



**THE AUSTRALIAN ASSOCIATION
OF MATHEMATICS TEACHERS INC.**

**Submission from The Australian Association of
Mathematics Teachers Inc. (AAMT)**

on

**School to Work Transition: A Review conducted by the
House of Representatives Education Committee**

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Introduction

AAMT

Within schooling, the Australian Association of Mathematics Teachers (AAMT; www.aamt.edu.au) is the peak national body of mathematics teachers. It exists to:

- support and enhance the work of teachers;
- promote the learning of mathematics; and
- promote progress in mathematics and numeracy education.

The AAMT has a proven track record of providing well-informed and professionally oriented advice and leadership in key areas of mathematics and numeracy education in this country over many years.

The Association's members come from all states and territories and all levels of government and non-government schools. They form an extensive network of committed and enthusiastic mathematics and numeracy education professionals including teachers, academics, policy leaders and administrators. Currently the Association has approximately 4,000 members — 2,200 of these are Institutional members (schools). The rest are individual teachers, thus giving the AAMT direct contact with more than 25,000 teachers and others.

Attachment 1 contains more details about AAMT and its work.

Mathematics and school to work transition

The capacity to use mathematics is increasingly important in an ever-widening range of workplaces. Hence young people's mathematical skills and orientations when they exit schooling are key determinants of the sorts of pathways available to them, and often of their likelihood of being successful in employment. This is as true for those who take work and vocational pathways as it is for those who move on to higher education.

Those young people who move directly into the workforce often encounter training and tasks that require them to apply their mathematical skills. The project *Identifying and Supporting Quantitative Skills of 21st Century Workers* (AAMT and AIGroup; 2014) identified the mathematical demands placed on young workers in contemporary workplaces. It concluded:

The application of mathematics in the workplace is not straightforward and goes beyond a command of 'core' or basic mathematical content. Workers perform sophisticated functions which require confidence to identify, use and apply mathematical skills in problem-solving situations and knowledge of the consequences of the procedures. Workers need a blend of the following:

- ability to recognise and identify how and when mathematics is used in the workplace;
- an understanding of mathematical concepts, procedures and skills;
- an understanding of the kinds of practical tasks they need to perform; and
- the strategic processes they should be able to use in using and applying mathematics.

(Tackling the School-Industry Mathematics Divide [Project Report Summary], p. 1)¹

The project identified significant disconnections between the mathematics experienced in school and the expectations of many workplaces². These disconnections are barriers to smooth transition from school to work for many young people. They are also an economic cost to employers.

In summary, mathematics is a critical element in school to work transition; AAMT contends that a smoother 'mathematics' transition from school to work is both feasible and essential.

¹ See Attachment 2 for the full document.

² The workplaces studied in the project ranged across several industry sectors including retail, services, mining, engineering and manufacturing

1. Measurements of gain in school and how this contributes to supporting students to prepare for post-school education and training

There is increasing focus on what students 'gain' from their educational experiences year-on-year, rather than their absolute performance. This shift in educational practice recognises that children develop and learn at different rates. It also serves to focus teachers' efforts on maximising the learning gains of each of their students. The focus on gains tends to create a rich picture of what a student knows and is able to do.

At the point of transition from school, many jurisdictions have established external assessment processes that sum up a student's performance with a single number (a score or a rating). These assessments may or may not involve an external examination. They are necessarily narrow and do not carry any sense of 'gain'.

Potential employers need accurate information about the capabilities of school leavers in order to make decisions about who to take on. The single 'number' that comes from an end of schooling external assessment process has credibility and may be useful to them. Of more potential use is the more detailed information that schools can provide from their assessments, provided these are based on good quality assessments of students gain (the 'rich picture' above).

The recently updated AAMT Position Paper on the Practice of Assessing in Mathematics (AAMT; 2017)³ outlines expectations for teachers, schools and education authorities. The approach recommended in the Position Paper is consistent with helping teachers map the gains of their students' learning of mathematics, and to communicate these to a range of audiences, including potential employers.

The need for an AAMT Position Paper in this territory is, in part, an indicator that the sort of assessment and reporting currently in place in schools in general does not generate information that employers find useful. Anecdotally, there are reports that employers can find the information 'confusing' and 'unreliable', leading to school reports being viewed as largely unhelpful.

The Quantitative Skills project has identified particular areas about which employers should be well-informed when using a student's school report as part of their means for evaluating a young person's suitability for a position. The four components identified by the project (see p.1) need to become the foci for assessment, both individually and collectively when students attempt authentic tasks. School reports that convey the resulting information clearly to employers will ensure better alignment with the realities of what is known to be needed in contemporary workplaces.

The response from the school education sector cannot simply be a reorientation in assessment and reporting, however. "Current school teaching approaches generally emphasise (the four skill sets) separately" (Tackling the School-Industry Mathematics Divide [Project Report Summary], p.1). In other words, the teaching of mathematics in our schools also needs to change.

AAMT therefore argues that action on the Recommendations from the Identifying and Supporting Quantitative Skills of 21st Century Workers project is central to more effective school to work transition in the core subject of mathematics. This recommendations are summarised in Tackling the School-Industry Mathematics Divide (project summary; p.1) as:

1. Generate national awareness and understanding of how mathematics is conceptualised and used in workplace settings.

³ Downloadable from <http://www.aamt.edu.au/About-AAMT/Position-statements>

2. Research and develop strategies for mathematics teaching in schools which meet contemporary workplace requirements.
3. Ensure that the Australian Curriculum provides guidance for the transfer of mathematical skills to the workplace .
4. Develop a strategy for supporting change in schools.
5. Develop a strategy for supporting development of mathematical capability and numeracy in the workplace.

with details in the full project report (pp 5-6)⁴. Gains through these means would establish the conditions for much more coherent and consistent school to work transition in mathematics; other areas could well benefit from parallel efforts.

These directions have much in common with the findings of The New Basics report⁵ from the Foundation for Young Australians. The elements identified in Section 5 of that report (pp 19-22) (“How should we prepare young people?”) provide a generic framework for the sort of mathematics-specific work recommended by AAMT and AIGroup.

The 2014 report from AAMT and AIGroup argues that “continuing and sustained dialogue and collaborative effort between mathematics teachers, their schools, industry, governments and other stakeholders is essential.” The establishment by COAG of the STEM Industry Partnerships Forum, Chaired by the Chief Scientist Dr Alan Finkel, is recognition at the highest level that partnerships between industry and schools such as those signalled by AAMT and AIGroup are an important pathway to improving STEM education.

Our colleagues at AIGroup have done further work in this area through their Strengthening School-Industry STEM Skills Partnerships project⁶. This work would guide future efforts to address the particular challenges in mathematics.

In summary, AAMT believes that facilitating better school to work transition in mathematics requires concerted collaborative effort that will be facilitated by the current commitment at all levels to schools and industry working in partnerships.

2. Opportunities to better inform and support students in relation to post-school education and training, including use of employment outcomes of students who undertake school-based vocational education or post-school tertiary pathways.

Experiences in mathematics at school that are more attuned to and informed by the realities of contemporary workplaces as outlined above would clearly “support students in relation to post-school education and training.” They would be better prepared to apply their mathematics effectively in formal and informal training contexts, and at work.

Career awareness initiatives build young people’s appreciation of what careers are available, what they entail and the entry requirements. Current efforts around career awareness and mathematics are designed to make mathematics more visible in careers. There are two distinct but related current emphases for mathematics:

⁴ Downloadable from <http://www.aamt.edu.au/Library/Projects/Workplace-maths-skills>

⁵ Downloadable from <http://www.fya.org.au/report/the-new-basics/>

⁶ Downloadable from <http://www.chiefscientist.gov.au/2017/06/report-strengthening-school-industry-stem-skills-partnerships/>

- Raising the awareness and appreciation of students, their families and the wider community that qualifications in mathematics – or at least a substantial component of mathematics in a qualification – can lead to a diverse range interesting and rewarding careers, many of which are not obviously connected to mathematics. The intention is for young people to maintain study of mathematics at school at a level that leaves open options in higher education.
- Highlighting the mathematics that is embedded in doing the work in many of the careers they may be considering. The intention is to help young people intending to enter the workforce from school having made good choices in their study of mathematics in their senior years.

The Australian Mathematical Sciences Institute (AMSI) has for some time had a range of programs to alert university-bound students to the scope of careers available to those who study significant amounts of mathematics. AMSI has also recently established the Industry/Mathematical Sciences Engagement Taskforce (IMSE) that has career awareness as one of its major goals. This work will complement CHOOSEMATHS Careers, (another AMSI program), that has a particular target of encouraging more girls and young women into STEM careers. AAMT supports these programs and views them as important contributions.

The matter of career advice to young people intending to take vocational pathways is currently less well serviced. In 2008-10 AAMT produced four community service announcements. Each is a 30 second, professionally produced video snippets designed for television. They highlight the mathematics involved in a wide range of careers⁷ that members of the community are generally unlikely to strongly associate with mathematics. AAMT believes that these entertaining and informative videos carry important messages for young people and their families; they are still available through the AAMT website⁸ and YouTube. Some posters produced by AMSI have also highlighted less-mathematical careers. Further information and promotion in this territory would contribute to efforts to smooth the school to work transition for young people – and their employers.

In summary, progress to better match school experiences in mathematics with the needs of contemporary workplaces will support young workers to be more successful in their future work and training. Overcoming the ‘invisibility’ of the mathematics inherent in a wide and increasing range of occupations will lead young people to make better choices in their study of mathematics at school.

⁷ These included plumber, chef, football coach, fashion designer, small business owner, landscape gardener, wedding planner, travel agent, police officer, farmer, builder and nurse.

⁸ See <http://www.aamt.edu.au/Library/Projects/Previous-projects/Community-Service-Announcements>

Attachment 1 – About AAMT

About AAMT

The Australian Association of Mathematics Teachers Inc. was founded in 1966 as a 'federation' of mathematics teacher professional associations in the states and territories. The AAMT is the nation's pre-eminent professional association in school mathematics and numeracy education. It exists to:

- support and enhance the work of teachers;
- promote the learning of mathematics; and
- promote progress in mathematics and numeracy education.

The nature of the organisation has enabled the AAMT to play a significant role of national leadership in mathematics and numeracy education over many years.

Membership

The Association's members come from all states and territories and all levels of government and non-government schools. They form an extensive network of committed and enthusiastic mathematics and numeracy education professionals including teachers, academics, policy leaders and administrators.

Currently the Association has approximately 4,000 members — 2,200 of these are Institutional members (schools). The rest are individual teachers, thus giving the AAMT direct contact with more than 25,000 teachers and others.

Governance and funding

The Council of the AAMT is the decision-making body (like the 'board of directors'). The Council consists of one member from each state and territory, plus a President, President Elect or Immediate Past President, and Treasurer.

The AAMT is a not-for-profit organisation with tax exempt status from the ATO as a scientific organisation. The Association is funded through membership fees and its other activities. There is no annual funding from any government. Annual turnover is generally around \$2 million.

AAMT currently has 14 paid staff

- Four full-time Professional staff with backgrounds, expertise in education (generally as teachers) are located in the head office in suburban Adelaide, with another (0.6 FTE) in Perth.
- 6 (FTE 5.0) with administrative and technical duties in the Adelaide office.

Activities

Through the work of its many volunteer members and skilled staff, the AAMT provides a range of services for teachers and schools that includes:

- Three refereed journals (primary, middle school and senior secondary)
- Annual Activities that promote the learning of mathematics by students and teachers, including the *National Mathematics Day*, *National Mathematics Talent Quest* and numeracy activities as part of *National Literacy and Numeracy Week*.
- An extensive catalogue of teaching materials for sale by 'mail order'.
- The Maths300 subscription service that provides access to high quality teaching resources.
- Professional Development activities including electronic networking of teachers, Biennial National Conferences and 'roadshow' workshops in some jurisdictions.
- Projects to undertake research, and curriculum and professional development.
- The Association conducts national 'special interest' conferences that use current best practice in schools as the basis for developing policy and program advice for governments and others. These are *Students, mathematics and graphics calculators* (2000); *Springboards into*

numeracy (2002); *Quality mathematics in the middle years* (2005); *Mathematics, numeracy and Indigenous learners* (2012) and *Connections and continuity: Mathematics from school to university* (2014; in partnership with the Australian Council of Deans of Science)

Significant current and past projects include:

- Partnership with the Australian Academy of Science on the *reSolve:Mathematics by Inquiry* project to develop materials and support structures for schools and teachers to adopt contemporary, research based practices in the teaching of mathematics (2015-2018)
- Partnerships with five university led projects in the *Australian Mathematics and Science Partnership Program* of the Australian Government to develop and publish consistent professional support for teachers of mathematics (2014-17)
- *Connect with Maths* (2012-16) to develop online support communities for teachers of mathematics (funded by the Australian Government).
- *Identifying and Supporting Quantitative Skills of 21st Century Workers* (2013-4) to identify mathematical skills required for contemporary workplaces with a view to informing approaches and practices in schools. In collaboration with the *Australian Industry Group* (AiGroup) with funding from the Office of the Chief Scientist.
- The *Top Drawer Teachers* (2012-13 and ongoing) project to develop professional support for the implementation of the Australian Curriculum: Mathematics as part of the *Supporting the Australian Curriculum Online* (SACOL) project of Education Services Australia, ESA.
- Three projects to develop support materials in mathematics and numeracy for the implementation of the *National Professional Standards for Teachers* (2011) (funded by the Australian Institute for Teaching and School Leadership, AITSL).
- A project to provide materials for inclusion in *Australian Curriculum Connect* and associated advice about that project (2011) (funded by Education Services Australia, ESA).
- A project to provide advice to ASIC in relation to Consumer and Financial Literacy development in and through mathematics in schools in the context of the development and implementation of the *Australian Curriculum: Mathematics* (2010).
- *Make it Count: Mathematics and numeracy for Indigenous students* project (2009-13) to develop models of whole school practices that result in significant improvement in Indigenous students' achievement in mathematics and numeracy (funded by the Australian Government as part of the *Closing the Gap* initiative).
- *Recognising Excellence: Highly Accomplished Teachers of Mathematics* project (2008-12) in which the Catholic Education Office of Melbourne (CEOM) is supporting annual groups of up to 12 teachers to undertake the process for assessment against the AAMT *Standards for Excellence in Teaching Mathematics in Australian Schools* (funded by CEOM).
- AAMT-SiMERR project to provide professional learning, leadership and infrastructure development for teaching mathematics in rural and regional Australia (2006-2008) (funded by the Science, ICT and Mathematics Education for Rural and Regional Australia [SiMERR] National Centre).
- *Mathematics? Why not?* project to investigate factors affecting students' decisions on study pathways in senior mathematics (2006-2007) (funded by the Australian Government through DEST)
- *Professional Learning Using the Mathematics Standards* (PLUMS) project (use of professional standards in in-school professional learning projects) (2005-6) (funded by Teaching Australia)
- *Reach for the Stars*, an annual project to provide an engaging mathematical activity for schools as part of the *National Literacy and Numeracy Week* (2003-2014) (funded by the Australian Government through its education department).
- *Teaching Standards Assessment Evaluation Project* (mechanisms for measuring and improving the quality of mathematics teaching, 2003-4) (funded by the Australian Government through DEST)

- *Excellence in teaching mathematics: Professional standards* project, a Strategic Partnerships with Industry for Research and Training (SPIRT) project undertaken by the AAMT and the Faculty of Education at Monash University (1999-2001) (funded by the Australian Government through DETYA).

Attachment 2 – Tackling the School-Industry Mathematics Divide

Summary of the Report of the Identifying and Supporting Quantitative Skills of 21st Century Workers project conducted by AAMT and AIGroup.



Chief Scientist



Tackling the School–Industry Mathematics Divide

The teaching of mathematics in secondary schools and the use of mathematical skills in the workforce are very different.

Students who are mathematically capable at school often have difficulty transferring this ability to the workplace.

Our society needs a much better alignment between the teaching of mathematics in school and its application in the workforce.

This issue was tackled by the Australian Association of Mathematics Teachers and the Australian Industry Group with support from the Office of the Chief Scientist in a project entitled ‘Identifying and Supporting Quantitative Skills of 21st Century Workers’.

The project examined the relationship between workplace mathematics and school practices to identify:

- gaps between numeracy and quantitative skills in senior schooling and the expectations of modern workplaces;
- how mathematical skills are understood and used in workplaces compared to classrooms;
- quantitative skills in use in workplaces; and
- how to support the transfer and application of mathematical skills required in workplace contexts.

Key messages

The application of mathematics in the workplace is not straightforward and goes beyond a command of ‘core’ or basic mathematical content. Workers perform sophisticated functions which require confidence to identify, use and apply mathematical skills in problem-solving situations and knowledge of the consequences of the procedures. Workers need a blend of the following:

- ability to recognise and identify how and when mathematics is used in the workplace;
- an understanding of mathematical concepts, procedures and skills;
- an understanding of the kinds of practical tasks they need to perform; and
- the strategic processes they should be able to use in using and applying mathematics.

There is a gap in the ability of young people to integrate these skills in the workplace. Current school teaching approaches generally emphasise these skills separately. Building these capacities through mathematics connects strongly with the general work on ‘executive functions’ that is emerging as important in preparing young people for work.



The case study approach

Twelve teachers ‘drilled down’ and examined twelve volunteer workplaces. These included engineering, drafting, manufacturing, retail, mining and defence.

The teachers used semi-structured interviews, work shadowing, observations and qualitative analysis to provide insights into how workers use mathematical skills and concepts to perform practical tasks, focussing on:

- identifying the mathematical skills used and how these skills were acquired;
- patterns and common characteristics in the examples of the use of mathematics;
- models of future practice of transfer of mathematical skills to the workplace; and
- investigating the skills workers needed for the job and what they currently have.

“ You use mathematics everywhere: you need to know what you’re looking for with mathematics—don’t trust machines. Math drives design: area, 3-D, volume are all done by ‘hitting the button’ but workers need to have an understanding of the mathematics involved in design drawing.

– Design Drafter Drafting Company SA

The place and importance of mathematics

- Mathematics is extremely important in all of the companies involved.
- Changing work practices generate new demands for mathematical skills, particularly in efficiency, innovation, quality and continuous improvement.
- Managers and Supervisors consider mathematics very important in ‘maintaining operations’ and the ‘routine procedures’ of a company.

What mathematics is used in workplaces?

The level and scope of mathematics used by the workers observed, and required by employers, was generally consistent with the Essential or General subjects of the new Senior Years Australian Curriculum: Mathematics. Although the skills observed appear to be fundamental, it is their use and application in work contexts that is not straightforward.

The mathematics used is never required in isolation, in contrast with common practices in schooling.

“ This is one of the most interesting aspects/concepts of this project. The relationship between workplace mathematical skills and school mathematics could be described as ‘distant’ at best.

– Teacher observation

How was mathematics used in the workplaces?

Mathematics is applied in both routine and complex tasks requiring sophisticated use of fundamental mathematical skills and ‘judgement’ or ‘problem-solving’ procedures. Workplace mathematics is performed differently to school mathematics. Mathematical demands may be present implicitly in the workplace tasks, often through tasks that are not obviously mathematical.

There is a growing need in the workplace to communicate information effectively, based on mathematical data and inferences, and involving managers, colleagues and customers. Team-based work is becoming more common because of its importance in improving processes and this includes using mathematical reasoning and ideas through appropriate language and representation.

The role of technology in the workplaces

Many people in the workplace are engaged with technology, particularly in using spreadsheets and graphical outputs. There is an inter-dependency of mathematical skills and the use of technology in the workplace in ways that are not commonly reflected in current teaching practice.

The perception is that technology is transforming workplace practices and the use of technology has changed the mathematical skills required – while not reducing the need for mathematics. Through technological change, mathematics has become more important and more embedded in the role of the modern worker.

The extensive use of technology has changed the way that work is done, and also the work itself – more sophisticated processes and analyses can now be done using technology.

Workers need to be more mathematically competent in order to understand the processes being undertaken, to assess and reflect on the accuracy and appropriateness of results, and understand and interpret the information produced by these analyses.

“ Workers now need experience in using spreadsheets. The algorithms consultants use are becoming more intensive and sophisticated. Expectations are that we are able to produce more meaningful reports.

– Workshop Manager, NSW

Quantitative skills

The following is a summary of the quantitative skills identified in the workplaces. These are detailed in the Quantitative Skills Map developed by the project.



Measurement

Workplace activities related to measurement generally include:

- making initial estimates of measurement and performing the measurement correctly using appropriate instruments;
- interpreting concepts and units of measure and describing using suitable language and symbols;
- choosing appropriate formulae to calculate quantities of common shapes;
- performing conversion between metric units; and
- checking reasonableness of results and interpreting in terms of original purpose.

Estimation

Workers are often required to estimate approximate answers when exact calculations are not required. They need to know when to make a choice between calculation and estimation, depending on a particular

process. Estimations can take the place of accurate calculations where precision is not required, or can be used to check mentally whether an error has been made.

Number skills—undertaking calculations

Workers apply basic mathematical concepts to calculate workplace information. Even when using technology, workers think through a problem to work out the right calculations to perform. They also need to know how to use the technology.

Multiplication, addition and subtraction: performed on whole numbers (for product quantities) and decimals (associated with measurements and money) on a daily basis.

Percentages: calculated by workers and apply to many functions in the workplace in order to communicate workplace information such as productivity and performance data.

Ratio and proportion: understanding and working with quantities and proportions.

Use of formulae

A diverse range of simple mathematical formulae are used by workers in the course of their jobs when calculating areas, volumes, dimensions and flow rates. They also need to select and use appropriate formulae

to calculate the measurement properties of common shapes.

Many need the ability to create formulae through an understanding of relationships between variables.

Interpreting plans, diagrams and scale drawings

Many workers use drawings, plans and diagrams in their day-to-day jobs. They are often involved in reading and interpreting some aspects of plans and diagrams—particularly with an array of symbols

and measurements. Workers interpret scales in diagrams, solve problems using plans, drawings and diagrams and create and investigate shapes and their representation.

Graphs, charts and tables

Workers use tables of product sizes, specifications and costs on a daily basis. The ability to interpret mathematical data is essential to the workplace, particularly in problem solving and quality

improvement. They need to read, interpret and transform data from charts and spreadsheets; interpret statistical data to monitor quality of products and recognise trends in data.

Evaluation, critique and modelling using mathematical concepts

Many tasks involve workers in problem solving and decision-making using mathematical skills. They use mathematical problem-solving techniques to investigate and solve problems and undertake sophisticated tasks. This includes the ability to:

- reflect on the reasonableness and accuracy of their results and possible alternative methods and solutions;
- model mathematical information; and
- communicate data and mathematical information.

Implications for teaching and learning mathematics

Teachers should be provided with information about the wider uses and applications of particular mathematical ideas in the workplace.

There is a need to improve the connections between mathematics in schools and in the world of work for young people. In the workplace, the mathematical skills are placed into a complex, problem based ‘whole’ (the process) and embedded in a specific work context. Neither form of these types of connections are emphasised nearly enough in school mathematics.

There should be an emphasis on building students’ confidence and their ability to interpret, understand and use mathematics in a range of familiar and unfamiliar contexts.

It is more important than ever before for teachers to consider how they teach as well as what they teach—what and how cannot be separated when developing skills in key areas such as critical thinking, communication, collaboration, and mathematical modelling.

Given that the transfer of mathematical skills to the workplace is not straightforward, there is a need to promote the teaching of mathematical skills and understandings in a way that encourages connections between mathematics and the real world and on the transfer of skills. The more contexts in which students are explicitly required and supported to transfer their mathematics, the more highly developed these skills will become.

There is a need to identify and take opportunities to embed work-related technologies—particularly spreadsheets and computer generated graphics—in the mathematics curriculum and teaching in schools.

Identifying and Supporting Quantitative Skills of 21st Century Workers

The Final Report and full Quantitative Skills Map are available from the websites below:

- The Australian Association of Mathematics Teachers
www.aamt.edu.au
- The Australian Industry Group
www.aigroup.com.au
- The Office of the Chief Scientist
www.chiefscientist.gov.au

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Recommendations

Continuing and sustained dialogue and collaborative effort between mathematics teachers, their schools, industry, governments and other stakeholders are essential to address the five key areas for action identified in the project’s recommendations:

1. Generate national awareness and understanding of how mathematics is conceptualised and used in workplace settings.
2. Research and develop strategies for mathematics teaching in schools which meet contemporary workplace requirements.
3. Ensure that the *Australian Curriculum* provides guidance for the transfer of mathematical skills to the workplace .
4. Develop a strategy for supporting change in schools.
5. Develop a strategy for supporting development of mathematical capability and numeracy in the workplace.