MERGA or MEGA: The Future of Mathematics Education Research in Australasia

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The state of mathematics education research is inextricably linked to other areas in the mathematical sciences as it cannot be separated from the teaching of mathematics nor the discipline itself. There is a crisis in the supply of mathematics teachers and no discipline can afford the losses documented across university schools of mathematics in Australia since 1995 and maintain a vibrant research presence. These factors, combined with other political forces, suggest an uncertain future for mathematics education research.

Last year a report on the mathematical sciences in Australia (Thomas, 2000) generated a cartoon. It had the Prime Minister at the HSC exams chewing on a pencil faced with question 17 which read "If a university mathematics department loses 26% of its staff in a 4-year period to 1999, in what year will the last mathematician leave the country?" The thought balloon was "When will I ever need to know this stuff" and the cartoon was titled "The fatal score". The report stated:

> There is something seriously amiss in a country when many of its best teachers and researchers in disciplines as important as the mathematical sciences are demoralised, disillusioned and depressed. This has many causes but to an insider the principal cause is fear for the discipline itself. No discipline will grow and prosper with the kind of loss of intellectual capital that is represented by the mathematical brain drain that has been documented here. Nor can Australia prosper while the mathematics education of its young is in the hands of an increasingly under-qualified cohort of teachers. (Thomas, 2000, p. 32)

For a number of reasons there appears to be more optimism in mathematics education research than in mathematics itself, largely due to the number of government funded projects which have generated both money and positions. But how healthy is mathematics education research when, as an example, many of Australia's best researchers are tied up with grants or tenders of various kinds where they have little control over the 'research'.

Mathematics education research needs critical debate if it is to have a future. It has been argued elsewhere that the debate about the control of research that almost began in 1995 is now urgent (Horwood & Thomas, 2000). This year MERGA has a conference where 'mathematics', 'education' and 'research' are missing from the title but it does have 'numeracy' whose origins are purely political. Meanwhile the economic divide in terms of access to a quality mathematics education grows every year. Teese (2000) has demonstrated how deeply ingrained and intractable factors relating to student background have become in regard to participation and achievement in mathematics. One of the few papers at last year's conference to discuss this issue came from work at the Australian Council for Educational Research (ACER) in a paper by Lamb and Fullarton (2000) which used Third International Mathematics and Science Study (TIMSS) data. Since then ACER has lost core government funding which may comprise its ability to conduct this kind of basic research.

The political influences on mathematics education research in Australia become more obvious every year. This paper is intended to start a debate about how to maintain the quality and quantity of mathematics education research in Australia that had earned

MERGA and its members international recognition. Begg (2000) expressed the hope that MERGA was incorporated because we wanted to take risks but avoid the dire financial consequences. Given the amount of money from government and industry sources that is now contributing to 'research', I suggest that it may be necessary to accept some of the financial consequences in the short term if mathematics education research is to maintain its integrity.

Dealing with silenced or compliant academics and educators is just one of the challenges of dealing with what are political issues and trying to get them debated. Begg (2000) also noted that "Research is personal, we need to be honest and use "I" in our reports" (p. 23). I intend to follow his advice and go even further and begin by describing how I used somewhat unorthodox research but got issues in the mathematical sciences into question time in the House and in the Senate. I will then turn more specifically to issues in mathematics education research.

Research by Story Telling

The politics of education in Australia in the 1990s have created a cautious academy where documenting some of the problems besetting the university sector and education more generally are not easy. When the current government kept insisting that there was no brain drain in the sciences it was considered that documenting what was happening in a identifiable area such as the mathematical sciences might offer a counter. The government data was known to be based mainly on the departure and arrival cards submitted to immigration. As a result a highly experienced research scientist could be offset by anyone with an higher degree even if that person was virtually unemployable in Australia.

Initial attempts to collect data via the Heads of Mathematical Sciences Departments in the universities yielded little data of any use. There were several reasons for this but I think the main ones were exhaustion so that even a small questionnaire was ignored and, more importantly, concern that documenting what was happening in their domain would become public in some way that might identify their institutions. They did not want to make what they knew to be a serious situation public if it was going to make matters worse within their own departments.

Frustrated by the lack of useful data, and surrounded by documents that talked of science, technology and innovation but seldom mentioned that mathematics was important to this, I started a list of mathematicians and statisticians I knew had gone overseas. If mathematics was going to get on the political agenda, what was known to be happening had to be public and there had to be data to back it up. The list I started used only names and where they had gone—many to prestigious places like Oxford, Cambridge and Harvard. It was circulated to the Heads and other key people in the mathematical sciences departments across the university sector. Almost overnight the names started coming in. More importantly comments and anecdotes came with them and they began to tell a story. The extent and nature of the losses in mathematics and statistics departments since 1995 shocked me and it shocked the broader mathematical sciences community. A frustrated media, who had wanted real evidence of the brain drain for months, ensured that the data had wide publicity. Some six months later they are still using it with claims such as "The science brain drain is well documented" (Lawnham, 2001, p. 35).

The publication of this largely anecdotal evidence, but backed by names of people who had actually left to real positions elsewhere, changed the language of the government from 'there is no brain drain' to 'measures to stop the brain drain' in the space of about twenty-four hours. For the first time 'mathematics' started to be talked about without being

assumed to be included in 'science'. I have called this 'research by story telling'—I set out to document what was happening in the mathematical sciences and I collected stories and anecdotes. The only quantitative data I had were senior secondary enrolment trends and less than complete figures relating to staff and student numbers in university mathematics departments. Given the debate that can surround methodology in educational settings, it is ironic the result of this work was complete endorsement and thanks from the mathematicians and statisticians.

Methodologies and Publishing Outside the Square

The above illustrates what I have said in many forums since I started writing about the political milieu in which mathematics education research and teaching reside. Conventional methodologies such as the carefully constructed questionnaire and the paper in the refereed journal either do not work or do not address the issues quickly enough. The writing of the report on the mathematical sciences was a political act and, to achieve its objective of raising the profile of the mathematical sciences at a time when reports by the Chief Scientist (Batterham, 2000) and by Miles (2000) on implementing an innovation strategy for Australia seldom mentioned 'mathematics' or 'mathematics teachers', it had to be published quickly in a way that gave it high visibility and easy access.

Fortunately it was endorsed by the Federation of Australian Scientific and Technological Societies (FASTS) for publication in their series of Occasional Papers which gave it immediate attention and credibility. That it had been read and subject to critique by the President and Vice-President of the Australian Mathematical Society (AustMS), the Chair of the National Committee for Mathematics (NCM), President of the Australian Mathematical Sciences Council (AMSC) and other FASTS Executive members gave me confidence that it did speak for the discipline and science more generally. Its strength lies in the data the Heads of Departments of Mathematical Sciences departments gave me and this says much for how we go about collecting data that 'tells a story' that needs to be told. Issues of confidentially and trust and how it is reported become very important but finding the means to get data and report it expeditiously are greater challenges.

Much of the cost was carried by the AustMS who would have carried it all if this had been necessary. The problem of making a document readily accessible to the press and others without huge additional costs was solved by having a pdf version on the FASTS web site, a useful mechanism that was borrowed from government. Only a handful of copies had actually been printed when the media release was sent out but plenty of copies were available for Science Meets Parliament day the following week. So when about 180 Members of Parliament met with the scientists, many of them were given a copy of the report. That this generated questions in the House and in the Senate was an added bonus.

I have achieved great personal satisfaction by being able to put together a report which has put the mathematical sciences in the political spotlight. However it is essentially owned by the profession—it will not generate my university any extra research funding. If I was personally ambitious, or concerned about promotion or tenure, I would not write many of the things I do nor would I spend the time on many of the lobbying, policy analysis and media related things that I engage in. But I took this path because I could not see the point in doing research in areas of access and equity when political structures meant that the educational divide, including access to mathematics education, was widening. From the perspective of what I wrote last year this divide is likely to become a chasm.

While there is likely to be some attention paid to the problems in this election year, they are now so deeply routed in an inter-connected way involving school mathematics, mathematics education and the discipline itself, that a word being used among the mathematicians is 'rebuilding'. In 1996 Australian had a relatively strong base in advanced mathematical sciences but it was seen as fragile (National Committee for Mathematics, 1996). It was in no position to withstand what has happened since. Mathematics education research in this period has also be caught up in issues of university funding, fundamental changes in the way educational bureaucracies operate and a number of other factors.

Mathematics Education Research 2001

I suggest that mathematics education research in Australia is moving towards two kinds. One is long-term projects funded by the Australian Research Council (ARC) which by their nature can be considered basic research. While they contribute important knowledge about the teaching and learning of mathematics, they tend not to produce critical debate about mathematics education outside of a rather elite group of fellow researchers. The other is long and short term projects which result from ARC Industry type grants or various forms of government tenders. These are even less likely to produce critical debate.

This should not be taken as a criticism of either kind of research. In particular some of the various 'numeracy' projects appear to be producing discussion and debate among teachers involved in them and this is a wonderful result. But where, for example, is the critical evaluation of the actual projects and processes within MERGA or the broader community? If Monsanto sponsored a major symposium to produce a statement on the benefits of genetically modified foods with participants who had nearly all had research money or sponsorship in some form from the company, what credibility would it have unless there is another stage of critical review by those who have nothing to lose by being objective. These kinds of events and projects occur in mathematics education research, often without the critical review stage.

The lack of critical debate is becoming a feature of education. At a recent conference in Melbourne the keynote speaker was Tom Bentley, an Oxford graduate with a gift for words who has been advising the Blair government on education and has been described by the London *Financial Times* as "one of the four men who think for Britain" (Australian Fabian Society, 2001, p. 1). At age 27 he has no actual experience of schools or education in England, let alone Australia, but he appears to have the ear of various Australian ministers and bureaucrats. I suggest this would not have happened in the mid 1980s and indicates the extent to which advisers and spin-doctors now control agendas. It further lessens any chance that educational research will have much impact on anything unless there is countering public critical debate.

It appears that mathematics education and research are destined to become more politicised and the discussion here should not be seen in isolation from events elsewhere. In this regard the situation in the United States where the National Council of Teachers of Mathematics (NCTM) has produced a highly political document in the form of their *Principles and Standards for School Mathematics* (NCTM, 2000) and also controls the main research journal is interesting. A number of critiques and comments on the PSSM have already appeared in the *Notices of the American Mathematical Society* and it is possible to see avenues such as this becoming the main venues for debate. This is not suggesting that the journal editors are less than professional but as a researcher it might

pose questions as to where an article that was either critical of the *Principles,* or attempting to generate critical debate about it, has greater likelihood of being accepted.

The Challenges for Mathematics Education Research

The most obvious challenge relates to the discussion above but there are several others. Many MERGA members are now tied to projects which are controlled in all kinds of ways. In the past many of these projects would have been the preserve of ministry curriculum departments and MERGA members would have been involved in aspects such as advisory committees. However others did the actual work, there were generally more resources available and the processes were more collaborative and less controlled. Corporate memory seems to have completely failed in regard to how parsimonious the money spent on projects and professional development and support for teachers now is. Fifteen years ago there were many more consultants in central and regional positions, there was much more money for professional development which was a mix of federal and state money and there were more mathematics educators in bigger schools of education.[1]

Challenge 1 is the current supply of mathematics educators. Like the discipline areas in the mathematical sciences, too few people are being expected to do too much and if senior mathematics education positions are advertised they are unlikely to be attractive to many overseas applicants. I am observing the same kind of shifting of academics between universities in both mathematics education and the discipline areas. When a position is advertised in Australia, it is filled from within Australia creating a vacancy which when filled creates another vacancy and so on. Even if conditions in the universities improved—both in terms of work load and access to research funds—Australian universities would struggle to compete with the competition that is going to come from the United States of America. Reys (2000) cites a recent survey of mathematics education faculty in 48 institutions which showed over 50% reaching retirement age in the next two years and almost 80% being eligible for retirement within ten years. He also noted job opportunities 'in schools/departments of education, school districts, governmental positions, publishers, and testing companies have increased' (p. 1267). I know of no data in Australia that addresses what the situation is in regard to supply and demand for mathematics educators, nor age profiles, but I suspect there are similar problems looming. Anecdotal evidence suggests that it is already difficult to find suitable candidates for research projects and for teaching release.

Challenge 2 is the future supply of mathematics educators. Education faculties have faced great difficulties maintaining course-work postgraduate degrees yet these were often an achievable objective for teachers. Some then found they liked research and went further. Recent changes to arrangements to postgraduate scholarships, with an emphasis on completion in a minimum time and other aspects, would appear to generate further problems. However, a far greater problem would appear to be the future supply of mathematics educators who have a strong mathematical background. The number of honours and higher graduates in the mathematical sciences has been decreasing and it is rare for them to go into teaching. Again there is no evidence but I suspect that, in general,

[1] Child Migrant Education Services in Victoria, for example, would have had nearly as many staff as are currently employed as the total central curriculum staff. Apart from other professional development, 3 ten-day materials writing workshops were run each year. These had two residential components and participants were fully covered for this plus relief teachers for the ten days. Resultant materials were available to schools free as were the wealth of resources coming out the central support body in Canberra.

younger mathematics educators have less mathematics in their background than the people they are replacing. It is difficult to see how mathematics education research can be done well it if is disconnected from either the discipline or from teaching.

Challenge 3 is the supply of mathematics teachers. It is clear to MERGA members what a major problem this is in Australia. While there was an upsurge in demand for eduction places this year, there appears to have been little increase in the number of places available nor in recent mathematics graduates applying. There has been an increase in mathematics methods classes in Victoria for example but this has been achieved by mature age intake, not recent graduates. This also happened in England when it became apparent that employment was more or less guaranteed but it was a temporary phenomenon. Mathematics education research becomes somewhat irrelevant when so many students are taught be teachers who do not have adequate qualifications. Meanwhile the Deans of Education keep publishing data predicting a crisis in teacher supply extending far beyond mathematics teachers and the federal Minister for Education keeps refuting it (Maslen, 2001) and very little happens to address the problem.

Challenge 4 is the invisibility of the mathematical sciences in Canberra. I am frequently asked why FASTS, governments and other bodies pay so little attention to mathematics. The answer is that it is not intentional although I have been known to show more than a little impatience on that score. There is a somewhat naïve view that mathematics resides within science and if 'science' is mentioned, then it includes mathematics. This ignores a number of aspects of the mathematical sciences in regard to areas outside of science and technology and why they have been described as 'a critical, generic, enabling technology' (National Committee for Mathematics, 1996, p. 33). It becomes a much more serious issue when the teaching of mathematics in schools is not given the same attention as the teaching of science in schools. Until the Australian Association of Mathematics Teachers (AAMT) takes a much more pro-active role in the broad policy debates that occur under the banner of 'science', then mathematics teaching will continue to take a back seat to science teaching. This has nothing to do with whether AAMT is a member of the AMSC or FASTS—it is about how the Australian Science Teachers Association (ASTA), which left FASTS before AAMT, have maintained political profile in Canberra by staying in touch with 'science' policy whereas AAMT has not. I will give one example of what I mean—the big 'science' meeting for 2000 was the Innovation Summit. It was clear that this was going to form the basis of the government's science and technology policy. ASTA sent a representative, AAMT did not, and science teaching got attention but not mathematics teaching. Science teaching issues are visible in Canberra—mathematics teaching issues are not.

Challenge 5 is the globalised world of mathematics education. This to me is the greatest challenge of all. How do we, as mathematics education researchers, make our work part of an agenda for social justice when it is so dependent on economic policies tied to multinational companies of immense power and influence? This has led to bureaucratic structures of control and accountability which ignore the underlying problems. For example, solving the problem of supply of mathematics teachers is an equity issue. Solving it will be expensive but governments win office by promising low taxes to individuals and companies. The recent publication by Atweh, Forgasz and Nebres (2001) is something of which MERGA should be proud. At least some of these issues are being written about—the solutions may be further away.

Solutions?

The following table is taken from the FASTS Occasional Paper and sets out the framework for rebuilding the mathematical sciences proposed there.

Table 1
Solutions for the Mathematical Sciences (Thomas, 2000, p. 23)

Action	Funding	Implementation
Public campaign to improve participation in mathematics	Some state and federal, most from industry	Discipline societies with assistance from MERGA and mathematics teachers associations
Improving teacher supply and quality	State and federal governments and other employers	State ministries of education in conjunction with university education and mathematics departments. Some national coordination through Fields type institute
Improving support for advanced level mathematical sciences and services	State and federal governments and industry, including finance, IT, engineering, manufacturing and biotechnology. Access to CRC program through revised guidelines	Establish Fields type institute. Key partners to be university mathematical science departments and mathematics educators, CMIS, industry users

The suggestions here address the fundamental weaknesses that were identified in the discussion paper. There is a need for young people to see reasons for studying mathematics and their parents need to understand that computers have not lessened the importance of mathematics. Unless this happens it will be harder to address teacher shortages as principals, unable to find staff to teach the higher level courses, will say they are not necessary. As universities drop pre-requisites, there is some anecdotal evidence that this is already happening.

In the short term the teacher supply problem can only be addressed by re-training existing teachers. Australia is not producing enough mathematics graduates to meet its needs and salaries keep going up in the business and finance sector making it even harder to attract them to teaching. Retraining could happen on a quite large scale if the Federal government funded the places and the State governments funded the study leave.

If students are encouraged to continue with mathematics there must be real careers in advanced level mathematics. The Institute structure proposed is similar to the Australian Institute of Sport and calls for central coordination of centre of excellence. The Fields Institute in Toronto began with a mathematical sciences research focus. Recently it has become host to a number of educational projects. This kind of Institute structure could provide a way for there to be a national centre for mathematics education research and teaching and a truly collaborative effort to address some of the challenges identified here. The current system where we compete against each other for bureaucratically controlled projects is neither logical nor in the interests of mathematics education research.

Concluding Comment

I did not set out to be deliberately provocative in writing this paper but I suspect others will see it in that light. However, unless the potential problems are discussed and debated then MERGA may lose its 'research'. I think the issues I am raising need to be discussed and I hope the paper is seen in that light.

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