P 6: Mirror images of an emerging field: Researching mathematics teacher education

Plenary Presentation based on the work of Survey Team 3

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Abstract

Survey Team 3 examined research in mathematics teacher education from 1999-2003. We focused our survey on published research in international mathematics education journals, international handbooks of mathematics education and international mathematics education conference proceedings. Some regional sources from various parts of the world were also included. We investigated who was writing, from and in what settings, with what theoretical frameworks, and with what sorts of study designs for what core questions. We also examined the range of findings and conclusions produced in these studies. Our analysis presented here focuses on four themes that stood out from our investigation of almost 300 published papers, and offers a reflection on the current state of the field of mathematics teacher education research. Our purpose was both to provide a mirror image of the field, and to stimulate discussion that can support its development.

Introduction

Mathematics teacher education as a field of study is relatively young. It is also thriving, with substantial progress in the past decade. It was thus possible, desirable and indeed timely, to take account of our[1] progress at the time of ICME-10: This paper reports our international survey of published research in mathematics teacher education in the past five years[2]. We present some of the mirror images reflected back to us in the survey.

We begin with a discussion of the current field of mathematics teacher education, the emergence of related research, and the value of critical reflection on progress at this juncture. We then discuss why we focused on *research*, and the methods we adopted – where and how we looked in order to construct the survey we did. This process brought to the fore a number of themes, in particular, the research methods in use, issues of authorship and voice, and consequences for the substance of research being done. We observed a field currently dominated by small scale studies in English-speaking countries. The studies we surveyed focused on teachers' learning in the context of a reform agenda, and researchers, typically, were studying aspects of reform programs offered by or in their own institutions. We offer these observed themes as mirror reflections on ourselves

1 We use "our" and "we" in relation to the mathematics education research community and teacher education community as each of us, though in different ways, is involved in mathematics teacher education, and mathematics education research.

2 The research was done by a team (Survey Team 3) of mathematics education researchers – the five authors listed above – and presented at ICME-10 in Copenhagen in July 2004. A copy of the presentation can be viewed on the following websites: www.wits.ac.za/jadler/presentations.html. or www-personal.umich.edu/~dball/BallSelectedPresentations.html.

and our work as a community. We present these as claims, each of which is followed by a range of commentaries. We conclude the paper with some suggestions for the field of mathematics teacher education research, as well as reflections on our work as an invited international survey team.

Mathematics teacher education in 2004

We are currently witnessing what can be called the "massification" of mathematics as a school subject. In many countries today there is an extensive move to make mathematics accessible for all. Mathematics is viewed as a necessary competency for critical citizenship. In her opening address to the Congress, the Minister of Education in Denmark pointed out that in Denmark, competence in both mathematics and English language are viewed as priorities in a globalised world. An obvious consequence of the increasing demand for mathematics proficiency for all is an increase in the need for quality teaching[3]. That this need is evident at all levels of schooling is unprecedented. Although the demand for quality teaching is high at the secondary and tertiary levels of schooling, where mathematics is a specialisation subject, quality teaching is even more important at levels where mathematics is a general requirement. More teachers and better mathematics teaching are needed if mathematical proficiency is indeed to become a widely held competence. Of course, quality instruction depends on teachers, and so their preparation and continuing professional development is crucial.

To make the magnitude of this demand more vivid, we offer a brief glimpse of who the children are that our world's teachers must teach. The snapshots (Pictures 1-5) on the next page are from mathematics classrooms in different countries. At first glance, it is clear that all are classrooms, and they are differently organised. But if we focus more closely, what else can we see? These visual images convey different class sizes and material resource bases, with implications for what it might mean to enable quality teaching in different contexts. In some countries (e.g. South Africa), many mathematics teachers are teaching in large (over 40 learners) classrooms often severely lacking even basic resources. For example, one South African classroom shows one group of learners sharing a single concrete tangram as they explore conservation of area. Class size also varies within countries (e.g. in the US, there is a relatively high pupil-teacher ratio in urban schools while more affluent suburban schools may often enjoy lower class sizes). In many contexts, mathematics classrooms also include a greater range of learners who live in and bring with them diverse cultural practices and languages, as well as linguistic and mathematical competences. This diversity adds to the challenge of providing quality teaching. Globalization is increasing the dominance of English as a language of instruction around the world. More and more learners are having to learn mathematics in English, a language that is not their main spoken language. This phenomenon is no longer specific to (British) post colonial countries. There are similar pressures for English language competence in Scandinavian[4] as well as some European countries (e.g. the Czech Republic). This quick look inside a few different classrooms brings to life that a

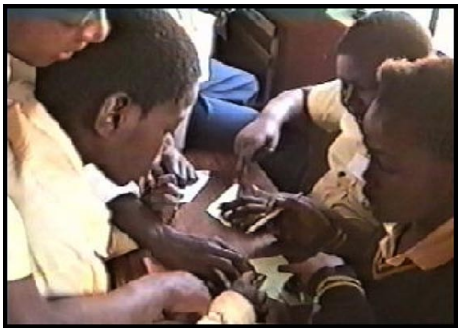
3 The scale of provision of mathematics teachers across countries varies, with enormous shortages of quality teachers in some countries (e.g. the USA) to over-supply in others (e.g. Taiwan). Across countries, however, is the demand for quality teaching at all levels and so a scale of quality provision like never before.

4 This point was made rather forcefully by the Danish Minister of Education in her opening address at ICME-10.

significant part of preparing mathematics teachers for quality instruction, includes preparing teachers to engage and mediate the increasing diversity of their learners.

1. Classroom in the USA

2. Classroom in Czech Republik



3. Classroom in South Africa

4. Classroom in Austria

5. Classroom in Taiwan

But what is it that mathematics teachers need to know and know how to do to enact quality instruction across these diverse conditions? How is teacher education research and practice dealing with these current challenges?

It is as instructive to look across a range of prospective as well as in-service teacher education classes. As we zoom in on the few snapshots (Pictures 6-10) on the next pages we see similar diversity across those learning to teach. There are some smaller and some larger (over 80) groups of teacher learners. There are also culturally homogenous as well as culturally diverse groups. We can detect diverse socio-economic conditions, with differences in the materials and resources being used across teacher education settings. Less

visible, but a significant additional note about who is (re)learning to teach mathematics, is that differences are increasing between teacher educators and their 'learners' – i.e. prospective and practicing teachers. Teacher learners bring increasingly diverse mathematical histories. In many countries prospective elementary teachers have learned limited mathematics in school. In countries where there are great shortages, even prospective secondary teachers are entering training with relatively poor mathematical experiences and performance at school. This reveals that we are dealing with different kinds and levels of under-preparedness, a phenomenon that extends into in-service teacher education. Many practising teachers, for different reasons, have not learned some of the content they are now required to teach, or they have not learned it in ways that enable them to teach what is now required. In particular, curriculum reform processes in mathematics across different countries have resulted in many teachers now having to teach a curriculum that is quite different from the one they were educated for, and from one with which they had become experienced – and often also successful.

Teachers need support if the goal of mathematical proficiency for all is to be reached. The demands this makes on teacher educators and the enterprise of teacher education are great. These, in turn, shape the context in which research on mathematics education is developing.

6: In-service teacher educators South Africa

7: Pre-service teachers Taiwan

8: In-service teacher educators in Czech Republic

9: Pre-service teachers in South Africa

10: In-service teachers in Austria

The timeliness of a survey of research on mathematics teacher education

The timeliness of the survey reported in this paper is not only a function of the current demands on mathematics teaching and teacher education. While still relatively young, mathematics teacher education (MTE), as an area of research and development, has mushroomed in the past five years in particular with multiple approaches and initiatives evident. For example, there were over 60 contributions on mathematics teacher education across various parts of the ICME-10 program (relevant Topic Study Groups, Discussion Groups and the Thematic Afternoon) from a wide range of countries and regions as listed on the congress website[5]. It is also interesting to note that only ten years ago there was very little research on processes of mathematics teacher education, in contrast to research on teachers' beliefs, knowledge, practice, biographies, expert-novice comparisons. Now, in 2004, we have with the *Journal of Mathematics Teacher Education* a journal dedicated to researching teacher education. And we have focus strands in major conferences, particularly the PMEs, as well as increased attention to mathematics teacher education in recently published international handbooks in the field[6]. The importance of teacher education for our community is further signalled by the invitation to develop and present this Survey at ICME-10, and in setting up of ICMI Study 15, focused on teacher education, which is currently in the process of its work.

The Survey Team saw as its responsibility to describe "where are we", globally, in the field and within ICME, and so complement work of ICMI Study 15 upcoming in May 2005. We intended to both survey and report and also contribute to the growth of this relatively new, but critically important, research field. We believed that it was a good moment to hold a mirror up to ourselves and see what it is we are doing. Survey Team 1 (reporting on research and practice in mathematics education)[7] noted the shifts over time in the field of mathematics education research, starting with studies focused on curriculum, then shifting to a focus on learners, then teachers. We would add that the last five years in particular, has seen the emergence of teacher education research. And this emergence is signified in the presence now of journals with specific focus on mathematics teacher education, as well as of dedicated strands in mathematics teacher education in key conferences in the field.

5 See www.icme10.dk

6 See for example Bishop, A., Clements, M.A., Keitel, C., Kilpartick, J. and Leung, F. (2003) (Eds.) *Second International Handbook of Mathematics Education*. Kluwer. Dordrecht.

7 The paper by Survey Team 1 is also in these proceedings. See Sfard, A. and others.

Central questions

For the Survey Team and its work, this meant that a massive amount of material was available to be examined. We decided that, in order to do a useful survey of the field, a clear focus would be helpful. Both because of our own interests, and the demands for research knowledge about teacher development, we posed the following question:

What is research in the field contributing to the improvement of the education of teachers of mathematics?

More specifically, given that the task of mathematics teacher education is to work with large groups of teachers, in diverse contexts, so that they are able to teach mathematics well in diverse settings and conditions, then

- What stands out about research that focuses on mathematics teacher education over the past five years?
- What research is being produced that can contribute to the massive need for supporting teachers' learning and development? We were interested in inquiries of two basic types:
  - *Understanding* how teachers learn, and from what opportunities, and under what conditions
  - *Improving* teachers' opportunities to learn

Delineation of mathematics teacher education research

Mathematics teacher education is a very broad field, and so a key task, as with any survey, was to agree on the meaning of central notions. First, we agreed that by "teachers," we would include student teachers, classroom teachers, and teacher educators. For us that also – importantly – entailed delineating and agreeing on what we would count as *teacher education research*. The *Journal of Mathematics Teacher Education* initiated in 1998 became a useful marker for us, as the research reported there was clearly mathematics teacher education research. We needed, for example, to be able to identify those papers in PME, for example, or in journals not dedicated to teacher education, that would "count" in our survey. There is much work to do to define the broad field we encountered, and this will be developed in a more detailed paper on the first claims to be discussed below. Our perusal of JMTE revealed many studies that occurred in the context of teacher education and focused on teachers' learning and change over time. This is captured in the inner circle in the figure below. In addition to research on teachers' learning, there were numerous papers on teachers' beliefs and knowledge. Some of these were not focused on teachers' learning or changes in their beliefs, and some were not situated in the context of teacher education. We included in the survey presented here, those studies on teachers' knowledge and beliefs where the teachers being studied were those participating in teacher education programmes, but not studies that investigated teachers' knowledge and beliefs independent of questions of learning or change (see Figure.1). The boundary, therefore, around what does and does not count as teacher education research in relation to areas like teachers' knowledge and beliefs is somewhat blurred, and its delineation will require further work. In addition to the papers depicted in the diagram, we included a third set of papers in our survey: theoretical papers focused on mathematics teacher education and papers that provided some meta-analysis of the field.

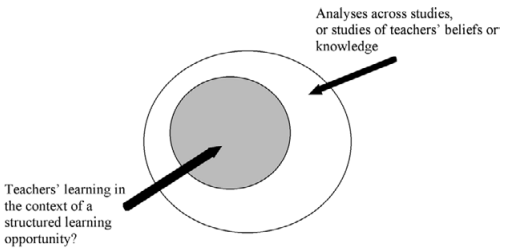


Figure 1. Delineation of areas of mathematics teacher education research examined in this survey

As we move on now to describe and explain what we did and what we found, we need to add that we see each of ourselves as deeply invested in what we are looking at. We are all researchers in mathematics education research, mathematics teacher education practitioners: hence the notion of the mirror. Our different experiences shaped our work, our interpretations, and the nature of our analyses. The differences among us were a resource for the quality of our work; our different perspectives also presented us with challenges. In addition, unlike other collective research endeavours where researchers come to work together over time, and usually in near locations, we were distanced, geographically, culturally, and in the work we do. We begin the next section with some brief comment on the processes we engaged to do this work as a team.

The method we used

Making the survey team work

We play intentionally with words here, capturing the critical dual dimension of our task. We are a diverse group from very different and distanced countries and cultures. We needed to find ways of making the team 'work'. It was clear that undertaking the survey was going to be hard work for each of us, and then together. So we needed to establish work patterns and deadlines. We also needed to find ways, set up processes that would enable us to accomplish team-work – to make this a joint, collaborative task.

We worked hard at both these dimensions of making the survey team work, developing a process that could transcend boundaries of geography, language, orientation and experience and that included: two meetings in person prior to ICME-10; sharing the extensive number of articles that needed to be read; developing a shared framework for this reading and then sharing the data that developed; deciding together on the claims we could make and then constructing common and different interpretations of our claims.

Our work began over e-mail in 2002, where we were able to agree on our focus on research (notwithstanding the massive development work in the field), and allocate parts of the survey. The two meetings, both in 2003 (and each facilitated by a conference that we could all attend), were pivotal in that at the first meeting (May 2003) we were able to discuss and agree on the scope of the work, and what we would and would not include. By the time of the second team meeting in July 2003, we had completed a substantial part of the reading and so were able to focus then on the themes that were emerging from the data, and begin a plan for the presentation at ICME-10.

What we looked at (included and excluded)

All the domains of mathematics teacher education were taken into account: pre-service and in-service, as well as primary and secondary teacher education. By this relatively

broad definition of professional development, we hoped to gain insight into issues that are topical in particular contexts, and into the kinds of problems that appear to be common, or substantively different, across levels and contexts.

We selected from multiple outlets for this work, including peer reviewed journals, international handbooks and key conferences proceedings. We looked across international journals as well as a handful of journals in Asia, Europe, i.e. published in languages other than English where it was possible to access these. In general, however, we did not have the time and resources to investigate thoroughly journals written in e.g. French, German, Russian or Spanish. We capitalised on the advantages we brought as a diverse team from diverse and distanced countries. At the same time, we restricted the survey to published research between 1999 and 2003, that is, since the previous ICME Congress.

The full range of what we looked at is listed in Table 1 below. The focus of our report is nevertheless on the highlighted publications that constitute a careful selection of those journals and proceedings widely considered as either leading publications in our field, or central to the work of the survey[8].

Journals (126 papers)	Journal of Mathematics Teacher Education JMTE 1998 – 2003, No. 3	65
	Journal for Research in Mathematics Education JRME; Journal of Mathematical Thinking &Learning JMT&L; Journal of Teacher Education JTE; all 1999-2003	13
	Educational Studies in Mathematics ESM 1999-2002	2
	Mathematics Teacher Education and Development MTED 1999-2003	34
	Pacific Journal of Teacher Education Chinese Journal of Science Education	11
	Pedagogika	1
Conference proceedings (154 papers)	Proceedings of Psychology of Mathematics Education Conferences 1999 – 2003	88
	Papers from discussion group on teacher education in proceedings ICME9 2000 (a selection of these appears as a special issue of MTED in 2001)	15
	Cerme Conferences of the European Society for Research in Mathematics Education CERME	4
	Symposium on Elementary Maths Teaching SEMT 01 and SEMT 03 MedConf 2000 and 2003 Second and Third Mediterranean Conference on Mathematical Education	21
	NSC and TE conf Taiwan Fou Lai – also here	24
Handbooks	2nd International Handbook of Mathematics Education. Eds. A.J. Bishop, M.A. Clements, C. Keitel, J. Kilpatrick and F.K.S. Leung. 2003 Dordrecht: Kluwer Academic Publishers	4
TOTAL		282

Table 1: Journals and proceedings included in our survey

8 Our survey selection is similar to that of Lerman, Xu and Tsatsaroni in their study of the field of mathematics education research as a whole i.e. key journals and PME proceedings. See, for example, Lerman, S., Xu, R. and Tsatsaroni, A. (2003) "The Production of Theories of Teaching and Learning: The Case of Mathematics". Unpublished paper presented at the AERA Conference, 21 – 25 April, Chicago, USA

How we looked

As mentioned above, we are a diverse team, and one that was constituted by the International Programme Committee of ICME-10. In addition to our geographic spread, we brought different orientations to research in the field. This was a strength in that it broadens the scope of what is 'seen'. At the same time, we faced a considerable challenge in establishing a shared framework that was necessary if we were to carry out a consistent survey. To launch our work, we developed a framework for looking across ranging publications, reproduced in Table 2 below.

Source	Title	Authors + country		
Pre- or in-service Primary or Secondary?	Mathematical topic or process in focus?	Is topic object of study or means to studying something else?	Author field position	Comment on article (summary points, what stands out / what is missing/ problematic)
Central problem	Theoretical orientation	Assumptions	Findings	"Argument"
Methodology	Research design and methods used	Analytic framework	Rigor	

Table 2: Framework for analysis of papers

A great deal of information is contained in the summaries we produced of the 282 papers read and captured in through this framework. A glance across and down the rows and columns of the table reveals that we captured the *who* (who was writing/doing the research, and from where), the *how* (what methods were used) and the *what* (what was being studied, theoretical orientations, assumptions and outcomes).

The value of working this way was that it enabled us to look across and discuss the wide range of papers we had read. It also enabled the job to be done within a reasonable time frame. In addition, this kind of capturing of the data enabled us to examine trends that we might otherwise not have seen. And as with any framework or structure, there were also limitations to the way we went about this work. In particular, when a research team undertakes a survey, they typically do so with a more focused question and theoretical orientation and so are more directed in theoretical underpinnings of the survey. This kind of orientation is thus absent in our survey, by design.

There are interesting things to report about all that we noticed as we read. We focused here, however, on those things that struck us as we began to look across all that we had captured. We formulated four main claims about these major findings. Our claims focus on: (a) where the research in this domain is being done; (b) how it is being done, (c) by whom, and (d) the consequences of these trends[9].

The claims presented below are not necessarily surprising. They reflect the progress we see in some areas. At the same time, we discuss some trends that we believe are troubling. Each of the claims presented is followed by three different comments – each a particular interpretation of the claim by one of us (authors). These multiple commentaries reflect our collective, and sometimes differing, views on the implications of what we saw for the field.

9 Additional aspects of the study will be reported in papers that expand on each of the claims presented below.

Emerging themes

Claim 1: Small-scale qualitative research predominates

By "small scale qualitative research," we mean studies that focus on a single teacher or on small groups of teachers (n<20) within individual programmes or courses. For example, 69% of articles we surveyed in the 1999-2003 PME proceedings were studies of this type.

Table 3 below shows a detailed analysis of 65 papers in JMTE. The first line indicates ten studies dealing with one teacher or teacher educator's learning. Take the following example from a Danish researcher, Jeppe Skott, who investigates very carefully how Christopher, a novice teacher, copes with the complexities of his mathematics classroom[10]. Studies involving two to nine teachers were those that focused on, for example, a study of a group of teachers within one school site or program. The third row in the table refers to papers reporting on investigations with, for example, an entire faculty; the fourth an institute or larger group; and the fifth refers to survey research, and so far larger samples of teachers in the study. The table also indicates what we referred to earlier as meta-studies, those that are theoretical or conceptual with no explicitly stated empirical base. Summing this up, there are 38 papers where there were fewer than 20 teachers in the study. Hence, we observed that a significant percentage of papers are small case studies.

Number of teachers	Number of articles (N=65)
1	10
2-9	18
10-9	10
20-99	14
100-553	5
No data or not claiming to be empirical	8

Table 3: Numbers of teachers studied in each JMTE article

Commentary 1 (Konrad)

The distribution of cases along the five categories including the dominance of small scale research is a mirror of the complexity of the field. For example, study groups at schools and even most entire mathematics faculties at schools have fewer than 20 teachers. A large number of pre-service teacher education classes or summer schools have these numbers of participants.

Only recently, given the results of international comparative studies like TIMSS and PISA, and the growing demands on a better teacher education and more knowledge about its effects, educational policy has begun to realize the importance of research in teacher education. This might give rise to bigger projects where large scale studies are done. In addition, it makes sense that in a new emerging field researchers first refer to a small number of cases, and even to studies of one single teacher, in order to better understand these particular cases and to further develop theoretical frameworks, methodologies and instruments. On that basis it is then easier to build on hypotheses that

10 Skott, J. (2001). "The emerging practices of a novice teacher: the roles of his school mathematics images". *Journal of Mathematics Teacher Education*, **4**, 1, 3-28.

can also be examined with regard to larger studies. From that point of view, it seems natural that the interest in particularisation precedes generalisation. Also, investigating teachers always means to put into consideration their interests, to share the goal of the research with them and to negotiate their role and part in the study. This is a difference, for example, to research on students where such questions of participation, communication, validation of results is not necessary. In addition, research in teacher education is often more complex since it deals not only with the beliefs and knowledge of teachers but also with students' beliefs and knowledge, as well as with the interaction between teachers and students, and the interaction between teacher educators and teachers. Thus, having teachers as the focus of research leads to high complexity. This increases the tendency to keep the sample small in order to reduce complexity. Teacher education needs both – the particular, and the general. However, there is also some general in the particular, and there is always the particular hidden in the general.

Small case studies have an advantage for the theory-practice relationship since it is easier to integrate teachers into research. Also, research results from such studies can be written in the form of "stories" which give an authentic view of practice and give principals, administrators, policy makers, etc. an insight into the complexity of change in the teaching profession. They are a good contrast to percentages which by non-experts often generate the view as if teacher education and teachers' growth is as easy as counting numbers and calculating a means. In addition, such stories are also a good starting point for working with teachers, in particular because they compare their situation with those of the case.

Finally, it is also interesting to reflect on the need expressed by policy makers for large scale studies. We need to engage policy makers and show them a single teacher, so revealing how complex teachers' learning is – and so avoiding falling into the trap of having some narrow conceptions of "best practice" that they, the policy makers, believe can be disseminated.

Commentary 2 (Fou-Lai)

Indeed, it is a natural state that particularization comes before generalization for an emerging field. Developing a theory of teacher learning is a key issue for research on mathematics teacher education: conceptualizing, modeling and theorizing are considered as three stages of development. Small-scale qualitative studies make great contributions for conceptualizing the complexity of teacher education and modeling individual teachers' learning process. Some of the reviewed case studies have developed models of individual teachers' learning[11]. Studies based on different perspectives naturally produce different results. The results of those in-depth small scale qualitative studies could be used as fundamental data for secondary analyses that seek to contribute to theory across studies. When theorizing, large-scale studies are needed for testing the hypothesis.

Commentary 3 (Deborah)

I agree with Konrad and Fou Lai, and want to elaborate the last point made by Fou Lai. Three types of studies are missing in the survey. There is a notable absence of large scale studies, and these are needed to understand the larger landscape of teachers' opportuni-

11 See for example, Chen, I.R. & Lin, F.L. (2004). "A beginning mathematics teacher becoming professional through action research". *Chinese Journal of Science Education*, **12**(1), 83-105

ties for learning around the world and within countries and to contribute to theories of learning to teach. For example we know astonishingly little about the range of ways teachers acquire – or don't acquire – the mathematical knowledge needed for teaching. Small scale studies don't help us sufficiently to understand at larger scale what these learning opportunities look like on large scale. Also notably missing are cross-case studies. There are strong beliefs about methods that help teachers to develop particular kinds of mathematical knowledge for teaching – and I use this only as an example. Without cross-case analyses, we lack opportunities to test those beliefs, to treat them as hypotheses and so to learn about how different approaches, programs and settings affect the content knowledge teachers need to learn how to teach. Finally, we also lack longitudinal studies. Many of the studies we looked at were short term. By way of example, teachers' knowledge develops across many years as they participate in professional development activity, use new curriculum materials, and meet new students. Without studies that follow teachers over time, our understanding of how teachers learn and under what conditions is lacking.

Claim 2: Most teacher education research is conducted by teacher educators studying the teachers with whom they are working

A focus here on JMTE and PME proceedings in the last 5 years bears out this claim most forcefully. Of articles representing research that focus on teacher education, 90% of JMTE articles and 82% of PME articles were of this type. Across all the articles in our survey, we see that articles of this sort amount to approximately 70%.

Commentary 1 (Jarmila)

This is the case because of the very nature of the teacher education profession. Mathematics teacher educators' professional responsibilities include both research and teaching. Research is one aspect of teacher educators' professional development. This kind of research is also an important part of teacher educators' learning to improve their practice. Finally, institutions of education differ from other kinds of institutions in that they provide direct access to teacher education practice and to school. There is thus ready accessibility for teacher educators' pursuit of important research interests.

Commentary 2 (Konrad)

Research done in the context of teacher education is a special kind of research that intersects practice. Teacher educators have the double role of intervening and investigating, or in other words, of improving and understanding. In addition, both aspects are strongly interrelated. This contributes to the complexity of this field.

We do need more external research, in particular, large scale studies. However, this will entail more specifically funded projects.

It also seems to be very important to engage teachers in research activities, for example by integrating them into research projects led by academic researchers or by supporting them to critically and systematically reflect their own practice within collaborative action research projects. Teachers tend not to read research papers within the context of their work, but being involved in such projects mentioned above, bridges might be built. It is important that teachers learn to balance nearness and distance, and that they gain interest in their particular challenges but also in the general problems.

Commentary 3 (Jill)
While agreeing with much that has been commented on above, I would like to add to the issue of nearness and distance. It is difficult, when you have an investment in who you are teaching, to take a sceptical stance towards that work. Important questions that need to be asked might be missed. So, a critical question is what we need to do to help ourselves do this. One way is to invite "external eyes" to gaze in with us on what we are doing. Another way is to develop strong and effective theoretical languages that enable us to create a distance between ourselves and what we are looking at.

Claim 3: Research in countries where English is the national language dominates the literature
For example, in JMTE between 1999-2003, 80% of the articles were from such countries. It is less stark, but nevertheless prevalent, in PME, where the percentage is 43%.

	JMTE (n=65)	PME (n=88)
North America	68% (65% U.S.)	30% (24% U.S.)
Oceana	8%	9%
Europe	15% (5% U.K.)	25% (6% U.K.)
Africa	3% (all South Africa)	8% (6% South Africa)
Asia	5%	9% (7% Taiwan)
South and Central America	0	3% (all Brazil)
Inter-continental	0	7%
Middle East	2% (all Israel)	14% (all Israel)

Table 4: Where is research being done? Two major examples

The detail in the Table 4 above helps us to focus in further. Presenting the information across regions at the same time hides some interesting phenomena inside regions. For example, in the Middle East, all of the papers we read were from Israel. Similarly, in Africa, all the papers were from South Africa, and in Asia, all from Taiwan. In North America, the vast majority are from the US, and, indeed, there is a remarkable predominance of US authored papers in JMTE overall.

Commentary 1 (Jill)
These disparities are not surprising. The prevalence and increasing hegemony of English was referred to in the opening ceremony of the Congress. But the disparities are deeply troubling. For some people in our community, their "local" becomes global. Their particulars become the basis of the general. In others, their local *remains* local – indeed does not even get heard. What problems, and whose problems then come to constitute the field? This is a critical question for us, particularly if we reflect back for a moment on the pictures of diverse learners across selected classrooms earlier in this article.

Commentary 2 (Fou-Lai)
Mathematics education, as a field of study, can be traced back 30 – 40 years, with strong roots in the United States, Europe and Australia. The presentation of Survey Team 1, ICME-10, showed the shift of research foci in mathematics education starting from a focus on curricula in the 1970s, then shifting to a focus on learners in the 1980s~90s, and more recently there has been a shift to a focus on teachers. These developmental

shifts seem natural since information resulting from research on curricula and learners very often are necessary as foundation for research on teachers. Those that start first, then can base their accumulated knowledge on curricula and learners to move on studying teachers. Thus, "first start-first" achieved is rather a natural development. The dominance of research from English speaking countries we witnessed is thus understandable.

However, there are other factors that exacerbate this dominance. Many students from other countries take mathematics education programs in the US, UK, Australia, Canada. When these students return to their homelands, and undertake research, they often base these on the perspectives they have learned from abroad. For example, the following topics are pursued: Changes of beliefs, growth of pedagogical content knowledge, and different degrees of awareness of the complexity of teaching. Studies that are based on the same research perspectives are often merely seen as replication, and thus rejected for publication. This stands in interesting contrast to the natural sciences where replicated experimental studies have their value. Replication studies in mathematics education are not favoured by journal reviewers. Comments from reviewers are that the research is not innovative and so not contributing to the field.

Recently (2003) a new international journal in mathematics and science education[12] has been launched with a support system for authors whose mother tongue is not English. In this Journal, the editorials encourage researchers to take societal and cultural practices into account. Hopefully, the publication of this journal will gradually change the phenomena of dominance of authors with English as their first language in the field of mathematics education.

Commentary 3 (Deborah)

As a person who comes from one of these English-speaking countries, I share the sense of how disturbing this is – of what we don't learn about and how we become persuaded that what we know from local settings is somehow more general in our field. And what this caused me to reflect on is what this might mean for the induction of new researchers where English is the main language. For instance, it is important in the education of new researchers to include the development of a disposition and set of skills to actively seek broader literature from more countries, to hold a more sceptical stance about beliefs and generalisations developed in one's own context or country. It is important to develop a stance that avoids confusion between the local and the global. And so it is important to be able to work (read and speak) in more than one language.

Moving on to our fourth claim: The first three claims combine to shape this emerging field in mathematics teacher edudation and we ask the question: *What* are the consequences for a field that is characterized in these ways: by a predominance of small scale qualitative studies *(how)*; teacher educators studying their own contexts *(who)*; and a predominance of publications from countries where English is a national language *(where)*. In other words, *the how, the who* and *the where* have important consequences for the *what* we are learning, and that takes us to Claim 4.

12 *International Journal of Science and Mathematics Education*, Kluwer, **1**, 2003; **2** 2004.

Claim 4: Some questions have been studied, not exhaustively, but extensively, while other important questions remain unexamined.

What has *been studied extensively?* We noted many articles that involve efforts to establish that particular programs of teacher education 'work'. Interestingly, you can understand how this particular trend follows from our second claim: that the research is often conducted by people studying their own program. One designs a program and one wants to show that it works. It is not so surprising that efforts to show that things work predominate.

We also found a large number of papers dealing with reform processes, particularly in the US. These include studies of teachers learning or relearning mathematics, teachers learning about students' thinking, their language, their orientations and pedagogical practices – and you can understand this as an instance of the local becoming the global. In the last case, efforts about math reform dominate with US researchers who are themselves involved in the program they are studying. And then those in the US get to publish more – we find our ways into the journals and this becomes a dominant theme in the literature.

We saw a large number of teacher studies in professional communities and in other institutional settings and we see this, in part, growing out of our first claim, and the emphasis we saw on small-scale qualitative work in the context where it takes place.

What has been studied less? We list here some important examples that we think are notably missing. Clearly you could make a different list as many things have not been studied, or studied less. We chose as a group to identify a small set of things of what is notably missing that has consequences for what we understand and can do in the practice of teacher education and in policy surrounding it.

We have studied less:

- Teacher learning outside of "reform" contexts – many teachers are struggling to develop their teaching skills in environments where reform is not the dominant issue; but assisting a wide range of learners at learning mathematics is. How does the dominant thrust of research on and in reform contexts help to understand this?
- Teachers' learning from experience – we know much less than we should *what* teachers learn from experience, *whether* teachers learn from experience, and what supports learning from experience. Teachers spend most of their time doing teaching. We understand far too little about what helps some teachers to develop from their own teaching while others do not.
- Teachers' learning to directly address inequality and diversity in their teaching of mathematics – we know far too little about teachers' learning to directly address inequality and diversity within their teaching of mathematics and here we include culture, gender, language, socio economic status and mathematical background.
- Comparisons of different opportunities to learn – we lack comparisons in the field that compare different opportunities to learn – how does one approach to helping teachers to learn mathematics compare with another? – we have studied these sorts of comparisons much less.

- "Scaling up": i.e. What happens when programmes spread to multiple sites – we have also done less of studying what it means to scale up or what it means to extend a program that has worked in one setting to another setting – what works, what goes wrong, what do designers need to know and think about?

Reflections on our Survey Team work

As with any research endeavour, it is important to reflect on one's own process of production. Before concluding with what each of the team believes is important for the advancement of the field, we offer some reflections on our work, reflection both on what we have and have not done.

What we have done

What we have presented, and how we have done so, are a function of our interpretation and enactment of our task and how we carried it out. We set out to survey the field over the past five years – since the last ICME; to take advantage of the diversity and expertise of our group; to develop ways to share and develop and communicate shared and contested interpretations of what we found; and to identify accomplishments of the field, as members of it, as well as ways in which the field can grow.

What we have not done

While accomplishing much of what we set out to do, we did not conduct a complete survey of literature around the world. Nor did we move on to systematically evaluate the *quality* of research in mathematics teacher education. In particular we have not commented on: the use and development of theory; the use of appropriate methods; the quality of analysis and how well claims are supported by evidence.

These are important tasks that remain to be accomplished. So we conclude now with brief comments from each of the team members as to what we see as directions for the field.

So: What now? Comments and directions for the field

Jarmila: I am speaking from the position of someone outside of main teacher education theories, but someone who has access and/or is trying to have access to them. The field needs to find ways to transcend cultural and language boundaries to profit more from multiple traditions and schools of thought. A good practice in this direction is international summer schools where colleagues from various places can meet and discuss and work together.

Jill: The field also needs to focus on is what it means to teach both *mathematics* and *teaching* in the same program. We do not understand well enough how mathematics and teaching, as inter-related objects, come to produce and constitute each other in teacher education practice. We don't know well enough what and how this happens inside a teacher education program, and then across ranging or contrasting programs, contexts and conditions. The field needs to understand better how mathematics and teaching combine in teachers' development and identities.

Fou Lai: The field needs better "local" (geographic, topic-specific, etc.) theories of teacher learning before trying to accomplish general theories about how teachers learn.

Konrad: More creative forms for presenting research results are needed, in order to represent the complexity of the field. The field has such variety and this could also be mirrored in the presentation of our research. For example, we need authentic and interesting stories, both practice-grounded *and* theory-driven, and combinations of "reflective papers" by teachers with cross-analyses by teacher educators. In order to overcome the gap between theory and practice – to support teachers to come nearer to our field – more action research is needed, combining first-order and second-order action research: Teachers investigate their practice, and teacher educators investigate their support processes.

Deborah: Teacher education research has been dominated by – and has profited from – small-scale studies, and from teacher educators studying their own contexts. For the field to grow to contribute to policy and practice, and to teachers' learning, however, we need to build capacity for smart, probing, comparative and large scale studies.

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