

research or **R**esearch AND ITS RELATION TO MATHEMATICS TEACHING

Barbara Jaworski – University of Oxford

This paper is about relationships between teaching and research in mathematics classrooms. Its main focus is research in which teachers participate in some way. This research is contrasted with established forms of research, and judged against its purposes in contributing to developing teaching.

Research is the activity of established researchers working according to academic expectations; **r**esearch refers to the kinds of enquiry in which teachers might engage, and which might not 'fit' the expectations of established research. I am interested in how these relate to teachers and researchers working together for the enhancement of teaching. I shall refer to three research projects that have involved in differing ways collaborative work between researchers, teachers and teacher-researchers. The paper will propose that teachers' engagement in research is a strong stimulus for developing teaching. The practices and processes of this engagement can result in a growth of knowledge of teaching both for the individual teacher and in the public domain¹.

Teaching is Research

In a group meeting at the end of the first year of a project in which teachers engaged in research into aspects of their teaching one teacher, Alex, stated the following: "When I started thinking about research, it seemed to me that any teacher is constantly engaged in research. Anything that you do, if you try to learn from it, that's research. It's just that what we're trying to do here is more formalised research."

Alex's point of view was that teachers engage in research in their everyday teaching acts as they construct classroom activities, reflect on these activities and feed back into their teaching the outcomes of their reflection. He implied that the cycle of planning → teaching → reflecting/evaluating → planning ... is a research process. It is a process in which the teacher is creating situations for exploration and from which the teacher is learning about teaching. *Planning* involves deciding *what* is to be done and *how* it should be done. This is a theoretical stage. It draws overtly on knowledge – mathematical knowledge, knowledge of children's

¹ In this short paper there will not be space for actual examples from the research. Such examples can be found in a lengthier paper, Jaworski (in press), or obtainable from the author.

learning of mathematics, knowledge of pedagogic processes and strategies – to create the form of a lesson. The *teaching* stage interprets this planning in the classroom. This is a practical stage. It also draws on knowledge, but this is knowledge-in-practice, often tacit, not clearly articulated knowledge. It involves a practical wisdom: knowing students, how to respond to students, how to manage the learning situations in the classroom, how to interpret theoretical planning. It involves crucial decisions and judgments, many of which cannot be anticipated or pre-planned. The stage of reflection/evaluation links the other two stages. It is a critical reviewing of what took place in the classroom: recognising interpretations of the planning, assessing the quality of decisions and judgements made, seeking evidence for learning, noting students' achievements and needs, feeding back to future planning.

The above rationale suggests that teaching *is* research. The teaching process *is* a research process. In this process the teacher *is* a researcher. We need to look more closely at what research, or being a researcher means in this process. To what extent is this research? How does it accord with traditional notions of research?

Established Research and its differences from teaching

Lawrence Stenhouse (1984) defined research as "systematic inquiry made public". This succinct definition can be used as a way to consider to what extent the teaching process described above might be seen as a research process. There are three elements to address: to what extent is the process *systematic*, is it a process of *inquiry*, is it made *public*?

The process is *systematic* to the extent that planning is overt and precedes teaching. Reflection/evaluation follows teaching and feeds back into future planning. The extent to which this cycle is explicitly followed in a systematic way depends on the individual teacher and circumstances.

It is a process of *inquiry* in so far as teaching is an interpretation of planning, and evaluation asks to what extent the planning has been effected and what it has achieved. Learning deriving from such reflections feeds back into further planning and teaching, and knowledge grows with experience. The often implicit or tacit nature of this knowledge and its growth is well documented in the literature.

For the outcomes of the inquiry to be made *public* they need first to be made explicit. Some form of communication and dissemination is then required. This might happen within a department or school as teachers

work together to develop their practice. It would rarely take place beyond the particular school, except in specially designed projects.

There are clear differences between the process of teaching, albeit a process of systematic enquiry, and established processes of (educational) research. Although the latter can take many forms, there are expectations of what would be involved. One difference is that the *purpose* of the activity would be different. Generally speaking, the purpose of teaching is to educate students, whereas the purpose of research is to generate knowledge related to teaching. A second difference lies in the generation of knowledge from the inquiry process. In established research a rigorous process of identifying and validating such knowledge would be an expectation. As we have observed, this is possibly rarely the case in teaching. Thirdly, in established research, in order to address research questions in a systematic way, a clear methodological perspective would be expressed, encompassing both research philosophy and research methods. Teachers are rarely knowledgeable about research methods – they are educated to be teachers, not researchers. And a fourth difference is the public nature of results of the research. Dissemination of results from inquiry in the teaching process would rarely go beyond the local setting.

The interface between teaching and research

This interface exists where teachers are engaged in research, often in collaboration with educators and researchers from universities. The relationships between teachers and these researchers are central to issues of developing teaching, and simultaneously adding to the wider knowledge of teaching and its development. Different forms of research relationship may be seen in the three projects.

1. Investigating Mathematics Teaching: External (established) researcher studying mathematics teaching.

The purpose of this research was to explore and characterise an investigative approach to mathematics teaching, and highlight the issues it raised for mathematics teachers in secondary schools. Over about 9 months for each teacher, typically, the researcher spent one day per week in a school, observing lessons and talking at length with the teacher. The intention was to study teaching and the thinking of teachers, not to change the teaching. However, a significant outcome was its contribution to the

development of thinking of the teachers involved through interactions between the teacher and the researcher.

2. Mathematics Teacher Inquiry (MTE) Project: A study of mathematics teachers engaging in research in their own classrooms.

This project was designed to study the implications for teaching arising from teachers enquiring into their own teaching. It was based on an outcome from the research in (1), that "hard" questions result in teachers' developing thinking about teaching and ultimately in developments in practice. The intention was to create situations where teachers asked the hard questions themselves and to study the processes and outcomes. The project began with six volunteer teacher-researchers (TR) and two university-researchers (UR) in collaboration. Declared expectations were that teacher-researchers would each choose some aspect of their teaching into which they would 'enquire'. None of the teachers had much experience of research, some none at all. The university-researchers would study the practices and processes of the teachers' enquiry, and provide levels of help or support as requested by the teachers, working on a one-one basis in the school. A key aspect of the methodology was that meetings of all researchers would take place regularly to discuss experiences, questions and outcomes in the teachers' enquiry.

3 The Teaching Triad Project: A joint project between teachers and researchers to study and develop mathematics teaching.

At one of the group meetings in (2) above, a theoretical construct, "The Teaching Triad", deriving from the research described in (1) above, had been introduced to relate to issues being discussed. The Teaching Triad describes or characterises the *teaching* in a classroom, attempting to provide a framework to capture the essential elements of the complexity involved. It encompasses three domains: the management of learning (ML); sensitivity to students (SS) and mathematical challenge (MC).

Two teachers indicated that they found the triad a useful idea through which to conceptualise their teaching. Thus, a further project was undertaken to explore the potential of the triad, as a device both to support teaching and its development, and to analyse the teaching. This involved two teachers and two researchers whose roles and goals were different. The teachers wanted to think further about their teaching and to use the triad as a device to aid their thinking. The researchers wanted to explore the value of the triad for analysing the teaching.

Learning from the three projects

- 1) Researcher's questions were significant in encouraging teachers to enquire into their own practice. This encouraged deeper reflection and in some cases, changes to practice. Thus an external researcher in the classrooms, engaging in established research, was to cause teachers to participate in enquiry leading to development of teaching.
- 2) Here each teacher questioned aspects of their practice, and fed the results back into their teaching. Over time, successive cycles of question and activity led to changes in thinking and practice. Although not systematic in an established sense, it was possible to perceive a developing system described as 'evolutionary'. The university researchers encouraged questioning and helped sustain activity.
- 3) Here the teachers used the Triad as a tool to think about their teaching. As a result of studying this overtly, alongside the established researchers, developments in thinking and teaching could be observed.

In each of these projects teachers engaged, to differing degrees and in different ways, in a research process. In each case the outcome was helpful to teaching in encouraging teachers' reflection and to differing extents, development of the teaching itself.

The degree to which the research compared to established research varied, but in the main it qualified as 'enquiry'; in some cases it could be seen as systematic, possibly 'evolutionary'; but only rarely did it result in published findings. The exception was in (2) where three teachers published articles.

Knowledge in the research process

Knowledge and its growth was evident at all stages of the various research projects. Each project involved 'established' research addressing clear research questions, a well-defined methodology and publications of outcomes in academic journals.

Where the teachers involvement in the research is concerned, teachers' knowledge grew through participation and questioning. The extent to which knowledge generation was explicit is significant. According to Alex's claim, early in the paper, teaching itself is research. This proposition recognises that teaching knowledge is growing through the teaching process for many teachers. This is mainly tacit knowledge. The experienced teacher draws on this knowledge effectively often without ever noticing it. However, evidence here shows that when teachers engage in research, knowledge grows overtly and teaching develops.

In established research, formal validation is an expectation in the analytical process. For teachers, validation is more subtle and is an element of the practice. For the teachers in each of the projects, communication and collaboration with another was highly significant in stimulating, sustaining and developing thinking. The reciprocal reflection of ideas between teacher and researcher, or between co-researchers, allowed a questioning and making explicit of what was being learned. Where a research group existed, the group meetings were acknowledged as central to challenging thinking and confirming awareness. Ultimately, however, all teachers needed to see the results of their activity as beneficial to their work in the classroom, and it was this practical challenge that was the ultimate tool in their validation of research.

It is possible here to recognise the growth of knowledge both individually and socially within these groups. For each teacher, the growth of their own knowledge of teaching was idiosyncratic. This growth was not in isolation. One to one research conversations and group interactions were highly significant to thinking and development. What was evident was that research 'cultures' or 'communities' grew through these interactions. Relationships between research and teaching became clearer to participants. Norms of mutual respect and interaction were developed. The confidence of teachers in thinking of themselves as researchers contributed to the vision of a research community.

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