use of the design/ innovation/tool etc. outside the research context and more widely

I am especially concerned about the roles of teachers in design research and the implications of these roles for sustained teaching development. Design researchers acknowledge a range of methodological issues and importantly the question of *warrants* for knowledge claims with controversial epistemological considerations that

I cannot start to address in the 6 pages allowed here. I welcome correspondence with people interested in considering the contribution of research to teacher education and teaching development, in terms of teachers' and researchers' developing knowledge and practice, and in particular the potential of a design research element.

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