RESEARCH AND MATHS TEACHER EDUCATION IN TEN YEARS OF SAARMSTE: TRENDS AND CHALLENGES

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This paper is a review of the research on mathematics teacher education as reported at SAARMSTE conferences 1992–2002. An analytic framework for such a review is described, as is a broad sweep of the international terrain. These enable an account of what has been made visible here, what remains in the shadows, and the challenges ahead for the field.

INTRODUCTION
Mathematics teacher education is a complex and layered domain of practice. It includes a wide range of distinct sites: pre- and in-service education (elsewhere described as preparation and professional development); primary and secondary education; urban and rural education. At the same time, with its ultimate concern being mathematical learning in school, it attends to teachers’ fostering of that learning, and then to teacher educators’ fostering of the learning of teachers. Of course, we can extend these layers outward - thinking yet further about the fostering of the practice of teacher educators. As with any social practice, teacher education anywhere is also enabled and constrained by its socio-cultural and political context, leading to varying policies and practices in mathematics teacher education across national contexts. And so too research related to mathematics teacher education.

In South Africa, we continue to work in a socio-cultural and political context deeply scarred by apartheid education. Elsewhere (Adler 2002a), I have described how, in teacher education in South Africa, we need to simultaneously work with repair (apartheid did damage), redress (apartheid was constructed by and productive of inequality), and reform (to produce a thriving democracy and supportive curriculum). In their paper on curriculum policy, research and practice, Vithal and Volmink (forthcoming) talk of roots, reforms, reconciliation and relevance of curriculum in pre- and post-apartheid South African mathematics education. A history of teacher education in South Africa, its present and future challenges, is discussed in detail by Welsch (2002). Neither need repeating here. Together, these analyses provide important reminders of the history that shapes our present. At the same time, they offer comfort and inspiration as they capture work already done and currently underway. Holding our past, living our present and creating a better future lies at the heart of what I would call the ethos of much of the research and development work in South African education, and so too teacher education.

This paper provides an overview of research related to teacher education in South Africa that has been published and/or discussed in SAARMSTE proceedings over the past decade. My task here is specific and general. It is general in that it looks at trends on research related to teacher education over ten years across all published papers in the proceedings. At the same time the overview is very specific in that it is

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1 The exploration of teacher education discussed in this paper was undertaken to inform a similar chapter for a book on research in mathematics education in South Africa (see Vithal, Adler and Keitel forthcoming).

2 Mathematics teacher education is typically restricted to the domains of primary and secondary education. At these levels, teachers are required to have professional formal qualifications. Of course, mathematics is taught in tertiary institutions, and the teaching and learning of advanced mathematics is an object of empirical and theoretical inquiry, yet no formal training is required. There is an assumption that those in university mathematics departments are able to teach. This issue is beyond the scope of this paper, but it is worth signalling why the focus in a discussion of teacher education is on primary and secondary education.
restricted to a particular community, participants in SAARMSTE over the past decade. Even within South Africa, this will not capture all research related to mathematics teacher education.

The focus on SAARMSTE proceedings is, nevertheless, illuminating. As will become clear through the paper, there are discernable trends. And these raise questions about how we have come to constitute ourselves, what has come to be focused on, what has and has not been made visible, and why? In order to engage these questions, the paper relates the overview of SAARMSTE papers to international trends. For it is in the similarities and differences between what has come in and out of focus in both arenas that we can reflect on challenges that lie ahead.

SOME UNDERLYING ASSUMPTIONS THAT INFORM THE DEVELOPMENT OF THIS PAPER.

The overall orientation to research that underlies the discussion in this paper is of research as social practice, and thus not a neutral domain. What research comes to be done, and where and how it is published, shapes and is shaped, on the one hand, by networks and communities of researchers, who and where they are, and relations among them. On the other, considerable influence is exerted by the ‘rules’ that regulate research practice and these would range from how funding is accessed and distributed, and how conferences, journals and other ways in which research is disseminated, create boundaries of legitimacy. 3 This paper, which is a meta-analysis of research in teacher education, does not and cannot claim some unassailable truth about teacher education research in South Africa. It can reflect on and describe how the field (at least through some of its public artifacts) has come to be constituted, what trends, questions and orientations are visible, and what challenges this presents. Inevitably, the description will be a partial view of the field, drawn as it is from a selection of publications. The SAARMSTE community is a significant one in mathematics education research in South Africa. It is, however, relatively new and still small. Much lies ahead.

Just as the assumptions that have guided this paper are important, so too is the framework that came to be used to organise the ‘data’ – the numerous papers, long and short, published in ten years of proceedings.

WHAT COUNTS AS RESEARCH RELATED TO TEACHER EDUCATION AND HOW IS IT IDENTIFIED?

Precisely because the domain of teacher education research is so broad and multifaceted, it quickly became obvious that some kind of framework was needed to systematically identify what could count as research related to teacher education. Simply, which papers in the proceedings should be included in this review and why? In 1999, Krainer and Goffree (1999) published a review of mathematics teacher education research in Europe. This review was undertaken within the work of the European Research in Mathematics Education community. Krainer and Goffree distinguished (and included) four different kinds of research that have come under the broad banner of teacher education research.

They focus first on research in the perspective of teacher education, wherein they included research that focuses on teachers’ mathematical beliefs, teachers’ knowledge and aspects of teaching. None of these are investigations into teacher education in the first instance. However, the results of the research “can be used as a basis for designing learning environments in teacher education programmes.” (p. 223). This is contrasted with research in the context of teacher education, which includes foci on teachers’ learning through professional development, the gap between what teachers learn in pre-service and their work in school, and changes in teachers’ beliefs and practices. Here there is a direct concern with the use of the research in teacher education. However, teacher education practice itself is not the object of the research.

3 See Lerman, Xu and Tsatsaroni (2003) and Tsatsaroni, Lerman and Xu (2003) and their research into the production of the mathematics education community. In these papers the authors describe the analytic tool they have developed to analyse central publications in the field of mathematics education and then use it to reveal how our community has come to constitute itself. Particularly interesting is the dominant academic identity of teacher educator-researcher that has produced and has been produced by this wider international community of practice.
Hence the third category: research on teacher education where teacher education itself is the object of research, and focus is on interaction processes within teacher education. The fourth category is research as teacher education. Here, the activity of research is in the foreground as means for teacher development. Included here is all forms of action research and reflective practice where teachers reflect on and/or research their own practice as a means for improving /learning more about their practice.

Through this set of categories, Krainer and Goffree produced a review of research in the field of mathematics teacher education in Europe and revealed that most of this research falls into the first two categories: research on teachers’ beliefs, knowledge, learning and changing practices predominated. They were also able to see how various kinds of research were distributed across contexts in Europe. They pointed out that much has developed and been learned. Most interesting however, was the observation that the practice of mathematics teacher education itself has remained a black box.

I have used this categorisation of research in the field of mathematics teacher education to first identify and then analyse relevant papers across SAARMSTE proceedings 1992 – 2002.

AN INTERNATIONAL PERSPECTIVE
It is beyond the scope of this paper to provide a comprehensive review of all research in the field of mathematics teacher education. I have selected to focus on teacher education as discussed in each of two international handbooks on mathematics education, both published by Kluwer Academic Publishers, and that appeared seven years apart: the first in 1996 and the second just recently in 2003. These chapters provide a perspective on how the international field of mathematics education constituted significance in mathematics teacher education and related research over the time span of the SAARMSTE review here. It is interesting to compare, even superficially, what was placed on the agenda in 1996 that remained in focus in 2003, what disappeared, and what is newly in focus.

In the first handbook (Bishop, Clements, Keitel, Kilpatrick and Laborde 1996), Section 4 includes a focus on teacher education. Four chapters focus on the relationship between research in mathematics education and teacher knowledge, on pre-service and inservice teacher education, and on teachers as researchers. In Krainer and Goffree’s terms, the first chapter falls within research in the perspective of teacher education. The concern here is with research in mathematics education and its implications for the professional knowledge of mathematics teachers. This is coupled with the difficulties of productive and constructive relationships between researchers and the outcomes of research, and mathematics teachers and their classroom practice. In other words, in focus here is the relationship between research and practice, and the gap between them. The chapter on pre-service teacher education compares systems, programmes and curricula across different national contexts. The concern here is with research that can illuminate the preparation of mathematics teachers and how comparative research provides a fruitful context for identifying common problems (i.e. problems constituted by the practice of teacher education) and then those that are context specific. What is brought into focus here is the relationship between research, educational policy and educational systems, and so too how research on teacher education (and pre-service curricula in particular) can/should influence policy and shape systems. The chapter on in-service teacher education presents a case study of a teacher and her participation, in and learning from, an in-service programme. The concern here is with the integration of theory and practice in teacher education. This concern is carried through into the chapter on teacher research or research as teacher education, where research or inquiry by teachers themselves provides a context for such integration. In focus in both these dimensions of research is the theory-practice gap, and its implications for teacher education practice and the learning of teaching – issues so well known and yet illusive in teacher education research and practice.

4 See Boero, Dapueto and Parenti (1996); Comiti and Ball (1996); Cooney and Krainer (1996); and Crawford and Adler (1996).
In the second international handbook (Bishop, Clements, Keitel, Kilpatrick and Leung 2003), Section 4 also includes four chapters on teacher education. Concern with the integration of theory and practice in teacher education continues, as does debate on mathematics teachers as researchers. Together these reveal an ongoing challenge as to the relative roles of teacher educators and practicing teachers in research in the field of teacher education. A core issue in teacher education and related research thus remains its own practice. Research on mathematics teacher education, and research as teacher education, are central to understanding and improving this critical field of practice.

And shifts in attention and foci are also evident. The first of the chapters in the current handbook on mathematics teacher education discusses a concern we share here in South Africa, and that is the regulation of the entry of mathematics teachers into the profession. In 2003, an issue thus in the foreground is the challenge of the massification or opening up of access to mathematics in school, at the same time as there are increasing shortages in people choosing to become mathematics teachers. As I write this, the new FET (Further Education and Training, Grades 10 – 12) curricula are coming on board in South Africa with a requirement of mathematical literacy for all. At the same time as attempting to provide this mathematical access for all, we face fewer and fewer school leavers and graduates in mathematics coming into professional training. The orientation in this chapter is towards policy and systems for mathematics teacher education, carrying through issues pointed to in 1996 on pre-service teacher education, though with a different urgency and problematic. Here the focus is on provision of teachers and consequences then for curricula in teacher education.

Following this chapter is a chapter concerned with the mathematics in mathematics teacher education, and a position that learning mathematics for teaching involves specialist knowledge (which by implication is not usually offered in tertiary courses in mathematics). This foregrounding of the production of mathematics teachers and their mathematical know-how for teaching is reinforced in the closing chapter on professional development. This chapter has a strong focus on rich mathematical tasks that foreground critical dimensions of the mathematical work of teaching, and hence appropriate to teachers’ mathematical development in and through teacher education.

This broad brush over the international field produces a set of implications for research. There are critical issues now in the preparation and in the ongoing professional development of teachers, a function of the massification of mathematical access on the one hand, increasing conceptual demands embedded in new mathematics curricula, and the simultaneous ‘shrinking’ of interest and status in the profession on the other. This suggests research at the level of policy and systems and how various dimensions - curriculum policy, teacher education policy, the status and growth of the profession and the systems of education that produce teachers and support teaching – interact to support student learning, and so access to mathematics. Research is also needed on the actual practice of teacher education (i.e. understand so as to be able to improve). There is also a need for greater understanding of the mathematical demands of teaching in current conditions and how these manifest across ranging classroom contexts. At the same time, work needs to continue to understand better, and be able to work productively with, the gap between theoretical and practical knowledge of teaching, between teacher educators and teachers as agents in the field of mathematics teaching, and between research and practice.

I now move on to a review of the research reported in SAARMSTE. What research in the field was identified in SAARMSTE’s early years, and what has remained, slipped out of view and come into focus in the later years? How do these constancies and changes relate to the wider field of research related to mathematics teacher education? I am aware that as I pose these questions, the framework constructed here makes the ‘what’ of mathematics teacher education research visible. The ‘how’ (theoretical and methodological orientations) is out of focus. Where possible, I bring these into focus in the review below.

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RESEARCH RELATED TO TEACHER EDUCATION IN THE DEVELOPMENT OF SAARMSTE

I have organised the review into a tabulation of the number of papers in each of the categories described above. I used Krainer and Goffree’s categories to identify relevant papers and the object of focus in each paper. At the same time, I examined aspects of the empirical field of the research reported, in particular whether it concerned pre- or in-service teachers, and at the primary or secondary level; as well as aspects of the methodological orientation evident in the research reported.

This somewhat simple framework of analysis did not translate into a simple process of identification. Conference proceedings, SAARMSTE included, place a space limitation on papers offered, and so in a number of cases, there is an underdescription of the study from which the paper is drawn. There were cases where it was not possible to clearly discern the orientation of the research – theoretical orientations and conceptual frameworks used were often absent. Nevertheless, interesting trends have emerged.

Table 1. Foci over ten years: 1993 – 2002.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total no. of papers</th>
<th>Pri or Sec (Some neither or both)</th>
<th>Inset Or Preset (Some neither both)</th>
<th>Small scale Case study (CS)</th>
<th>Research in the perspective of teacher education</th>
<th>Research in the context of teacher education</th>
<th>Research on TE itself, or on methods or researching TE</th>
<th>Action research by teachers as part of their TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>5</td>
<td>1:4 (0)</td>
<td>3:1 (1)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>5</td>
<td>1:4 (0)</td>
<td>4:1 (1)</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>5</td>
<td>2:3 (0)</td>
<td>4:1 (1)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>6</td>
<td>1:3 (1)</td>
<td>4:0 (1)</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1997</td>
<td>14</td>
<td>4:8 (2)</td>
<td>10:4 (0)</td>
<td>13</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>9</td>
<td>6:3 (0)</td>
<td>8:1 (0)</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>9</td>
<td>3:4 (2)</td>
<td>8:1 (0)</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>14</td>
<td>7:5 (2)</td>
<td>9:4 (1)</td>
<td>10</td>
<td>6</td>
<td>5</td>
<td>3 (method)</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>6</td>
<td>3:2 (1)</td>
<td>6:0 (0)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1 (method)</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>8</td>
<td>3:3 (2)</td>
<td>6:0 (1)</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Overview comment trends

<table>
<thead>
<tr>
<th>Major increase in 1997</th>
<th>Shift from more secondary to more primary to balance</th>
<th>Inset dominant</th>
<th>Case studies dominate. Two cases of large scale studies. Some papers theoretical or focused on research methods</th>
<th>Consistent interest in teacher beliefs and knowledge</th>
<th>With increase in 1997 comes focus on impact or learning from INSET</th>
<th>Very few studies here and then on pre-set. In-service teacher education itself, as in Europe, is a black box</th>
<th>Action research present in the early years, disappears</th>
</tr>
</thead>
</table>

Together with colleagues and students, and as part of the work of the survey panel for ICME -10, I have been doing a survey of teacher education research reported in PME proceedings over the past four years, and a similar limitation has factored into this work. The eight page limitation of PME papers is one reason for papers not fully illuminating the research being done, both in terms of the methodological orientations underpinning the research and the analytic frames used for data analysis.
Over the years, interest shifted from a greater focus on secondary settings, to primary settings, with an interest in both reflected relatively evenly in the last few years. Research related to teachers in-service, predominates over pre-service as does case study research. In the main, what is reported is a study of a particular teacher education programme, or a particular teacher (or small group of teachers). A small minority of papers employed a large-scale survey or a test of some kind, either on teachers themselves, or their learners, and only two of these were relatively large scale (Kulubya and Glencross 1996; Austin et al. 1999).

- **Dominance of INSET and issues of change**

  Through a focus on the ‘what’ we can see clearly that research here has predominantly been in the perspective and in the context of teacher education, and in in-service teacher education more specifically. There continues to be a concern with and interest in teachers’ beliefs about mathematics and about pedagogy, as well as their knowledge of various topics in mathematics. Research in the context of teacher education emerges in force in 1997, partly a function of the growth of SAARMSTE in general, but nevertheless a reflection of a new emphasis on the impact of in-service programmes. Being part of the context that produced this shift, it is possible to point, on the one hand, to the influence of funding practices post 1994 and a demand by funders that mathematics teacher education programmes demonstrate their impact; and, on the other, to the influence of the increasing formalisation of professional development programmes.

  What threads across this research in the perspective and context of teacher education is a concern with ‘change’: what are teachers’ philosophical beliefs about teaching and/or mathematics, and whether and how these should or do change; what do teachers know about various topics and/or processes in mathematics and whether and how these should or do change. A concern with change, and so to research related to change, makes sense in the South African context: the 1990s have been constituted by change in all domains of social and political life and particularly schooling.

- **The emergence of a stronger focus on aspects of mathematics**

  Together with the shift in 1997 to concerns with the impact of inset, is a visible attention shift to specific aspects of mathematics in curriculum reform in South Africa and related questions for teacher education. Papers related to critical and ethnomathematics education (e.g. Vithal 1997), to mathematical modelling (e.g. Lebeta 1999), learner-centred mathematical practice (e.g. Brodie 1998; 1999), and the question of the specificity of mathematical knowledge for teaching, or ‘conceptual knowledge in practice’ (e.g. Adler 2002b) are all part of the collection of research related to mathematics teacher education in recent SAARMSTE proceedings.

  This focus on in-service, on change and on aspects of mathematics in teacher education research mirror shifts in the international arena and are taken up directly by Graven (2003) and Breen (2003). 7 Graven’s analysis of inset design brings central dilemmas in inset to the fore, one of which relates to the mathematical in teacher education. And Breen provokes our thinking about change, firstly in terms of the shift noted above to formalising professional development, and secondly in terms of the notion of change, and whose business is mathematics teacher change. Ultimately, in a discourse of change, teachers will always be found lacking – as either not changing enough or in the right way. Reporting on a teacher development research project (aspects of which have been reported in SAARMSTE proceedings), Adler and Reed (2002) describe the shift in the language they used from ‘change’ to ‘take-up’ precisely because of how the notion of change inevitably produced a deficit discourse in relation to teachers.

- **Where is research related to pre-service mathematics teacher education?**

  In its absence, research in the context of and/or the pre-service preparation of mathematics teachers, particularly at the primary level, becomes starkly visible. It is quite clear from the table above that,

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7 In a similar fashion to this paper, the papers by Graven and Breen presented at SAARMSTE in 2003 have been elaborated as chapters in the book on research in mathematics education mentioned earlier.
relatively speaking, pre-service teacher education has been under-researched in South Africa. Ensor’s in-depth study of a small group of pre-service teachers during their pre-service programme and their first year in practice in a school is a notable exception (see, for example, Ensor 2000), as is Vithal’s study of the crafting of a socio-cultural and political approach to mathematics education in teacher education and again with a small group of pre-service teachers (see, for example, Vithal 2001). Naidoo’s chapter in Vithal et al. (forthcoming) thus makes a significant contribution for not only does it report on research on pre-service primary mathematics teacher education, but it does so in the context of rural KwaZulu-Natal, and a college of education structured by apartheid education and fundamental pedagogies.

• What happened to action research and research as teacher education?

As the table above reflects, action research by teachers, and so research as teacher education is present in the first years of SAARMSTE, and then disappears. In 1993, three of the five papers related to teacher education concerned action research. By 1997, however, if such continued in the field, it was no longer reported at SAARMSTE. It would be fruitful for the community to reflect on this disappearance?

• Where is research on policy and systems in mathematics teacher education?

A final comment on noticeable trends over ten years of SAARMSTE relates to policy and large scale or systems research. In the proceedings of the first meeting of SAARMSTE in 1992 and the first conference following in 1993, or what we can refer to as our early years and the setting up of an agenda for SAARMSTE, there were a number of papers and reports on workshops related to priorities for research in mathematics and science education in South Africa. Teacher education features in that agenda, though rather broadly. But it is interesting to note the kinds of questions raised about teacher education at that time. In particular, in a plenary address in 1992, Treagust (1992) discussed an agenda for research, and the opportunities, options and obligations we faced, one of which was the shift emerging (evident in both the USA and Australia) at that time towards greater articulation of what counted as competencies in teaching and hence possible prescriptions for curricula in teacher education, and certification processes. Implied was the opportunity for research on these policies and pending system-wide changes. The working group on teacher education at the 1992 conference identified five research areas that warranted attention, included in which was the effectiveness of pre-service teacher education. In addition, and already at that time, the factors contributing to low enrolment of well qualified students in colleges of education was identified for our research agenda. That we have not taken up challenges for research of this kind is an important area for reflection and action.

• Issues of theoretical orientations and research methodologies

As I mentioned earlier, the framework that helps to see the ‘what’ in mathematics teacher education research obscures the ‘how’. The numbers in the table above limit what is seen. They cannot tell us (in the form they have taken) who is doing this research nor where, and these are both important in understanding what knowledge is being produced. Moreover, these numbers do not provide any means for interpreting the rigour of the research and thus the actual value of the reports, nor the orientations.

With this limitation in mind, I nevertheless take a step to make some comments on these invisible, out of focus aspects of our research in the field of mathematics teacher education. Firstly, and this is visible, the research we are doing is by and large restricted to small case studies. More often that not, the research is focused on a teacher education programme in which the authors/teacher educators are themselves involved. There are benefits and constraints in this. The benefits relate to these insider accounts and the possibilities for grounded, rich descriptions (though often the papers in the proceedings are too short to portray these adequately). At the same time, however, we now face a situation where there is little that engages with the wider system through research. What does this mean for us as a community? How might we embrace the challenge in the field of teacher education in particular, for studies that have a wider empirical base?

Secondly, while this is not visible in the table, a glance through any one set of proceedings reveals that in a number of papers, the theoretical orientation (and so too methodology) of the research study is under-
described. This raises the question as to whether the research itself is theoretically informed. Related to this, again across many papers, is a similar under-description of the analytic tools and frames used to analyse data and so make knowledge claims. What does it mean for a community that its methodologies and analytic frames are, in many cases, not being made visible in the papers in the proceedings of its major conference? It remains unknown whether the wider research projects themselves suffer in this way, or whether this phenomenon is a function of the space limitations for a paper in conference proceedings. Nevertheless, what is pointed to here is a challenge for teacher education research that has been noted in South Africa (e.g. Adler 2001) and elsewhere (e.g. Wilson and Berne 1999): evidencing claims about the effects of teacher education, and about teacher learning, particularly in and through rich qualitative studies of practice is no straight-forward matter. There is much work to be done here if the research and its outcomes are to be valued.

Thirdly, an interesting phenomenon emerges in 2000 and 2001 and this is pointed to in the column on research on teacher education in the table above. Three of the papers in the 2000 proceedings in the field of teacher education and one in 2001 are discussions of the research process itself. They include the ethical issues of research “with and on teachers” (Setati 2000), issues of validity in collaborative research (Vithal 2000), the kinds of instruments that might better reveal teacher practices and enable claims about impact on teachers’ learning and/or the mathematical learning of their pupils (Ensor 2000; Adler 2001). Together these reflect a growing and developing field paying increasing attention to the rigour of its research, and by implication the validity of its claims.

CONCLUSIONS
The framework I have brought to bear on research related to mathematics teacher education as reflected in SAARMSTE proceedings has been illuminating, pointing to areas of focus and growth, and how we have come to constitute our field. The review has also brought into focus, that which appears absent in our work. One way to describe our work here is as a predominantly responsive domain, influenced heavily since 1996 by the demands of curriculum reform. We have seen action research disappear from focus, and a concern with the mathematical preparation and development of teachers come into focus. We can see our growth in relation to case studies and rich descriptions of practice, and at the same time an absence of policy and system wide research.

And there is much that resonates here with the implications I drew out earlier from the broad brush over the international field. In addition to identifying the need for research at the level of policy and systems, the black box of the actual practice of teacher education needs opening up. A critical element that has emerged here is a growing acknowledgement that there is specificity to the mathematical work that teachers do. There is an urgent need for a greater understanding of these mathematical demands of teaching across ranging classroom contexts, so as to be able to inform (and then examine too) the mathematical curricula offered to teachers as they prepare and continue learning to teach.

At the same time, we need to continue to work productively with the gap between theoretical and practical knowledge of teaching, between teacher educators and teachers as agents in the field of mathematics teaching, and between research and practice. These tensions in teacher education as a complex site of research and practice persist. It is perhaps fruitful to talk of them as the practice, as constitutive of and constituted by the field. From this perspective, research in the context of and on teacher education will necessarily remain a core concern.

REFERENCES


\[8\] As notes earlier, as similar phenomenon is present in PME proceedings.


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