Submission from the Australian Association of Mathematics Teachers Inc. (AAMT) to the Discussion Paper: Strategies to Attract and Retain Teachers of Science, Technology and Mathematics

Summary

The Executive of the AAMT, on behalf of its Council and over 5000 members welcomes the opportunity to provide input to the Review of Teaching and Teacher Education. This submission represents the views of members in as comprehensive a manner as possible, given the short timeline for submissions. All members were invited to contribute to the submission via an email notice, the AAMT web site and the AAMT Newsletter. A draft of this submission, incorporating those comments received from members, was then posted on the web site, and further comment invited from members over a period of two weeks.

As teachers of mathematics in schools at all levels and in all states, territories and jurisdictions, our members have a keen interest in the recruitment and retention of teachers and the promotion of excellence and innovation in the teaching and learning of mathematics in Australian schools.

Please note that this Submission should be read in conjunction with the initial submission from the AAMT, reference number RTTE 3.

Initial comments

What is the cost of not enough teachers? What is the cost to a school that cannot fill a position with a suitably qualified teacher? What is the emotional cost on the teachers of that school trying to fill the gap? What is the impact of children being taught science, technology or mathematics by under-qualified teachers "filling in"? What is the long-term impact on students in terms of their attitudes towards learning mathematics, doing mathematics and teaching mathematics? What is the long-term impact on society of people who have not been taught mathematics by enthusiastic and knowledgeable teachers, in an era where the capacity to make informed and critical decisions based on a capacity to apply a sound knowledge of mathematics to a real situation is becoming increasingly important?

The cost to children, to schools, and to society cannot be measured in dollar terms alone, but even a cursory calculation of the material and personnel cost of a society that is not scientifically, technologically and mathematically aware is enormous. The key to preventing such a situation from arising is a school system in which young people are challenged and inspired by well-qualified teachers of science, technology and mathematics. The AAMT believes that the current and impending shortage of mathematics teachers has enormous cost to Australian society, both in financial terms and in terms of the loss of knowledge. We believe that significant expenditure now to address these serious problems will save far greater losses in years to come.

The AAMT believes that the issue cannot be avoided, and that significant investment of resources needs to be made on several fronts. These include exemplary education and training for new teachers, significant ongoing professional development for existing teachers of mathematics as well as effective and innovative retraining

programs for teachers not qualified in mathematics who are teaching out of their subject speciality. However, such exemplary pre-service and in-service education will count for little unless issues such as the pay and conditions of teachers are addressed. The impact of low salary scales for teachers who quickly reach a ceiling, when compared with other work that people with expertise in science, technology and mathematics could undertake, cannot be underestimated. In an education system where structures and working conditions have changed little in the past fifty years, yet community expectations and teachers' responsibilities have increased dramatically, it is little wonder that recruitment and retention of well-qualified teachers looms as a major problem. Any long-term solution requires a systematic addressing of salary scales, working conditions and school structures.

Simplistic attempts to address the problem such as encouraging more people to undertake tertiary studies in mathematics, recruiting new teachers from interstate or overseas, or advertising campaigns will provide, at best, short term benefits. Long-term solutions depend on raising the profile of teaching, and recognising the enormous contribution teachers make to the lives of young people and to society in general. This, in turn, depends on outstanding teachers being given the opportunity to share their expertise through professional associations, in Universities, in systems, and in centres of excellence in mathematics education training and research. Organisations and centres such as these, working in partnership, with adequate funds for coordination, research and development, will go a long way towards re-establishing teaching as the cornerstone of a scientifically and mathematically advanced society.

Nothing less that a whole-hearted engagement by government, state systems, the independent and Catholic sectors, and the community in general will suffice if there is to be a culture of innovation in mathematics education. Australia's future depends on a sustainable and strong school system, both government and non-government. Schools that do not have excellent teachers of science, technology and mathematics will become behaviour management institutions, rather than places of learning.

Discussion of the background

The use of the term 'more innovative culture' in the context of the Discussion Paper is not backed by a definition. Hence, an important and urgent need is for clarity about the term itself and the characteristics of such a culture — the thinking needs to be worked through in order to generate ownership among teachers and schools of the kinds of thinking and approaches that are implied by such a culture. Substantial information and debate is needed — not 'slick' and superficial presentations. Also, there needs to be some careful research and development to create knowledge about managing teaching and learning in this new culture, and perhaps some models for others to begin with. Telling people to 'just do it' will not be efficient or effective.

The discussion of demand for teachers within the section headed "Teacher Supply and Demand" glosses over current deficiencies in the personnel management employed by education systems across Australia, which are a major contributing factor to high resignation rates among certain groups of teachers, particularly those with science, technology and mathematics backgrounds.

This submission is not the place to quote personal work histories that have been related to the AAMT through its consultation process and by other means. In summary, however, it is true to say that the employment processes in at least some

jurisdictions are bound by rules, rather than reflecting the flexibility that would lead to the provision of some well qualified and capable teachers of mathematics. Implementation of the recommendations of this Review in a range of areas is critical and must be effective. An important area is for the jurisdictions to actively pursue strategies that will work, but which are outside of current practices — more flexible employment practices are an important part of the 'innovative culture'.

It also ignores the demand created by changing curricula and by changes in the workloads of staff employed in schools. Through its focus on 'different models of teaching' the Discussion Paper implies that there is a concurrent radical overhaul of curriculum. To take the critical stance necessary to work in different ways will inevitably challenge much of the content and assessment that is currently in place. Again, this submission is not the place to argue the details, but there is no doubt that the mathematical 'basics' of the knowledge economy are very different from current curricula. For example, there is little or no serious coverage of the mathematics of codes and security of information in any senior secondary courses around the country, yet these areas are fundamental to commerce, the health sciences and so on. This is not to say that the nature of a 'new' curriculum in mathematics that meshes with innovation orientation and the knowledge economy is known. The Review should mount the argument and design a process for such a national initiative. A key principle that would be needed is to have an inclusive, apolitical process not dogged by interstate rivalries and prejudices.

There is considerable anecdotal evidence that the real demand for teachers of science, technology and mathematics is hidden, due to the large numbers of teachers teaching in these areas without an adequate academic background. Figures relating to this issue are difficult to collect, as there is often an implicit assumption that experience in teaching in a given specialization is sufficient qualification in itself. The AAMT would dispute this view.

For this reason we believe that the actual shortage of teachers of mathematics is more acute than that portrayed in the section headed "Teacher Shortages". Not only is there a potential problem in the years to 2010, but there is an existing problem in 2002. The decrease of 46% from 1992 to 2000 in the number of students undertaking first year mathematics courses serves to exacerbate this existing shortage.

The AAMT notes that 280 new places, rising to 665 as students complete their course of study, were allocated to innovative teacher education programs focusing on specializations in science, technology and mathematics, but recommends that further evidence regarding the degree to which these were taken up by students, and the completion rate, be collected. Given the absolute decline of 1403 students studying first year subjects in these areas, these innovative programs provide, at best, only a very partial solution.

The AAMT notes the discussion on the gender profile of the teaching workforce, but recommends that further evidence regarding the extent to which this imbalance is reflected in the areas of science, technology and mathematics be provided. Gender is but one aspect of the broader issue of diversity in the teaching profession. The lack of indigenous teachers is another aspect of this issue, as is the under-representation of other minority groups and teachers from lower socio-economic backgrounds. This lack of representation is a contributing factor, at least in part, to curriculum and assessment regimes that may not be as inclusive as is desirable in modern Australian society.

The figures regarding the under-representation of indigenous Australians mask the true extent of the problem. While 17% of indigenous students entering universities undertook courses in education, the percentage of the indigenous population proceeding to tertiary education is significantly lower than that of the non-indigenous population. Further, it is necessary to investigate completion rates for indigenous students undertaking teacher education courses. The under-representation of indigenous students in scientific and technological fields exacerbates this problem, and may well lead to a continuing cycle of indigenous students failing to choose these areas of study in senior secondary school. The AAMT recommends that participation and success of indigenous students in senior secondary mathematics courses, and in courses of teacher education, be a priority for research and action.

The AAMT welcomes additional research on teacher supply and demand and has taken the opportunity to make input into the qualitative research into factors involved in attracting people to the profession, and in influencing their decision to remain in, or leave, the profession. We note, however, that this will involve a relatively small sample of teachers from across all levels and discipline areas, and may thus include only one to two hundred mathematics teachers. We believe that further research is needed, and believe that the findings of the Review can be informed by such research.

An important note on implementation:

A number of our members who provided input to this submission voiced a concern that can be summed up as

Is this Review just another political exercise and as a result will nothing change?

The simple truth is that this will be the sad reality without sufficient and sustained commitment and resourcing from governments (commonwealth, state and territory) for the implementation of the Review's findings. The approach should be bi-partisan, given its importance and necessary longevity.

The AAMT approaches the task of providing input to the Review in a positive way, with a commitment that the goals of *Backing Australia's Future* are worth pursuing. An early practical and public demonstration of a similar level of commitment from governments would do much to allay our members' fears that 'nothing will change'.

Attractiveness of Teaching as a Career and as a Profession

1.1 What can be done to ensure a realistic perception of teaching as a career choice?

A more productive approach to this issue is to recognise that the perception *is* the reality. Teaching is seen as having low status, being poorly paid and stressful by the community and teachers alike. The TIMSS Study (early 1990s) indicated that 75% of the Year 8/9 mathematics and science teachers surveyed thought that the "society does not value their work". Only New Zealand recorded a higher percentage.

Hence, action should be about *changing* the perception of teaching held by:

- The community
- Young people
- Teachers ourselves

This is long-term and represents a fundamental shift in community values that are reflected in status, salary etc.

Media campaigns along these lines would only have marginal effect. A study by Brinkworth and Truran (1998) found that students' perceptions of teaching mathematics depend very much on their perceptions of mathematics. They suggest that until you can improve students' perceptions of mathematics, science and technology themselves through what they experience at school, efforts aimed at improving perceptions of their teaching is hollow action. Hence, later in this submission we argue strongly for an injection of 'excitement' into teaching mathematics, science and technology as this is a means of addressing the issue of the perceptions of the disciplines themselves, with spin-off advantage in terms of further study of mathematics and positive orientation to teaching the subject as a career.

What is required is an idealistic view of teaching that values education as the cornerstone of a critically aware and productive society. This is a long-term outcome that can only be achieved when current students are taught well, enjoy school, and when teachers enjoy their work.

1.2 What current strategies are in place to attract suitably qualified graduates and mid-career professionals with industry training and experience to consider teaching as a career, especially in the fields of mathematics, science and technology? How effective are these strategies?

Anecdotal evidence from members working in Universities suggests that the majority of people seeking to become teachers of mathematics are now mid career professionals. The reasons for these people wishing to take up teaching appear to be more to do with security of employment or a desire to contribute to society, than financial. However, the decline in the number of young people going into teaching as a first career, particularly in science, mathematics and technology, relate strongly to issues such as salary and working conditions.

There is some HECS relief in some states and territories aimed at both young people and mid-career professionals. Education authorities will be able to supply this information and should furnish actual numbers who take up these schemes, and the level of relief provided. However, these strategies appear piece-meal and seem to make minimal impact on the number of people training or retraining as teachers.

1.3 What factors may dissuade people from seeking teaching employment, especially in the fields of mathematics, science and technology?

There are a legion of these related to salary, work loads, perceptions of the difficulties of the task, perceived lack of appreciation of the work done etc. These are realities that need to be addressed.

A particular problem is faced by people with qualifications in science, mathematics and technology seeking to make a mid-career change to teaching. It is more difficult for people wishing to make such a change than it is, perhaps, to change to other professions. A career change to teaching requires at least one year of full-time study, or its equivalent. The financial implications of a career change are thus a significant disincentive, particularly as such a change often results in a salary decrease.

In addition, as indicated above, negative experiences in their schooling such as poor and unengaging classroom experiences and the conditions and levels of strain they

observe teachers working under, have a significant impact on students' career choices and the negative disposition of many towards teaching mathematics as a career.

1.4 What other strategies could schools, State, Territory and Commonwealth Governments, universities or the private sector consider (including industry and relevant professional bodies) to attract people to consider teaching mathematics, science and technology?

One constructive and immediately achievable means is to create a career structure that acknowledges and rewards highly skilled practitioners as leaders. This structure should provide recognition, as well as remuneration (salary and other benefits) that acknowledge this 'highly skilled' status. Some previous programs (such as the Advanced Skills Teacher awards in some jurisdictions) have lacked credibility and had limited impact — the profession must truly own the standards, the means and the credential. (cf the arrangements in many states of the USA for teachers who are accredited as highly accomplished by the National Board of Professional Teaching Standards).

The structure for this new way of conceptualising teachers' careers needs to be based on a credible and accepted statement of the qualities and capabilities of excellent teachers. The AAMT *Standards for Excellence in the Teaching of Mathematics in Australian Schools* provide this consensus position and the Association is working towards establishing a means of credentialing volunteer teachers as *Highly Accomplished* against these as the benchmarks. This credential could easily become the mechanism for acceptance within a career structure as an outstanding teacher of mathematics, with the attendant rewards (salary and other).

Associated with this is the strategy of establishing and implementing a "standards driven professional development (PD) system" that links all PD in mathematics to the AAMT Standards.

One means for attracting people into the profession, and addressing some of the issues highlighted above, might be to create a 'special' pathway into the career of teaching mathematics in more of the universities. Rather than expecting potential teachers of mathematics to undertake three years' study of pure mathematics, courses with a greater (or even exclusive) focus on the mathematics of school and how to teach it could be such a pathway (a 'bachelor of mathematics education' degree). Graduates would not be as attractive to employers outside of education due to their more limited mathematical background when compared with those who do a full mathematics degree. Hence they would be less likely to be 'poached'. Such arrangements may be in place in some universities, but are apparently not universal. Double degree structures in education and mathematics may also be a way of integrating discipline knowledge and pedagogic knowledge.

Please note: One of our respondents indicated he was aware of a project instigated by MCEETYA in 1999-2000 to find ways to attract students to teaching. He has seen a video produced as a result of that project, which had the message that 'if you succeed in life, it was a teacher who probably contributed to that fact'. He saw it as a step in the right direction, but one that needed other actions to be taken in parallel. He was unaware of how widespread the material was disseminated.

Pathways into Teaching

The questions in this section do not pose two fundamental questions:

- *What should pre-service teacher education be like?*
- *What should induction into the profession be like?*

Both these are clearly important in relation to pathways into teaching.

What should pre-service teacher education be like?

The following input from Tasmanian members highlights the importance of good teaching of tertiary mathematics.

> There have been recent reviews at the University of Tasmania in both the School of Education and in the School of Mathematics and Physics. We can only hope that some more attractive first year courses are presented in the mathematics faculty at the University. It is desirable that such a course provides students with a broader understanding of the truly wonderful applications of Mathematics. This course could be taught as a series of short units where mathematicians, and academics from other departments, give inspiring teaching about their own research areas (at an appropriate level) and could include some Discrete Maths, History of Maths, Statistics, Engineering, Art, Antarctic research and the list goes on. Prospective teachers do need to meet the rigours of some standard courses such as First Year Calculus but regular sessions such as those suggested above are essential as well to assist in making the mainstream courses seem worthwhile! Such a course need not be restricted to prospective teachers only, but would be valuable for all. It could then be built on as part of a teaching qualification later if a student decides to do teaching qualifications on completion of their degree. There is much scope for a partnership between Mathematics Faculties and Mathematics Education Faculties, but this is not acknowledged as being 'easy'.

What should induction into the profession be like?

Mentoring and variety of initial experience are important strategies. For example, all new teachers in a school could spend at least one year in a team-teaching situation, but on full salary. This could mean spending time with different experienced teachers in the school mathematics/ science faculty. This situation of complete commitment to support would be incredibly valuable in enabling entrant to the profession to learn about all aspects of teaching, including understanding appropriate methods and levels, report writing, duties expected, extra-curricular expectations, protocols expected, school philosophies, professional development requirements. Such a system would be invaluable in adding to a positive start to a wonderful career.

See also 4.2 for the story of a teacher who retrained from being a primary teacher.

2.1 How effective are current approaches in encouraging potential teachers to take up teacher education, whether immediately after completion of schooling, while at university or when seeking a career change later in life?

It almost goes without saying that most current initiatives have not been very successful in attracting students to the profession as teachers of mathematics, science and technology, given the current review and other reactions in educational circles.

2.2 What new approaches could be adopted to encourage other professionals to take up teacher education?

It would seem that there is a need for different approaches to teacher education that value these people's life experiences and other skills as springboards to learning the theory and practice of education, and mathematics education in particular. A greater emphasis on 'on-the-job' teacher education tailored to these people and their skills and needs is a strategy worth consideration.

However, as noted above, the financial implications of a move from another profession into teaching can be enormous. Any attempts to encourage other professionals to take up teacher education must address this issue. One important strategy could be to ensure that prior experience in other professions is recognised and rewarded in teachers' salary scales.

Creating innovative approaches to the teaching of mathematics, science and technology in the secondary school setting through partnerships with industry and other professions (see 2.3) would inevitably create contacts. 'Marketing' the idea of career change into teaching could be built into these sorts of programs.

However, even if other professionals can be attracted to teaching as a career, without adequate support, an inclusive school structure, exciting curriculum, appropriate assessment regimes, and enjoyable working conditions including technological resources, people will leave the profession. There is no doubt that teachers are expected to do a far wider range of relatively low-level tasks, and experience working conditions that are far less conducive to productive and reflective practice, than most other professions. Excellent teachers will only remain they have the time and resources to be professional. This requires flexible work places in which reflection ad professional dialogue is valued and supported with adequate time.

2.3 What potential impacts can University-school links have on attracting potential teachers of mathematics, science and technology?

There is a great need for in-service teacher education for mathematics teachers on the contemporary uses of mathematics, as many have been out of real contact for many years. Involving undergraduate students in these programs, as well as programs of a similar intention directed at school students could give them a 'taste' of the rewards to be gained from teaching. The overall intent of these sorts of initiatives (among many with similar intent) would be to build the 'excitement' associated with teaching, a key ingredient in breaking the cycle of lack of attraction of teaching in these areas.

2.4 To what extent does the perceived quality of teacher education influence the attractiveness of teaching?

Although we do not have any data on this, our information is that the impact is huge, and currently exclusively negative — potential students perceive teacher education as being of poor quality, and this is another factor in the discouragement of these people to enter these courses.

It is important to ensure that tertiary courses are packaged attractively, taught by highly skilled and innovative mathematicians and mathematics educators. Courses studied at University should model excellence in teaching, particularly for those students taking up teaching as a career. The drive for economies of scale in Universities, and the ever-increasing pressure for academics to carry out a range of activities in addition to teaching and research, can cause the quality of teaching to decline.

As noted in the Ramsey report in NSW, professional experience is a key to ensuring high quality teacher education courses. School-based internships may be one way of enhancing the links between the academic program of the University and the practical experience in schools. However such programs are expensive, and must be well supported. To be truly effective school-based mentoring teachers require appropriate professional development, and should contribute in a tangible way to the academic program of the University. While some effective programs appear to be in place, particularly in primary education, further research on effective models of professional experience is required.

Retention of Existing teachers

As a general point, mentoring is a strategy that can and should be encouraged, supported and used in relation to a number of these questions.

3.1 How successful can professional support initiatives be in aiding the retention of teachers of mathematics, science and technology?

More data is clearly needed to identify the rate of 'leakage' of teachers of mathematics, science and technology, who they are and their reasons for leaving teaching. But it is clear that the current processes are not working.

Principles for such programs include that they must be heavily informed by teachers and driven by their learning needs; genuinely value teachers; planned and sustained over teachers' careers. It is the AAMT's strongly held position that the programs need to be directly linked to, and driven by the AAMT's *Professional Standards* where appropriate.

Many excellent classroom teachers feel that career advancement is dependent on a move into administration, with current school structures rewarding management rather than teaching expertise. There is also a perception that it requires less effort to move into an administrative position such as a school principal, which may require little more than an application and interview, than it is for teachers to achieve recognition as Advanced Skills Teacher, which may require a portfolio, a presentation, and an assessment.

3.2 How can such programs be introduced, improved and/or expanded?

It is the strong view of the AAMT that, now that there is a consensus, national view of the elements of good teaching (ie the AAMT *Standards*) that all 'professional support initiatives' should be built around those *Standards*.

There is a general need to 'energise' teacher networks as a key support structure, and this is best done through existing professional associations. These associations represent value for money for funding agencies (for example, the evaluation of the National Professional Development Programme of the Commonwealth in the mid-1990s reported a multiplier effect on funding provided to professional associations of perhaps four or five to one). They are the means/organizations teachers trust. Yet they have been running down in their impact through neglect and lack of understanding of their vital contribution, and consistent with the fall off in commitment to 'volunteerism' in Australian society. Teacher professional associations in mathematics, science and technology need strategic support, and regional input to strengthen beyond capitals.

As an example, perhaps the strongest state-based professional association in mathematics in the country is the Mathematical Association of Victoria. There are many factors in its success, and many people who have worked to make it so, but it is also noteworthy that successive Victorian governments have, over a long period, supported the MAV by fully funding an extension education officer. This level of support has had lasting benefits to the capacities of the MAV to serve its members and support innovative teaching in mathematics. This is not to say that the provision of a funded officer is the *only* (or even the best) mechanism for supporting teacher associations. What the example illustrates is that ongoing and significant support has been a critical success factor for the MAV.

Energising professional teacher associations is important at both state and national levels. State-based associations have close links with local schools, and hence are in touch with the day-to-day needs of teachers. National associations enable teachers to see themselves as part of a national and international community of educators. Funding an extension education officer, such as in Victoria, is one way of reinvigorating teacher professional associations. However, other models, such as eight state-based projects focusing on teacher professionalism, linked nationally to form a network of innovation in mathematics teaching, also have the potential to enhance the status of teaching and assist in the retention of existing teachers. This national network could include national institutes where teachers could meet for a week to share, at a deep level, their knowledge and experience of student learning, and to develop new knowledge for the profession. Such institutes could help connect teachers to the big picture: a valued profession, making a difference in society, sharing teaching and learning ideas around the nation. This is exciting and important work that would do more to raise the status of teaching than any advertising campaign.

3.3 Can these programs be applied successfully to mid-career entrants to the teaching profession?

It is not clear that there is any difference relating to the timing of entrance to the profession. More important to note is that the commitment to retaining teachers is seen as an ongoing priority and that actions are in place and suited for all stages of careers. These strategies should include stimuli, support and rewards.

Professional Development

4.1 What should be the level of qualification and experience necessary to teach mathematics, science and technology?

We note the previous review of teacher education in mathematics and science (the Speedy Enquiry of 1989). Clearly the level of qualification depends somewhat on the level of schooling (see table), but the tacit assumption in this paper is that the focus is on secondary teachers and teaching, far more than primary.

The use of the term ‘experience’ in this question is interesting. It is possible that people without qualifications can have ‘learnt on the job’ and do have necessary knowledge to teach mathematics well. This is not about a number of years of experience, however, but rather as a result of their learning through that period. This learning should be reflected against the AAMT *Standards* — specifically in relation to discipline knowledge (*Standard 1.2 Knowledge of Mathematics*) and subject pedagogical knowledge (*Standard 1.3 Knowledge of Students’ Learning of*

Mathematics). Note that this domain of knowledge is distinct from general pedagogical knowledge (Schulman).

This learning can and should be evidenced through Recognition of Prior Learning (RPL) processes (as anticipated in the AAMT *Standards* processes). It is our view that however such knowledge is developed (formal courses or 'on-the-job' and recognised by RPL processes) it should be robust and substantial. Note also that these knowledge bases are not static — the AAMT *Standards* expect ongoing professional learning as part of a teacher's professional responsibility.

In its consideration of this matter the AAMT *Standards* project produced some draft guidelines on minimum qualifications. These are presented below for discussion — they are not AAMT policy.

	Mathematics	Mathematics education
All teachers	Satisfactory score in a year 12 mathematics subject that contributes to Tertiary Entrance Rank.	Nil
Teachers of Mathematics — Pre-K to 6 (or 7 if secondary school begins at year 8)	At least 5% of initial teacher education course concerned with personal knowledge of mathematics OR RPL equivalent	At least 5% of initial teacher education course concerned with the teaching and learning of mathematics (pedagogy) OR RPL equivalent
Teachers of Mathematics — 7 (or 8) to 10 (ie junior secondary)	A mathematics minor (University level mathematics equivalent to at least 15% of a recognised degree) OR RPL equivalent	At least 15% of initial teacher education course concerned with the teaching and learning of mathematics OR RPL equivalent
Teachers of Mathematics — 11-12	A mathematics major (University level mathematics equivalent to at least 25% of a recognised degree) OR RPL equivalent	At least 25% of initial teacher education course concerned with the teaching and learning of mathematics OR RPL equivalent

The minimum requirements are indicated in proportional terms to accommodate the considerable variation in initial teacher education provision. It is anticipated that total hours and/or credit points will be used to justify proportions.

4.2 How can teachers who are either teaching in areas outside of their original specialization or are underqualified in those areas, be assisted to improve their knowledge and competencies to teach in these fields?

There is nothing that is satisfactory other than a long term, continuing learning program involving mathematics and mathematics pedagogy. Such a program should be driven by the consensus position established in the AAMT *Standards* and include both formal study and on the job learning.

The AAMT rejects the apparently commonly held view of systems that one year's experience in teaching a subject outside a person's area of expertise qualifies them to teach in that area. While there is no doubt that experience produces knowledge, this experience must be supported by opportunities to systematically expand that knowledge in a long-term program of professional growth.

A number of jurisdictions have in recent years put in place relatively short term 'retraining' programs as a response to shortages in mathematics teachers. It would be instructive if there could be some data about the effectiveness of these programs. One teacher's experience is related below. The degree to which this experience is replicable is, of course, open to question. At the very least it would appear that an extensive, paid retraining program, backed up by supportive school structures, is essential if such programs are to be successful.

> I was a primary teacher. I became a mathematics teacher after having a year off in 1974 on full pay to study the first year of a degree in science. I then taught science for a year (I had the fall back of going back to primary after a year if I didn't like the secondary set up). I swapped to Mathematics because I decided to finish my degree in mathematics. The school I was in allowed me to transfer into mathematics department and gave me a terrific timetable to develop my scope as well. Teaching all the mathematics courses from years 8 to 12 kept my interest up for the first four years of mathematics teaching. After that I transferred schools and have subsequently held a range of leadership positions in mathematics, both within and outside of schools.

4.3 What structures are currently in place for professional development, and what other models might be appropriate to the teaching of mathematics, science and technology?

It is necessary to distinguish between professional development, and much of what goes under the title. To be 'professional' development, the learning needs to both relate to the professional work of teachers — in this case in relation to their teaching of mathematics — and be about matters that the teacher sees as important (ie volitional in terms of focus). This definition encompasses a very wide range of professionally oriented activities from the formal to the informal.

Hence, training about new policies, information about new courses and assessment regimes, many 'whole school change' initiatives and the like may be worthy and necessary, but they do not constitute the kind of professional learning that is implied in the directions of this review towards 'innovations in teaching'.

Beyond activities such as these, the picture of genuine professional development in mathematics can be characterised as lacking coherence, uneven in quality and involvement, reliant on the innate professionalism of teachers to take on — often unsupported — this extra workload.

In a real sense, perhaps the only constant institutions have been teacher professional associations at the state, territory and national level. The commitment and infrastructure exists for addressing the issues above and creating a PD effort that has the capacity to provide teacher learning necessary for the kinds of changes necessary to achieve the outcomes envisaged by *Backing Australia's Ability*.

The way forward is through the establishment of a PD system that is driven by the AAMT *Standards* (and others in science and technology). This would result in a focus on professional needs in the field. From there a raft of known strategies and models for professional development could be built around this framework and used by

teachers according to needs and preferences. Some comments about research and development of new models and approaches are included in 4.4.

We need to build in what we know about good professional development. It must address teachers' needs, be student focused, promote and model excellent practice, encourage reflection, be collegiate, and challenge teachers to review and renew practice in a supportive environment. One such model is action learning/research in which teachers in a school develop priorities and strategies for action, and research the impact of those strategies, supported by other members of staff and mathematics education researchers. Such programs are necessarily long-term, and often uncertain in outcome. Hence funding is difficult to obtain. Consideration should be given to setting up a national school action research grants scheme, by which small scale, school-based projects through which teachers can access resources to enable them to work in partnership with researchers to conduct innovative and relevant projects. National professional associations would then play a leading role in networking teachers involved in such projects, so that learning can be shared across schools, across states and across the nation.

4.4 What level of resources for professional development are necessary to ensure teacher professional standards?

Consistent with the comment above (4.3), only resources actually applied to learning programs that are professional in their focus on the teaching and learning of mathematics and which are self-directed (as above) should be 'counted' as being PD. A current audit would identify significant resources being applied to these, but very little of this resourcing is derived from employers and government — the vast majority is from the teachers themselves (time, effort and money). This significant investment by teachers will continue, and should be encouraged as it increases the value teachers place on their learning. However, a substantial and sustained contribution from government and employers is needed to complement teachers' own commitment, demonstrate that teachers' commitment is valued, and to create new opportunities and ways of supporting teachers' professional learning. Put simply, to do this job properly will require a sustained commitment of funding by government on a scale that has not been approached previously in this country.

Past system developments around curriculum initiatives have often involved little more than token consultation with teachers, and mostly only in the developmental stage. The implementation of these ideas has involved minimal support and consultation. Hence such initiatives, regardless of how important and worthwhile, have often had limited impact in schools. Involving teachers more closely in the professional development associated with all stages of the implementation of such systemic initiatives would enhance their capacity to bring about lasting and effective change in education.

As discussed above, ensuring teacher professional standards can only be achieved when teachers recognise and own what it means to be an excellent teacher of mathematics. The coherence provided by establishing and working with the AAMT *Professional Standards* is the only means of ensuring maximum positive impact.

The current QTP has had mathematics as one of its priorities. Clearly the evaluation of this program will give some guidance about structures and programs for the future. There have been two instances of relatively low level support (in dollar terms) for strategic work at the national level provided to the AAMT under QTP. While this

support is appreciated and has enabled good work to be done, the lack of a major corpus of strategic national work involving the AAMT and others is not consistent with a 'culture of innovation'. The AAMT, and similar organisations are proven innovators, yet it is our view that an opportunity to foster this and create new knowledge and innovative approaches has been missed within the current QTP. We also note that there has been relatively small involvement of mathematics teacher associations in this program in the states and territories. It is noteworthy, perhaps, that none of the respondents to our consultative process has made mention of QTP initiatives as contributing to professional growth.

Flexible and Innovative Teaching Practices

'Flexible and innovative teaching practices' is a term that is easy and 'catchy' to use, but if it is to have real meaning the practices need to be well fleshed out and exemplified for teachers to be convinced that it is more than just mere rhetoric. It needs also to be remembered that teaching is continually evolving. Hence the practices will not be static, and there will be a need for ongoing and sustained support for research, development and implementation.

Questions of different models of teaching are inextricably linked to different models of curriculum, different models of schooling and different purposes of schooling. What comes first?

5.1 What would be the impact on teacher shortages of further developing different models of teaching?

The phrasing of this question suggests that there is a fear that 'different models of teaching' could be instrumental in driving more teachers out of teaching. It is a reasonable fear. It is not inevitable, but the approach to the change that is necessary needs to acknowledge this human dimension. It must be emphasised that teachers cannot be told to adopt different models of teaching. They will need time to assess the 'different models'. They will need to see examples of the benefits. They will need to work through the issues for themselves and undertake the learning that is necessary. They will need to interact with leaders with substance and credibility in teachers' eyes (ie respected peers), not "educational soothsayers" promoting their own particular perspective on schooling. They will need support and encouragement for this. That is, an educational change process the like of which is seldom if ever seen in Australia, on a scale that requires substantial resourcing.

5.1 (cont.)…How would this impact on student learning outcomes?

Excited teachers give exciting lessons. If moving towards and using these different models doesn't create this excitement, then it is not being done well.

5.2 Would the adoption of flexible models of teaching and learning be likely to encourage teachers of mathematics, science and technology to remain in the profession?

As noted above, if flexible models of teaching are well supported and embraced by the profession, the excitement factor may contribute to teachers remaining in the profession. However, if they are seen as imposed, and an attack on current practice, they may well encourage people to leave. New models will require new resourcing and support mechanisms. These will need to be in place to maintain the feasibility of teachers continuing to work and develop in new ways.

5.3 What kinds of broad workforce planning models would support flexible career pathways in the future?

The career structure in our response to 1.4 is very relevant here. This would enable good teachers to advance and be rewarded, while remaining in the classroom.

As a principle, the models would need to be understood, owned and used by teachers. This means that in developing the models, those responsible would need to actively involve teachers (the ultimate target audience) and value and act on that input. Again, it is not worth *doing things to* teachers — they will resist it.

Initiatives such as paid sabbaticals to allow teachers to work in industry placements, tertiary institutions, or other school systems could also contribute to more flexible and rewarding career pathways. One member supplied the anecdote below highlighting the professional and personal value of a fully-funded sabbatical in a tertiary institution.

> After teaching secondary mathematics in government schools for ten years, I was awarded a scholarship, on full pay, to study and work at the University of South Australia for six months. Those six months were some of the most personally and professionally rewarding in my career. I was able to devise my own study program, focusing on new areas of mathematics that were not available for me to study during my first degree. I was also able to spend time working in industry looking at how statistical ideas were used in quality assurance, and in my daughter's primary school as a parent helper during mathematics lessons. Each of these experiences gave me a much broader outlook on mathematics and its place in society, and enriched enormously my own teaching of secondary mathematics.

Sabbaticals are not cheap, but they represent an investment in people that recognises in a tangible way their value and importance to the profession. They would raise the status of teaching and reinvigorate teachers.

School leadership and Role Models

Note that the notion of 'school leadership' is not just confined to the principal. There are many other 'leaders' in schools, and the AAMT promotes the acknowledgment and support of 'teacher-leaders' in schools, as well as those with a more formal role. Education systems, too, are school leaders, and their role is also canvassed in this response. Indeed, it should be recognised that state and national professional associations are leaders, particularly in the area of professional standards.

6.1 What impact can effective leadership have on retaining teachers in the profession, particularly in the areas of mathematics, science and technology?

One could argue that the current parlous state in terms of teachers and teaching in mathematics is a direct result of neglect and/or antipathy from educational leaders. All the evidence in the literature suggests that the impact of leadership is profound in many aspects of education, and this is likely to be true in the case of retaining teachers.

Good principals create good conditions, often by supporting teacher-leaders in the school to generate new ideas and programs, thus creating the excitement factor noted previously. However this is not nearly as common a state as is necessary, and many teachers of mathematics feel they work in environments where they are not valued or

supported. Principals need to take responsibility for this. Effective school leadership requires a focus on teaching as the core business of a school, and a recognition that excellent teachers are central to students' learning. Hence teachers should have major input into areas such as curriculum, assessment and pastoral care. Teachers need to be supported to demonstrate achievement of excellence such as the AAMT Professional Standards, through on-going professional development, adequate time to reflect on their pedagogy, and school structures that support on-going learning.

Teachers in middle management positions, such as curriculum area coordinators, are an integral part of school leadership. They are in the best position to provide models of excellent practice, and to promote innovative practice among their staff. However, such leaders are seldom supported to carry out their role effectively. At a school level they are often called upon to conduct administrative tasks unconnected with classroom teaching and curriculum leadership, and at a system level there are few, if any, programs in place to enhance their leadership skills. The Mathematical Association of NSW, one of the associations affiliated with AAMT, conducts an extended professional development program for curriculum leaders, but this is an isolated instance in which teachers have taken the initiative. The AAMT recommends that, as a matter of priority, collaborative professional development programs for curriculum leaders, involving systems, schools, Universities and professional associations, be developed. Such programs could contribute towards further qualifications, such as a Master of Education.

The lack of leadership shown by others with clear leadership roles is demonstrable. This is manifested in the lack of grounded expertise in mathematics in the support services of many education systems, assessment and curriculum boards that respond to anti-innovative forces in academia and the community in relation to curriculum and assessment change, and an apparent lack of workforce planning and of flexibility in employment practices over many years, which has resulted in the issues of teacher recruitment and retention being so urgent as at present.

The AAMT urges systems throughout Australia to look closely at the level of curriculum leadership support for mathematics. It could be argued that the numeracy focus, accompanied by an emphasis on population testing, has had a negative impact in terms of narrowing the curriculum, reducing teachers' willingness to embrace new pedagogy and consequent reduced sense-making by students. Isolated analysis of numeracy testing results, without a more comprehensive and inclusive assessment process that relies on teacher professional judgment, results in teachers who feel pressured to produce results whatever the cost. A relevant and inclusive curriculum that encourages all students to learn mathematics well is more effectively informed by teacher conversations than by systemic testing. Systems seldom ask teachers and schools what they know about their students' learning.

6.2 In what ways might the development of a more innovative culture impact on how schools organise and manage teaching and learning?

Any comments on this matter would be pure speculation. However, we need to be vigilant that the reverse is not taken as the approach. That is, it must be the culture impacting on the school's organisation and management, not the reverse. Unfortunately this latter has too often been the approach in practice. For example, there are educational reasons for adopting middle schooling approaches (akin to 'culture')— most often education authorities have created middle schools as organisations.

As noted above, stronger links between teacher professional development and the core work of the school through action research would help to create a culture of reflection and innovation in schools. Such a culture emerges from teacher engagement in student learning about new ideas, which, in turn, impacts on school management, rather than the other way round.

6.3 What concerns are there with the profile of the teaching workforce, and what kinds of strategies might address those concerns?

Age and burn-out are the two main concerns. In relation to age, and to create a more realistic age-profile for teachers of mathematics, strategies that poach professionals from outside teaching (and that keep them in it) are a sensible approach and are clearly envisaged as an outcome of this Review.

Strategies to address burnout include ones that actually value the work and contribution of teachers; that lift their self-esteem and in the eyes of the community; that help them focus on what they see as their job — teaching —and innovation and development within it; time to reflect and engage in serious professional learning.

Overall, excited teachers aren't prone to burn-out, and creating conditions for teachers to be excited is the overall task.

Concluding comments

In developing this submission, it has been difficult to separate out the issues as suggested in the discussion paper. In considering the submissions it will be important for the committee to look at the connections between the various issues canvassed in the discussion paper. This will be an important step in beginning to think about the interplay of issues such as curriculum, leadership and school structures. We suggest that the AAMT *Professional Standards* provide a means by which teachers can strive for and demonstrate excellence in teaching, which can, in turn, drive innovative curriculum and new ways of thinking about schooling.

For teaching to once again become an attractive and rewarding career, society needs to recognize and value excellence. This will be reflected in desirable working conditions, appropriate salary scales and rewarding career structures. In preparing this submission the AAMT acknowledges the outstanding contribution to Australia's society already made by teachers of mathematics throughout the nation. Our members urge both state and Commonwealth governments to recognize that contribution, and to institute long-term measures to promote and maintain standards of excellence in the teaching of mathematics, which is the only sustainable solution to problems of teacher recruitment and retention.

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