

Looking over the fence
- mathematics in the
post-compulsory years
in other states and
countries

A critical analysis of selected Australian and international mathematics syllabuses for the post-compulsory years of secondary schooling.

A report prepared for the NSW Board of Studies

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http://www.boardofstudies.nsw.edu.au/manuals/pdf_doc/math_s_st6_lit_curr_rev_pt1.pdf

Relevant documents

- *Review of Senior Secondary Mathematics Curriculum* (Stacey, Dowsey, McCrae and Stephens, 1998)
- *Comparison of Year 12 pre-tertiary Mathematics Subjects in Australia 2004-2005* (Barrington and Brown, 2005)
- *Participation in Year 12 Mathematics Across Australia 1995-2004* (Barrington, 2006).

Other sources

- Websites maintained by State and International Curriculum Authorities
- Academic sources: journal articles, books, conference proceedings etc

Main parts of my report (97 pages)

- Executive summary
- Acknowledgements, Introduction
- Australian states: NSW, Vic, Qld
- International Baccalaureate
- International Comparative studies
- Singapore, Hong Kong, UK, USA
- Conclusions, references, appendices

Parts of the report for comment today

- Executive summary
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Extracts from the Executive Summary (1 of 4)

- Calculus courses for university-bound students:

appropriate level of challenge in current NSW courses, but need updating

Extracts from the Executive Summary (2 of 4)

- Course for students not intending to proceed to university:

the NSW mathematics courses do not provide the same opportunities that are offered in other states

Extracts from the Executive Summary (3 of 4)

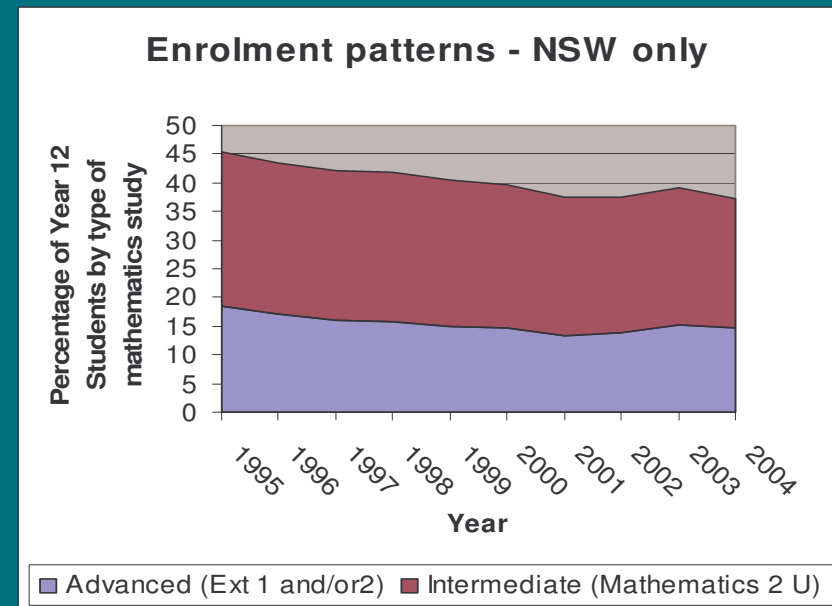
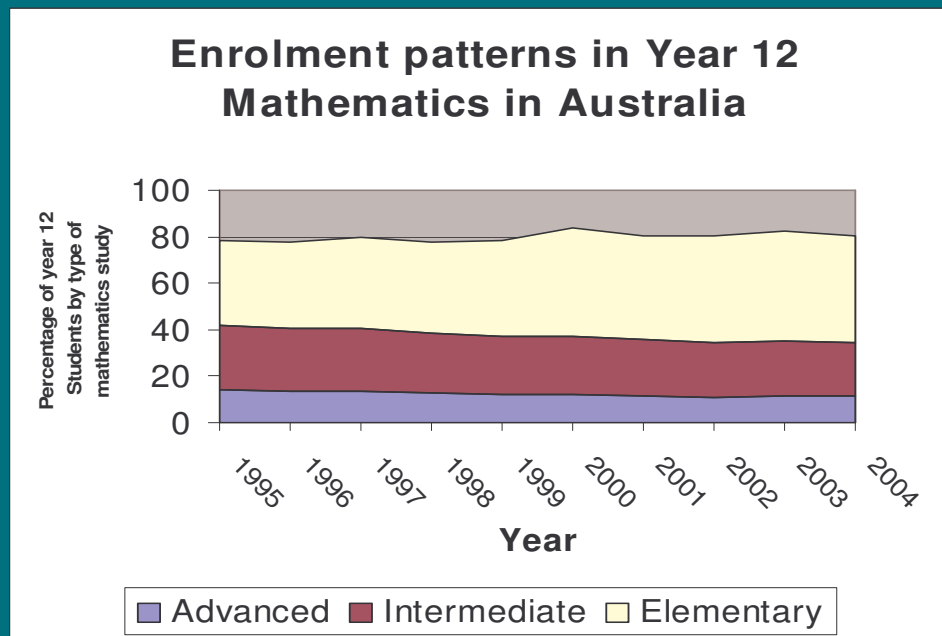
- Re technology for the teaching and learning of mathematics: still a matter for debate...
- Must ask more than “are graphing calculators going to be in the exams?”

Extracts from the Executive Summary (4 of 4)

- New technology is changing the way mathematicians work, and is changing the way mathematics is used in the workplace.
- If mathematics is regarded as something people *do* rather than a disembodied collection of rules and results, the focus changes from the tools to the tasks.
- Practical measures can be taken to ensure that valuable by-hand skills are still learned

Australia: enrolment patterns

(Data from Barrington, 2006)



Victoria

- VCE, VCAL (Cert. of Applied Learning)
- VCE: At least 16 units. Units 1 & 2 of a subject in Year 11, Units 3 & 4 of a subject in Year 12. Most do 20-24 units over 2 yrs
- ENTER requirements
- Extension Studies run by universities

Victoria: subjects

Year 11

- Foundation Mathematics
- General Mathematics
- Mathematical Methods (Units 1&2)
- Mathematical Methods (CAS) (Units 1&2)

Year 12

- Mathematical Methods (Units 3&4)
- Mathematical Methods (CAS) (Units 3&4)
- Specialist Mathematics
- Further Mathematics

Comparisons: Calculus based subjects

- Victoria's Mathematical Methods (Units 1-4) vs NSW Mathematics (2 Unit) and Mathematics (Extension 1): same emphasis on algebra, functions, and calculus.
- Victoria provides a deeper and broader treatment of probability, NSW instead has plane geometry. The difference in the ages of the syllabus documents is evident in the choice of examples and applications.

Comparisons: non-calculus

- Direct comparison is not easy because of the selections possible within the Victorian subjects.
- General Mathematics (Units 1&2, Year 11 Vic) followed by Further Mathematics (Units 3&4, Year 12, Vic), vs General Mathematics (NSW)
- It should be borne in mind that in Victoria, not all students study all parts of General Mathematics and Further Mathematics. (Options and modules.)

Content with more emphasis in Victorian General Mathematics followed by Further Mathematics, (depending on the school's choice of topics)

Content with more emphasis in General Mathematics (NSW)

Complex numbers (basic introduction)
Matrices
Sequences including recursion
Regression
Simulation
Logic and Boolean algebra
Polar co-ordinates
Modelling using the log function
Focus-directrix properties of certain graphs
Networks
Linear programming
Kinematics
Vectors
Geometry in art, tessellations

Wider variety of topics within personal financial mathematics (e.g. shares, taxation, budgeting)

Future value, present value calculations

Wider applications of area and volume

Spherical geometry leading to location on the globe and time differences

Financial expectation in games of chance

Queensland

- Queensland Studies Authority
- Senior Certificate after 12 years schooling
- No external examinations
 - Teachers assess own students
 - Criteria-based assessment
 - Moderation across schools
- Qld Core Skills Test contributes to Tertiary Entrance

Queensland: subjects

- Functional Mathematics
- Pre-Vocational Mathematics
- Mathematics A
- Mathematics B
- Mathematics C

Queensland: Mathematics A

- “Maths for informed citizenship”, not maths for university study
- Two year course
- Seven compulsory core topics
- One of four elective topics
- Could be regarded as similar to NSW General Mathematics

Queensland: Mathematics B

- Intro to functions
- Rates of change
- Periodic functions and applications
- Exponential and log functions and app'ns
- Intro to integration
- Applied statistical analysis

Queensland: Mathematics C

- Taken with Mathematics B for a rigorous preparation for university mathematics
- Six core topics
- Two of seven option topics
- Wider choice and more modern topics than in NSW, at the expense of calculus

Queensland: Mathematics C

CORE: Intro to groups, Real and complex no. systems, Matrices and app'ns, Vectors and app'ns, Calculus (builds on Maths B calculus), Structures and patterns.

OPTIONS: Linear programming, Conics, Dynamics, Intro number theory, Intro modelling with probability, advanced functions, school option.

Singapore

Streaming from the end of Primary Year 4 (age 10+)

Year 6: Primary School Leaving Examination, more streaming

Age 16, “O” level, decides practical (Polytechnic) or academic (Junior College) stream

Age 18+, “A” level for top 25% of cohort

Recent changes to increase breadth of study at A level

Singapore: new subjects

- Mathematics Higher 1
- Mathematics Higher 2
- Mathematics Higher 3 (must do H2 also)

All with external assessment, all with Graphing Calculator, non CAS.

Singapore H1

- Designed for students intending to study business, economics, and social sciences and similar courses at university.
- Topic areas are Functions and graphs, Calculus, Probability.
- In Calculus, the product and quotient rules are not included. Definite integrals are introduced as areas under curves, not limiting values of sums. Numerical integration on the Graphing Calculator is included. The Probability section includes binomial and normal distributions, hypothesis testing, correlation and regression.

Singapore H2

- Designed for students intending to study mathematics, physics, and engineering.
- Topic areas are Functions and graphs, Sequences and series (includes proof by mathematical induction), Vectors , Calculus , Permutations combinations and probability, Binomial Poisson and normal distributions, Sampling and hypothesis testing, Correlation and regression.

Singapore H3

- For students who have a strong aptitude for mathematics and are passionate about it.
- Students taking H3 must also take H2.
- Differential Equations *plus*
- two more topics from Plane Geometry, Graph Theory, and Combinatorics.

Hong Kong

- Entry to final years of secondary schooling is competitive
- Changing from 7 years secondary school, 3 years university to a 6 then 4 pattern
- Concern that previous mathematics curriculum too packed and emphasised routines and memory work at the expense of real world problem solving

Hong Kong: final years

- Students to study 4 core subjects and up to 3 electives
- Core subjects: Chinese Language, English Language, Mathematics, Liberal Studies
- Mathematics has a compulsory part and an extended part
 - The extended part is a choice, do only one
 - Calculus and stats OR algebra and calculus

Hong Kong: Compulsory part

- Number and algebra
- Measure, shape and space (includes trig and locus)
- Data Handling
- Further Learning Unit (to allow for extended investigations and school based assessment)

Hong Kong: Module 1 Calculus and Statistics

- Foundation material incl. log and exp fn.
- Conceptual intro to differentiation
- Intro integration with applications
- Further probability
- Binomial, geometric, Poisson distributions
- Normal distribution
- Point, interval estimation, conf. intervals
- Further learning unit

Hong Kong: Module 2, Algebra and Calculus

- Foundation knowledge
- Limits and integration
- Integration
- Matrices and systems of linear equations
- Vectors
- Further learning unit

Hong Kong

- Changes are well thought through and based on wide ranging surveys of students, parents, teachers, university lecturers, curriculum planners and human resources personnel in the commercial sector
- Mathematics specially chosen to be compulsory

Hong Kong: Law (2006b)

The rapid advancement of modern technology, coupled with the fast development of the Internet, has not only transformed the way in which information is disseminated, but also brought about tremendous changes to mathematics education. For instance, while basic understanding of number, measurement and data handling will always be a necessary foundation, the need for drilling computation skills has reduced significantly due to the availability of calculators and the emergence of computer algebra systems in recent years.

Hong Kong: Law (2006b) cont.

With the help of information technology, many learning topics and meaningless drilling have become obsolete. Mathematics education is no longer confined to the rote learning of formulae, principles and algorithms. In light of societal changes, secondary students should not only possess foundation mathematical skills and concepts; more importantly, they should build up confidence in learning mathematics and be well-trained in logical deduction, abstract thinking, analysis and problem solving, and communication through symbols and graphs. They should also cultivate in themselves a spirit of perseverance in finding solutions and a habit of independent rational thinking.

There is much to learn by looking over the fence – however:

- We must always remember that social, cultural, historical and political conditions provide the context within which curriculum and assessing bodies operate.
- Beware of the assumption that there is some “natural” or “ideal” curriculum suitable for all.