MATHEMATICS EDUCATION RESEARCH GROUP OF AUSTRALASIA, INC.
ABN 14 351 328 453

30th September 2009

MERGA Response to the National Curriculum in the Senior Secondary Years Position Paper (August 2009)

This response from the Mathematics Research Group of Australasia (MERGA) has been formulated with mathematics subjects at the forefront of our considerations. That said, many of the issues discussed apply more generally. In this submission, we draw on statements from the Curriculum Design Paper (June 2009, from now on referred to as the CDP) with the understanding that evidence has already been provided to support these statements and further evidence is not required.

MERGA focuses particularly on five issues we highlight for further attention:

a) Social justice issues associated with equal opportunities to access to a range of career pathways for *all* students

b) Implications of offering four senior secondary mathematics subjects

c) Setting minimum requirements for technology use in the study of mathematics

d) Raising awareness of the nature of deep understanding of mathematics

e) Raising awareness of psychological characteristics that can be built to enhance learning potential.

Social Justice: Access and Equity

The Senior Secondary Years Position Paper (from now on referred to as the SSYPP) describes mathematics subjects that differ in both content and intended purpose, that lead to a variety of courses and career pathways. Thus, by the structure of mathematics subjects proposed for the Senior Secondary Years Curriculum, there should be greater opportunity for more students across Australia, than previously, to study mathematics at the senior secondary level.

This only partially addresses issues of equity and access that have been found to influence the level ('Advanced', 'Intermediate', and 'Elementary', Barrington, 2006) and spread of participation of minority groups, low SES students (Helme, Teese et al, 2009), and girls in senior secondary mathematics (Forgasz, 1-5 July 2006) and thus opportunities for these students to select from a full range of career pathways. The CDP makes statements about enabling more students to achieve their career goals by through increased access to pathways through school and beyond:

> "The curriculum for students between 16 and 18 years of age (typically Years 11 and 12) will provide students with increased opportunities to make choices about pathways through school and beyond" (Curriculum Design Paper, CDP, p.8)

MERGA considers that the SSYPP waters down this statement by:

a) Leaving the authority to deny entry to senior secondary subjects with schools

b) Exempting some providers from delivering a full subject range without specifying that alternative arrangements need to be made for affected students

c) Not requiring that schools to *fully* explain to students the implications of subject choices on future career pathways.

Each of these points is now discussed in more detail.

Denying Access to Senior Secondary Years Subjects

The following quote from the SSYPP shows that decisions about who can study high-level mathematics are made at the school level without the SSYPP qualifying this statement for students who were not provided with adequate learning opportunities in the middle years of schooling:

> "… it is assumed that students who choose to undertake a senior secondary course have the prior knowledge and skills developed up to Year 10. … The decision on whether a student should enroll in a subject in the senior years, taking into account assumptions about prior learning, is a matter between students and their schools." (SSYPP, p. 7)

Disadvantages that can affect opportunities to learn can be experienced by many groups including minority groups, students with English as a second language, and students from low SES backgrounds. For example, students in lower streams can be disadvantaged by:

- Lack of challenge in the curriculum offered
- Superficial coverage of content
- Discipline problems in the class
- Being devalued in the eyes of the school community.

In reality, the students who are allocated to the bottom streams are not always those with the lowest rankings, and those with the lowest rankings are not always those with the least mathematical ability. For example, pressures from more articulate parents with more powers of persuasion can lead to an inordinate number of low SES and minority students being placed in lower streams to leave positions in higher streams for these parents' children who were not ranked as highly (see Tytler et al, 2008, Section 3.6, p. 51-55 for more detail). In addition, second language students may not have the same opportunities to display their mathematical abilities (Oakes & Lipton, 1996).

Where students have been streamed into classes in lower secondary school that are limited in the range and depth of mathematics taught, students may reach the end of Year 10 without reaching the academic level required to enroll in the senior secondary subjects of their choice.

To be consistent with the philosophy of 'The *National Declaration on Educational Goals for Young Australians'* (MCEETYA, 2008), such issues need to be addressed. The national declaration states that the senior secondary years of schooling:

> '... should provide all students with the high quality education necessary to complete their secondary school education and make the transition to further education, training or employment' (p. 12)

Recommendation 1:

The SSYPP state that students who are dedicated to a career pathway, and have not met the prerequisites for particular senior secondary subjects should not be denied access to these subjects *if* their participation is focused and their behaviour is not likely to deny learning opportunities for other class members.

Recommendation 2:

The SSYPP make explicit that schools need to arrange opportunities (internally or at a regional, state, or national level), for students to catch up mathematics they have missed.

Recommendation 3:
That online learning (regional, state, or national) be made available for students to enable this catch up process.

Exempting Small Providers: Limited Subject Range

The SSYPP states:

> "The extent of differentiation of the national curriculum in the senior secondary years should take account of the capacity of providers to deliver a range of courses." (SSYPP, p. 6, Item 14f).

Recommendation 4:
The SSYPP make explicit that where providers do not offer subjects required by their students to pursue career opportunities of their choice, it is up to the provider to make alternative arrangements to cater for these students.

Recommendation 5:
That regional, state, or national online opportunities be made available in subjects that are not offered by some providers.

Recommendation 6:
That provisions be made for dedicated students to repeat Year 10 subjects in conjunction with their senior secondary subjects

Inadequate Provision of Information About Implications of Subject Choice

A high proportion of disadvantaged students do not select appropriate subjects to optimize access to their intended career pathways because they are unaware of the implications of their subject choices, and do not tend to select subjects that give greater weight to their Year 12 scores (Helme, Teese, Dulfer, Robinson & Jones, 2009; Darling-Hammond, 2007; Oakes & Lipton, 1996). There is a lower number of students from low SES schools participating in high-level mathematics than would be expected from their proportion in the community (Helme, Teese, Dulfer, Robinson & Jones, 2009).

Although the SSYPP makes explicit that students are to have prior knowledge of prerequisites and pathways through the following types of statements:

> "These prior learning assumptions need to be explicit in the course description" (p. 7 Items 18/19).

> "For continuity of learning it is necessary for students to know, by mid-Year 10, the nature of the courses from which they will select. Schools prepare 'subject-selection' materials for students and parents to consider. These materials are typically produced in May/June for selection choices to be finalized by July/August.' (SSYPP, p. 13, Item 51)

MERGA does not consider these statements sufficient to overcome the above-mentioned access and equity issues.

Recommendation 7:
That the SSYPP make explicit to schools that providing students with written information on subject selection and career pathways is not sufficient to fully inform all students of career pathway implications of their subject choices.

Recommendation 8:
That the SSYPP address the need to better prepare some career advisors in the roles they fill (OECD, 2004).

Recommendation 9:
That the SSYPP should raise the awareness of career advisors and other teachers, of

research findings about disadvantages associated with providing students only with written information about career choices.

In summary, the position of the SSYPP is inconsistent with statements on equity and access in the CDP. The SSYPP should make explicit that access to senior secondary subjects should be enabled for students who do not meet the academic requirements, but are dedicated to a particular tertiary pathway and willing to work to achieve this.

There is little to no reference in the SSYPP to educational policy and goals regarding:

- Participation and retention in senior secondary school for *all*, or for particular cultural groups who are currently disadvantages;
- Participation in vocational, further and higher education for *all*, or for particular culturally disadvantaged students.

The curriculum of the senior secondary school needs to be planned with the expectation that these goals can be and will be met, and the curriculum structure should enable access to high stakes subjects and enable success.

Implications of Four Senior Secondary Mathematics Subjects

Although there are benefits to having four different levels of mathematics at the senior level, there are also resourcing issues involved, particularly for small schools and schools in low SES areas (Teacher Supply and Demand Reference Group, 2006). The shortage of qualified mathematics teachers across Australia (Committee for Review of Teaching and Teacher Education, 2003), along with the tendency to place qualified teachers at the senior level could result in fewer qualified mathematics teachers at the junior secondary levels. This is likely to exacerbate problems associated with the need for pedagogical changes to develop deep understanding of mathematics rather than the commonly held teacher goals of teaching rules and procedures without addressing the mathematical understandings that underpin them. Such considerations need to be taken into account when deciding how many mathematics subjects to offer at the senior secondary level.

Recommendation 10:

That implications for teacher resourcing be taken into consideration and addressed when making decisions on the number of mathematics subjects to offer at the senior secondary level.

The Nature of Deep Mathematical Understandings in Mathematics

The CDP advocates in depth study, and sequencing of the curriculum:

> "The selection of curriculum content will provide for rigorous, in-depth study, preferring depth to breadth wherever a choice needs to be made"
>
> And that:
>
> [The curriculum] be developed to ensure that learning is appropriately ordered and that unnecessary repetition is avoided"
> (CDP. p. 18)

The inability of many senior secondary students to respond adequately to questions on final senior secondary exams (e.g., Examiner's Reports, VCAA, http://www.vcaa.vic.edu.au/vce/studies/mathematics/methods/exams.html#H2N400111) point to the inadequacy of commonly used teaching practice of the teacher transmitting rules and procedures. MERGA members in tertiary settings across several university faculties have found the same lack of ability of many students to apply the mathematics they have learnt to unfamiliar situations. It is important that the SSYPP not remain silent on what it means to understand deeply.

As there is a commonly held belief amongst many senior secondary mathematics teachers that in depth study of mathematics consists of being able to apply sophisticated rules and procedures, descriptions of the mathematics subjects for senior secondary years need to be extended beyond their present content focus. Such a focus limits the likelihood of the types of pedagogical changes necessary to develop flexible and creative mathematical thinking that is valued in the 'The *National Declaration on Educational Goals for Young Australians'* (MCEETYA, 2008).

Barnes, Clarke, and Stephens (2000) found that changes to assessment at the senior level drove pedagogical change. Thus, by connecting the assessment of the senior secondary mathematics curriculum to the proficiency strands: understanding, fluency, problem solving and reasoning, there is increased likelihood that the teaching and learning of mathematics at the senior secondary will shift towards student controlled mathematical thinking and collaborative development of new knowledge like:

- Selecting appropriate mathematics to use
- Making decisions about the reasonableness of mathematics generated
- Making judgments about elegant ways to proceed
- Synthesizing mathematical ideas and concepts to develop insights.

Recommendation 11:
The SSYPP make explicit the nature of deep mathematical understanding

Recommendation 12:
The SYPP add a proficiency focus to the descriptions of mathematics subjects.

Recommendation 13:
Similar to Maths D, the SSYPP include the types of career pathways each subject can provide access to in the description of each mathematics subject.

Requiring a Minimum Standard of Technology Use

The document is **silent** about the role of digital technologies in senior secondary learning. This is surprising given the substantial benefits that have been found in using technology in appropriate ways to development deep mathematical understandings. One way to stimulate student connection of mathematical representations and deepen student understandings is through exposure to dynamic visual images that can be generated by technology during exploratory activity (Brown, 2005; Goos, Galbraith, & Renshaw, 2002; Dreyfus, Hershkowitz, & Schwarz, 2001; Stillman, 2004). That said, there are many instances where technology has been used in inappropriate ways and substantial learning did not occur (Tytler et al., 2008). Dynamic visual images generated through explorations with graphing technologies and interactive geometry software have the potential to deepen mathematical understanding so this raises serious questions SSYPP's silence.

Recommendation 14:
Assessments in mathematics subjects should include exploratory activity including some technology-assisted activities in which students select appropriate technology, and use it in discriminating ways.

Recommendation 15:
The SSYPP should take a greater lead in providing opportunities for students to engage in technology supported learning environments by placing a minimum requirement on technology usage (e.g., all students should have some exposure to the use of graphing calculators in senior secondary mathematics).

Psychological Characteristics Strengthening Learning Potential and Well-being

The SSYPP does not give due attention to the needs of students in senior schooling with respect to enhancing personal opportunities and well being. The curriculum of the senior secondary school needs to be planned with the expectation that these goals can be and will be met.

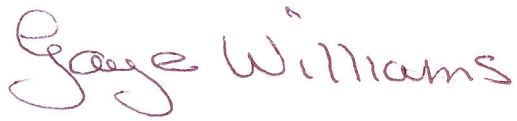
Academic resilience (Martin & Marsh, 2006), and optimism as a form of resilience (Seligman, 1995; Williams, 2008; Yates, 2002) have been found to increase student potential to learn, and resilience has been linked to emotional well being (Glover et al., 2002; Seligman, 1995).

Recommendation 16:

The SSYPP value psychological characteristics that strengthen student learning opportunities.

Recommendation 17:

That the SSYPP address the need for professional learning for teachers associated with building psychological characteristics as they teach their senior secondary subjects.



Gaye Williams
VP (Development)
Mathematics Education Research Group of Australasia

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