

Bridging the Gap: A Challenge for the Dual Community

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The 'research-practice gap' has its roots in the concept of Technical Rationality – the 'Positivist epistemology of practice' (Schon, 1987). This is interpreted by some in mathematics education as the hierarchical division of labour, wherein it is the task of the tertiary-based mathematics educator to create the fundamental knowledge and theories, and the task of the mathematics teacher to apply that knowledge to practice. This paper considers the issues that arise from this demarcation, highlights the problems it creates, and suggests ways to alleviate these problems.

Four years ago, just around the time that I had been elected President of MERGA, I was privileged to listen to a talk by Tom Koballa, then President of NARST – the US-based National Association for Research in Science Teaching. He spoke about what he called the 'research-practice gap' – the discrepancy between what is known about teaching and learning, and what actually goes on in the science classroom or laboratory. Tom hadn't coined that term – its origin is debateable, but it is most often attributed to F. Weinert and his colleagues in a 1989 article in the *International Journal of Educational Research*. Undoubtedly other educators had considered this phenomenon earlier – David Schon in 1987, in his book *The Reflective Practitioner* for example. Even prior to that, as far back as 1974, Graham Nuthall when writing in the *New Zealand Journal of Educational Studies* had asked his readers a question that touched on this issue: "Is classroom interaction research worth the effort involved?". His advice to us at the time was that we should not answer the question too rapidly nor too glibly.

As I listened to Tom, I remember thinking to myself that we mathematics teachers in Australia were better off than our US-based science colleagues as far as putting the results of research into practice. I was aware of the excellent professional development opportunities available to Western Australia's mathematics teachers and those in other states too, and I was also aware that, in WA at least, a significant proportion of the mathematics teachers in the State attend the annual conference of the Mathematical Association where a considerable proportion of the discussion involves mathematics education research. I really did feel complacent about the situation at the time. I've thought about this issue as it applies to mathematics education since then, and it was at the centre of my thoughts throughout my term as MERGA President. I'd like to share a few of my ideas about this matter with you.

What does mathematics education research really achieve for us? Despite Graham Nuthall's advice, here are a few glib suggestions: It can bring us recognition from our colleagues. It can win us awards. It can even get us promoted. But apart from these self-serving gains, what does research really achieve for the teaching and learning of mathematics? Over the last 18 months I've taken the opportunity to ask this question of a number of secondary, pre-service and cooperating teachers with whom I've been working. There were many positive comments, but this is what some of them had to say:

I guess that I've always assumed that the research part of teaching the maths curriculum has been done for me already by the curriculum people, and built into the syllabus and the guidelines they give us. I've never been conscious of research impacting on my day-to-day teaching. (Greg, Western Australia)

Maths education research should be useful to me, but it really isn't. It looks at what teachers should do to make maths better, but ignores what's really going on in the classroom – irregular attendance, lack of motivation, no application among kids. (Cathy, New South Wales)

Research results don't reach maths teachers, or it doesn't reach us in a form we can use. (Diana, Queensland)

Maths education research isn't useful to everyday teaching. Most of it isn't practical – it doesn't translate easily into working ideas. (David, Tasmania)

Maths education research is self-perpetuating, (and the) ill-founded study of very little that is applicable to 'real' teaching. (Margo, South Australia)

These responses surprised and disappointed me. I now believe that there are many mathematics teachers in Australia and around the world whose answers to the question of what mathematics education research really does for them would be in much the same vein. The literature supports my belief also:

Research in mathematics education is of limited value unless it affects classroom practice and experience. (Hatch & Shiu, 1998, p. 297)

Most educational research is perceived by (mathematics) teachers as irrelevant to their daily working lives. (Cochran-Smith & Lytle, 1992, p. 304)

There is a growing concern that the voices of classroom teachers are absent from published accounts of educational research. (Patterson & Thomas, 1993, p. 1)

There is a widespread view that educational research is of little relevance to practice. (National Board of Employment, Education & Training, 1992, p. 9)

Teachers often see the proposals for change made by others as 'frivolous' when they do not actually affect their working constraints. (Bishop, 1998, p. 36)

Researchers (need) to embed their work in a practical theory of pedagogy, one which takes account of the real world of teaching. (Chambers, 1992, p. 245)

Research results are rarely functional in, or applicable to, real classrooms. (LeCompte & Preissle, 1993, p. 355)

Firstly, teachers and researchers do not conceptualise teaching in the same way. They live in different intellectual worlds and so their meanings rarely connect. Secondly, the usual form of educational research - the psycho-statistical or agricultural-botany paradigm - has severe limitations as a method of construing and making sense of classroom reality. For these two reasons, teachers and others concerned with understanding classroom life have increasingly adopted different approaches to classroom research. (Hopkins, 1993, p. 40)

These eight quotations covering the last eight years mirror the discrepancy that Tom Koballa was at pains to describe – the 'research-practice gap'. Boostrom, Jackson and Hanson provided a wonderful analysis of this phenomenon in a 1993 article in the *Teachers' College Record*. The 'Gap' has its roots in the concept of Technical Rationality which Donald Schon (1987) calls the 'Positivist epistemology of practice'. In mathematics education, technical rationality is seen in the hierarchical division of labour wherein it is the task of the tertiary-based mathematics educator to create the fundamental knowledge and theories, and it is the task of the mathematics teacher to apply that knowledge to practice. The mathematics education research community's historic adherence to the model of technical rationality has led to the situation where rigour and relevance are often at odds. As mathematics education researchers, we have tended to investigate problems framed by research-based theory that utilises a quantitative and/or qualitative methodology – the hallmark of technical rationality. Unfortunately, teachers see many of the problems that we investigate as irrelevant, impractical and out-of-touch with the actual classroom of today's schooling. Not that the actual research is considered unimportant or lacks rigour: Rather the research cannot be implemented as recommended because of the constraints of the classroom.

Virginia Richardson (1994) distinguishes between formal research and practical inquiry. The latter falls outside the model of technical rationality. According to Richardson (1994, p.5), 'practical inquiry (is) undertaken by teachers to improve their practice, while formal research (is) undertaken by researchers to ... contribute to an established and general knowledge base'. She contends that it is practical inquiry and not formal research that provides teachers with the knowledge that they need to address their immediate day-to-day classroom problems. Even as our research shifts more and more towards the hermeneutic purpose of understanding how mathematics teachers make sense of teaching and learning, we cannot but agree with Richardson (1994, p.6) when she observes that it is unlikely that we will be successful in developing a formal knowledge base that responds to the immediate day-to-day needs of mathematics teachers.

I can illustrate this point with an example. Some time ago I spoke to a pre-service teacher after having observed him teaching a mathematics lesson. I asked him about a number of students who had sat with their heads buried on their arms and otherwise disinterested throughout the lesson. He explained that that on one day those students would be totally engaged, while on another day they were as disinterested and as unmotivated as I had observed. Getting these students regularly on-task was among the teacher's priorities. My knowledge of mathematics education research, or for that matter educational research in general, was of little help in terms of offering advice to this teacher on how to get those students involved regularly for the entire class period.

If one acknowledges that our needs as researchers to address the more general conceptual questions of mathematics teaching and learning are not the same day-to-day needs of mathematics teachers, then one must also acknowledge the existence of two mathematics education research communities. As MERGA members, we are well acquainted with one of these communities, namely the one which engages in formal research on such topics as the discourse that mediates mathematics learning, the obstacles to mathematics education reform and the role of persuasion in mathematics teaching. This community shares the outcomes of its work at the annual MERGA meeting, among other places.

Such an association, however, does not necessarily represent the other research community that does not operate as part of a hierarchical structure. In that other community, teachers are the researchers, the recipients and the consumers of their own research. Their research activity is not defined in terms of rigorous methodologies and well-articulated theory. (The idea of evidence-based practice is one that informs many other professions – for example, medicine). Members of this other community exchange their research findings in the staffroom and corridors of their school between classes, often as anecdotes and stories, and they evaluate the quality of their research in a very pragmatic way – in terms of what works with their students. However, one does not have to be a primary, middle school or secondary mathematics teacher to be a member of this second research community. All of us who teach mathematics and mathematics method courses also engage in practical inquiry – we ask questions about our practice from our colleagues who offer suggestions for improvement. If the suggestions work, they become part of our teaching repertoire; if not, the suggestion is discarded or modified to make it work.

I should mention at this point that, quite recently, some questions have begun to be raised about the status of the knowledge produced and published through teacher research (Kilpatrick, 2000; Cochran-Smith & Lytle, 1999; Fenstermacher, 1994) and, in particular, whether that knowledge should be included in the same category as traditional academic research knowledge. The debate appears to hinge largely on the nature of the evidence offered in support of teachers' narratives that seem to constitute the major way of reporting teacher research nowadays. Jeremy Kilpatrick, while delivering a keynote address at a conference this year (Kilpatrick, 2000), stated that although 'teachers as researchers' has become an

important mantra in many programs of teacher education in mathematics, such research has not had much impact on the larger community. I'd respond to this statement by saying that it is impossible to gauge how much research teachers have conducted on the teaching of mathematics, and I believe that there is ample evidence to demonstrate that teachers' research is having considerable impact locally, even if it doesn't have a high profile when viewed from outside the profession.

Jeremy's statement was made in the context of his somewhat controversial argument that the mathematics education community simply does not have good evidence to support its claims regarding the need for any sort of mathematics education reform, owing in large part to its move away from research that might have provided such evidence, namely 'well-controlled experimental and quasi-experimental research – the building blocks of scientific knowledge about teaching and learning' (Carnine & Gersten, 2000, pp.139-140). This is not the place to discuss the merits or otherwise of his argument – that we should shift back to more quantitative research-based paradigms – but it is interesting to consider the impact that such a move would have on the way that teachers view what we do, and how their reception of us into their classrooms might change as a result. In a period when it is becoming increasingly difficult to gain access into classrooms to conduct research, our position might well deteriorate further if we were to insist on, say, conducting long-term, large-scale formal experimentation. Reversing the shift in current methodological approaches this way would certainly highlight the gap between the evidence-based research of the teacher and the form of research they observed us implementing. Regardless of the research methodology we mathematics educators adopt however, formal guidelines for teacher research are being developed and promulgated by educational authorities in various English-speaking countries.

The Association for Science Education (ASE) in the UK recently set up a research group to promote teaching as 'a research-based profession', and it aims to 'promote an evidence-based culture'. In the first of a series of articles in *Education in Science* (September, 1999), Ratcliffe and Wellington looked at what they believed counted as science education research. They saw teachers becoming involved in conceptual research that built theory and cleared away the undergrowth so that the main ideas stood out. Such work might involve critiquing previous studies in a particular area. However empirical research is what we generally think of as research; it collects data on how and why something is happening, either by intervening as little as possible so that the situation can be described as it is (a case study), or by planning and implementing an intervention and describing its effect (an evaluation). Where teachers become engaged in the process of improving some aspect of teaching and learning through a cyclical process of questioning and making changes to their practice, the research is action research. The ASE urges teachers to become involved in any one of these activities – action research, evaluative research, case study research or survey research (using questionnaires).

With this science education initiative in mind, I was a little disappointed after browsing through the two-volume tome published in 1998 by Kluwer – *Mathematics Education as a Research Domain: A Search for Identity* edited by Anna Sierpinski and Jeremy Kilpatrick. While this work represents the outcome of an international study of the state of the field of mathematics education research - particularly as it relates to hard-core mathematics - the title of the work virtually proclaims the identity crisis I refer to in the title of this presentation. Of the 33 expert papers published in the two volumes, only four (including one by Alan Bishop) directly discusses the relationship between theory and practice (Alan makes the point in his chapter: "the lack of relationship between research and practice is well documented" (pg.35)). Gillian Hatch and Christine Shiu's article in this publication (pp.297-315) proposes some strong arguments for the multiple benefits of collaborative efforts, both to the teachers themselves and to the profession. Reviewers of this

publication document a field in disarray, a “field whose high hopes for a science of mathematics education have been overwhelmed by complexity and drowned in a sea of competing theories” (Steen, 1999). Two questions that exemplify the dilemma, he believes, are:

- How relevant is basic, as opposed to applied research, for mathematics education? and
- Are qualitative, or quantitative methods, or a mixture of both, more appropriate for mathematics education research?

We may think that we know the answers to these questions, but do we really? Weinert and his colleagues (1995) believe that debate on the first of these questions is unproductive both theoretically and practically. On the one hand, it is difficult to differentiate pure or basic research from applied research; on the other hand, it has become clear that findings from both research prototypes have specific advantages and disadvantages with respect to their practical applications. The second debate has degenerated into what is almost a religious war for many, and is undoubtedly at the bottom of the ‘math war’ currently raging in the United States. Jeremy Kilpatrick’s argument that qualitative research remains unacceptable to many ‘hard-core’ mathematics researchers and the public, and that a considerable number of the reforms in school mathematics that have upset these people are the direct result of qualitative research is a worrying accusation. On our part, we’ve come to believe that both qualitative and quantitative approaches are necessary and complementary components of any system of research in the mathematics, science and social sciences fields. It will be interesting to see how this issue develops over the next few years.

The research-practice gap is a related complexity. Consideration of the issues surrounding the gap has been given relatively little exposure in the literature, although there are notable exceptions - for example, its treatment in the *International Encyclopaedia of Teacher Education* (Anderson, 1995), and other references listed at the conclusion of this article. Carolyn Boulter from the University of Reading has examined this matter in the context of the effects of curriculum change on teachers in England and the fact that the professional development of teachers is becoming a central focus of government concern in the UK (Boulter, 2000). She suggests that not enough notice has been taken of the effectiveness of getting teachers in classrooms actively involved with a wide variety of research, and that developing teachers’ research agendas can be a sustaining influence on their professional life. She believes that such agendas can be initiated during teacher training, and that they lead to gains in lifelong involvement with critical and reflective thinking about classroom practice. While many of us may not be involved in mathematics teacher preparation *per se*, the majority are involved in the professional development of teachers in some way, and this perhaps affords us with the opportunity to create a research agenda for working closely with the practitioner. We should be committed to research being an integral strand in professional development.

Carolyn Boulter’s description of the reaction of the government in the UK is interesting, for I do not believe that State Education Departments and Ministries of Education in many other parts of the world see it as their job to encourage teachers and researchers to collaborate, preferring to leave this task to the teacher training institutions. This belief puts me in the same category as that West Australian teacher named Greg whom we heard at the start of this presentation. It seems that education authorities will utilise the results of research in, for instance, their curriculum development efforts certainly, but they are not in the business of actively encouraging teacher-researcher collaboration in their operations. To my knowledge there has only been one ‘official’ document published in the last ten years in Australia that emphasised the need for teachers to ‘seek guidance for improving the mathematics curriculum, both its content and pedagogy’, and which stressed that ‘teachers, like other

workers, need to be engaged in professional development throughout their careers if they are to keep abreast of developments'. This was the *National Statement on Mathematics for Australian Schools*, published by the Australian Education Council in 1990. In the United States, the push for such collaboration has, as we are all aware, been championed by the NCTM, particularly in its publication entitled *Professional Standards for Teaching Mathematics*, published in 1991.

So, as we begin working in this new millennium, it seems to me that it is up to us to acknowledge the existence of the two research communities, even though we like to link the two terms and speak of the *teacher – researcher* as though it describes a single entity. We must also take advantage of the strengths of both communities to meet the challenge of improving mathematics teaching and learning. Neither community can truly achieve its true potential without the other. How can we bring about this collaboration? Anderson (1995) lists the following four steps to be followed “if research is to be linked to improved practice”. First, valid and reliable data on important characteristics of teachers and components of teaching must be collected. Second, the data must be interpreted properly, both in terms of what they mean (theoretical) and how they relate to effective teachers and teaching (practical). Third, the data must be integrated or synthesised across a set or series of studies addressing similar characteristics or components, initially looking for common findings and ultimately resolving contradictory ones. Finally, he says, ‘ways must be found to translate research effectively into practice’. What a letdown that fourth step is, for it is precisely that information – those ‘ways to translate research’ – that we are seeking! Also somewhat disappointing is the NCTM’s *Position Statement on Research* (NCTM, 1999). Following comments such as: ‘If mathematics education research is to be responsive to questions regarding pedagogy and student learning, then collaboration between teachers and researchers is critical’, and ‘Teachers should meet with other teachers and researchers to discuss outcomes and observations...and to offer classroom data for analysis and interpretation’, the Statement concludes with the advice: ‘...researchers must share their interpretive insights in ways that address teachers’ daily concerns for classroom practice’. Unfortunately there are no suggestions about how this might be achieved effectively. Again, not very helpful to either teacher or researcher.

To its credit though, the NCTM has addressed this issue in a recent editorial by Judith Sowder in *JRME* (Jan, 2000) that asked the question: *how can we communicate mathematics education research beyond our own community to reach the broader audience?* Once again, a complete solution was not forthcoming, but one of the points made was that attention should be paid to the manner in which research is reported in journals such as *JRME*. The editorial suggested that the current form of reporting is often a turn-off for teachers. At the place where I work, we have been attempting to overcome this situation by preparing and distributing to every secondary school in Australia a user-friendly, four-page publication called ‘*What Research says to the Teacher*’ that we hope goes some way to overcoming this particular problem.

In her keynote address at this conference, Deborah Ball has suggested another solution. Deborah has described to us how she and her colleague Magdalene Lampert have used the school context to situate their research question, namely: *How should prospective teachers come to know?* (Lampert & Ball, 1998). The question provides the background for their reporting on their extensive research in this area – research that has used the notion of constructing teacher knowledge *within* practice. These two researchers were not merely observers in the classroom – they helped plan, teach and reflect on the lessons they observed using a research-in-action model. They listened to students as they worked, and they were free to respond to students’ needs for direction and assistance. Post-lesson sessions were devoted

to analyses of the interactions that had taken place, group reflections and the planning of further instruction. Further learning activities were 'negotiated' between the students, the teachers and others.

My plan too would be to link research to improved practice. It would involve the notion of working more closely with teachers than we have before. There will be many in this audience who already do what I am about to say, but their efforts aren't shared by all of us – as the teachers' voices at the start of this presentation verify. To me, it seems that in order to take advantage of the strengths of both communities we must do at least four things: First, spend some proportion of our research activity on finding out the matters which are of major concern to the classroom teacher. Let's never be accused of researching irrelevant issues and being out-of-touch with the actual classroom. Undoubtedly, some of our efforts in the past have resulted in an indifferent and cynical reaction from our classroom colleagues. Let at least some of our research activity be directed towards solving the day-to-day problems within the classroom. Admittedly there are probably too few of us to go around – we cannot visit as many teachers as we would like and participate in their classroom research, and we do not have the time to devote to prolonged classroom action research. However we do need to become more 'user-friendly' for the practitioner, and one way we can do this, in addition to school-based work, is by making sure that we participate as often as we can at conferences and workshops involving mathematics teachers.

Next, double our research efforts to understand the practical inquiry undertaken by mathematics teachers. For example, over the past 10 years we have carried out significant research that has led to a better understanding of students' naïve and alternative conceptions in mathematics and how these conceptions affect mathematics learning. I would like to see a research program of the same magnitude that focuses on mathematics teachers' practical inquiry. This program would focus on how teachers develop knowledge of mathematics content, students' learning styles, lesson planning, instruction, assessment and reflection, and how they use this knowledge to solve their day-to-day problems. I believe that all teachers, not only those who teach mathematics and mathematics methods courses, would value the findings of such research. As we all know, one way to investigate the practical inquiry of mathematics teachers is through collaborative action research. However, while this strategy is used and is evident in many of the research studies reported during this conference, I feel that more can be made of this approach. Working together, MERGA members, other researchers and teachers can build mutual understandings and clarify complementary interests that can lead to learning and common actions. I see practical inquiry and formal research as two phases of a continuous collaborative action research cycle, where practical inquiry stimulates formal research, and formal research leads to practical inquiry. Work of this type is likely to encourage researchers and practitioners to grapple with issues of relevance and rigour.

Like Tom Koballa, I view collaborative action research as a win-win situation for researchers and teachers. When engaging in collaborative action research, teachers gain new insights into their practices and come to see themselves as researchers into those practices, while researchers grow in their understanding of the mathematics teaching-learning context and the day-to-day concerns of mathematics teachers. More importantly, both teachers and researchers come to respect and value each other's work and perspectives and, more often than not, revise their own assumptions about the relationship between research and practice.

The third thing I believe that we should do is this: we must rethink how mathematics education research is communicated to teachers. We must view ourselves not only as constructors of new knowledge, but also as the disseminators of the knowledge we construct. As disseminators, we must recognise that it is unlikely that the vast majority of our work will provide the answers to mathematics teachers' immediate day-to-day problems. More realistically, the results of our work may stimulate teachers to think about mathematics

teaching and learning in new and useful ways (Fenstermacher & Richardson, 1993). Weinert and his colleagues (1989) suggest that because researchers tend to issue general statements which are difficult for practitioners to implement, and because practitioners tend to rely more on historical data (eg. traditional practices) rather than on current research evidence in informing their practice, the gap can only be closed if research findings were viewed as *one* source of background knowledge for the practitioner. In other words, researchers should be more interested in *informing* teachers than in influencing their practice. This was the thrust of the *'What Research says to the Teacher'* publication mentioned earlier.

From the perspective of many mathematics teachers, the product of mathematics education research is a body of prescriptive propositions about teaching and learning. Because many mathematics teachers tend not to participate in MERGA conferences, nor read JRME, MERJ or MERGA's new publication *Mathematics Teacher Education & Development*, they do not see mathematics education research as a process in which mathematicians grapple with uncertainties and display the art of inquiry akin to the uncertainties and art of practice. Also, inherent in the way in which mathematics education research is often presented to teachers is that hierarchy of status referred to earlier, where the knowledge constructed by the tertiary-based mathematics educator is elevated above the practical knowledge constructed by the teacher. Too many teachers interpret us as saying 'here's what research says you should do, so go out and do it!' We must do a better job of communicating with teachers about the nature of mathematics education research, and our communications with them must be on an equal footing. When discussing mathematics education research with teachers, we should speak about the uncertainty and challenges associated with our work and not just the prescriptive outcomes. Perhaps we need to get our hands chalkier, as did Deborah and Magdalene, and seek to contribute to the classroom action whenever it is appropriate and when we are invited. We probably need to communicate verbally more too. Deborah Schifter (2000) believes that mathematics education researchers are unused to addressing audiences outside their immediate field. Tightly focused on exchanges with peers, researchers share assumptions, language, references, goals, and concerns that make their discussions opaque to outsiders – including mathematics teachers.

My fourth suggestion for what we should do is to make students' and teachers' classroom experiences central to the university programs of pre-service teachers. I believe that it is in the teacher-preparation area where the seeds would be best planted to foster the realisation that, though the research-practice gap exists, it can be decreased significantly through the efforts of teachers and researchers working closely together. The inclusion of a small research project in the training program of a pre-service teacher would go a long way to fulfilling this aim. Those of us involved in teacher education have a big responsibility here to demonstrate to our charges not only *what* can be achieved, but also *how* it can be achieved. We need teachers who possess the desire to know how to access, interpret and conduct research. We are the ones to motivate them and to instil this desire and knowledge into them at the outset of their careers.

In summary, in this presentation I have focused on the plight of two mathematics education research communities, both striving to attain the same goal – to improve mathematics teaching and learning. If we are to succeed, it is imperative that we make use of the strength of both communities as we move ahead. As we attempt to bridge the research-practice gap, my suggestions can be summed up in two recommendations: the first is that we double our research efforts in order to understand the practical inquiry of mathematics teachers. Collaborative research is one way to do this, but certainly not the only way. My other recommendation is that we rethink how mathematics education research is transmitted to teachers. Successful performance here will, I believe, make an enormous difference in how mathematics education research is perceived and used to improve practice.

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