

Mathematics K-10 Review Strategies and Overall Key Findings

(October 2000 - March 2001)

The Syllabus Review Phase of the Review and Development of Mathematics K-10 Syllabuses project involved six data-gathering strategies. These six strategies, and other means used to collect additional data, are briefly described below, along with the overall key findings from the review.

1. Literature Review (November 2000 - January 2001)

The purpose of the literature review was to research, review and report on significant literature and other Australian and international mathematics syllabuses relevant to the Stages of compulsory schooling in NSW.

The recommended methodology indicated that the review should include literature produced over the last five years (unless material produced outside this period was of particular significance) by:

- developing a framework to analyse the significant issues indicated by the review
- identifying and critically analysing relevant research reports, articles and other literature that address particular issues including theoretical frameworks, working mathematically, mental computation, technology, continuity of learning, standards-referenced assessment, and optimum course arrangements for Stages 4 and 5
- critically analysing relevant syllabuses from Australian States and Territories, and the mathematics curricula from at least five countries drawn from North America, Western Europe and Asia. Due emphasis was to be given to the primary and junior secondary (Years K-10 in NSW) aspects of the curriculum in each of the locations selected. (An important factor in the selection of overseas countries was to be their performances in international assessment programs).
- maintaining an annotated record of all reviewed literature regarded as significant
- maintaining an annotated record of all syllabuses reviewed.

In addition, the report needed to include a list of recommendations based on this review with particular attention to the implications for any revision of NSW mathematics syllabuses for Years K-10.

The Literature Review was undertaken by Dr Kay Owens and Associate Professor Bob Perry from the University of Western Sydney and included an

executive summary, a list of key findings, and recommendations for curriculum development. Separate chapters examined approaches to learning, major curriculum themes, curriculum issues and developments elsewhere, teacher reform, assessment, technology, and developments in specific areas. These specific areas focused on number sense, proportional reasoning, spatial and geometric thinking, and data sense and probability sense.

LINK to web copy of the LITERATURE REVIEW

2. Oral Submissions (December 5-6, 2000)

A formal letter of invitation to present an oral submission was sent in November to organisations and individuals with an interest in Mathematics. This resulted in a total of twelve presentations, which were heard over two evenings by a panel comprising two nominated members of each of the Mathematics K-6 and 7-10 Board Curriculum Committees, and Board Officers.

Presentations were made by the following organisations and individuals (in order of presentation):

- NSW Department of Education and Training (Presenter: Mr Peter Gould)
- Association of Heads of Independent Schools of Australia (Presenters: Ms Jenny Allum, Mr John Scott)
- Associate Professor Bob Perry (University of Western Sydney)
- NSW Secondary Principals Council (Presenter: Mr Bob Healy)
- Associate Professor Michael Mitchelmore (Macquarie University)
- The Mathematical Association of NSW (Presenters: Ms Margaret Bigelow, Ms Bernice Beechey, Ms Jacqui Whitland)
- Ms Pamela Shaw (Statistics Society of Australia, NSW Branch)
- Associate Professor Terry Gagen (University of Sydney)
- Catholic Education Commission (Presenters: Ms Jan Glazier, Mr John Ley, Ms Cathy Smith)
- Federation of Parents and Citizens Associations of NSW (Presenters: Ms Di Butland, Ms Sharryn Brownlee, Dr Don Lang)
- Associate Professor Beth Southwell (University of Western Sydney)
- Australian Association of Special Education (NSW Chapter) (Presenters: Mr Ian Thompson, Dr David Evans).

Presenters were allocated a maximum of 15 minutes for their presentations. A period of 5 minutes was set aside at the completion of each presentation for panel members to seek clarification on particular aspects of the submission. In formulating their presentations the presenters were invited to either address issues from a K-10 perspective or choose a particular area of focus such as:

- an aspect of K-10 Mathematics,
- a particular syllabus, or
- a period within the compulsory years of schooling.

The timing of this data-gathering strategy was important as it enabled key organisations and academics to highlight early in the Syllabus Review Phase what they considered to be key issues in the review and development of mathematics syllabuses for the compulsory years of schooling.

LINK to web copy of the ORAL SUBMISSIONS REPORT

3. Survey of a sample of schools (December 2000 - March 9, 2001)

Years K-6 and Years 7-10 surveys sought school and faculty views on K-10 Mathematics including the main strengths and weaknesses of the relevant syllabus documents (K-6, 7-8, 9-10 [Advanced, Intermediate, Standard, Stage 5 Mathematics Life Skills]). The surveys were sent to a sample of 100 schools. A total of 54 schools responded (28 primary schools, 16 secondary schools, 7 central schools, and 3 special schools).

4. Written Submissions (December 2000 - March 9, 2001)

A formal letter of invitation to prepare and submit a written submission was sent in December to organisations and individuals with an interest in Mathematics. Submissions were received from the following:

- Association of Heads of Independent Schools of Australia
- NSW Federation of School Community Organisations
- Junior Schools Heads Association of Australia
- Statistical Society of Australia (NSW Branch)
- The Mathematical Association of New South Wales
- NSW Department of Education and Training
- Australian Association of Special Education (NSW Chapter)
- Early Childhood Education Council of NSW
- Federation of Parents and Citizens Associations of NSW
- Associate Professor Beth Southwell (University of Western Sydney)
- Professor John Mack (University of Sydney)
- Dr Mohan Chinnappan (University of Wollongong)

5. *Aboriginal Students and Numeracy Discussion Forum (February 20, 2001)*

In response to the announcement that the K-10 Mathematics syllabuses would be revised, the Aboriginal Curriculum Unit of the Office of the Board of Studies commissioned Ms Tracey Frigo (ACER) and Ms Lee Simpson (Charles Sturt University) to write a report providing an overview of current literature on Aboriginal students and numeracy. The research report included recommendations for most effectively meeting the needs of Aboriginal students in Mathematics syllabuses.

A discussion forum was held on February 20 at the Office of the Board of Studies to discuss the issues raised in the report. Attending the forum were representatives from the NSW Department of Education and Training and the Catholic Education Commission, academics from universities in NSW and Victoria, teachers, principals from both systemic and independent schools, and representatives of the Office of the Board of Studies.

6. Symposium (February 24, 2001)

A Mathematics K-10 Symposium was held on February 24 at Lucas Heights Community School, a purpose-built K-12 school with an established middle-school profile.

The purpose of the Symposium was to hear the views of six academics (Mathematics/Mathematics Education) on a range of key issues relating to Mathematics K-10. The intention was to engage participants (mainly teachers) in dialogue regarding their views and ideas about mathematics syllabus development for the compulsory years of schooling.

A total of 170 participants including primary school teachers, secondary school teachers, academics, systems consultants and representatives, parents and Board Officers attended. Board Curriculum Committee members acted as observers, facilitators and recorders in the workshop sessions. Reflections on the day were presented by five members (one parent representative and four teachers) from the Mathematics Board Curriculum Committees for Years K-10.

Each of the invited speakers has written a paper that is included in the Symposium proceedings.

The speakers were:

Professor Sue Willis, Dean, Faculty of Education, Monash University

Professor John Mack, School of Mathematics and Statistics, University of Sydney

Associate Professor Bob Perry, Department of School and Early Childhood Education, University of Western Sydney

Associate Professor Dianne Siemon, Department of School and Early Childhood Education, Language and Community Services, RMIT University

Professor John Pegg, Director, Centre for Cognitive Research in Learning and Teaching, University of New England

Professor Garth Gaudry, Head, School of Mathematics, University of New South Wales

Presentations were followed by workshops; there were 8 workshop groups with approximately 17 participants in each. The following questions were provided as starting points for discussion.

Session 1

From your experiences in classrooms, knowledge of teaching and learning mathematics, and reactions to this session, please consider the following questions:

1. What mathematical ideas should be included in K-10 Syllabus/es that would ensure essential knowledge, skills and understanding for ALL students?
2. What do you believe to be the major issues that need to be addressed in relation to the structure (eg number of courses, strands) and delivery (eg, planning, teaching, reporting, resourcing) of Mathematics K-10?

Session 2

Given the presentations from this session, and the current structure for K-10 Mathematics (organised as three syllabuses — Years K-6, Years 7-8, Years 9-10 [Standard, Intermediate, Advanced, and Life Skills courses]), please consider and discuss the following:

1. What curriculum models should be considered when addressing the issues involved in the design of a continuum of mathematics learning for the compulsory years of schooling?
2. What structure for the K-10 continuum do you believe would best meet the needs of ALL students?

LINK to web copy of the SYMPOSIUM PROCEEDINGS

7. Collection of Additional Data

Data have also been collected through other means, such as surveying students, written submissions from individuals, and surveys from non-sample schools.

7.1 Student Surveys

Members of the Years K-6 and 7-10 Mathematics Board Curriculum Committees, and Board Officers, surveyed students from Kindergarten to Year 11.

The main questions posed to students included:

- What is mathematics?
- What do you think you will learn in mathematics this year?
- Was last year's mathematics what you thought it would be?
- What do you like about mathematics?
- What don't you like about mathematics?
- What do you think you learn in mathematics that is/will be useful to you?

Responses were collated and displayed on posters at the Mathematics K-10 Symposium.

7.2 Additional Written Submissions

Additional written submissions were received from:

- Ms Anne Hastings, Deputy Principal, Kambala Church of England Girls School
- Mr Ed Lewis and Mr Jim Grant, Australian Catholic University
- Mr Harry O'Brien, Progressive Education Pty Ltd
- Dr Bill Pender, Subject Master in Mathematics, Sydney Grammar School.

7.3 Additional Mathematics Surveys

Additional surveys have been received from a total of 17 schools (4 primary schools, 12 secondary schools, and 1 central school).

Overall Key Findings from the Review of Mathematics K-10 Syllabuses

The set of overall key findings from the review is outlined below.

Student Learning

- Students need to develop a connected understanding of mathematical concepts; this needs to include connections between strands and between prior and subsequent learning.
- The experiences of students need to connect with the mathematics they learn: whenever possible, students need to be able to see where mathematics is already a part of their lives, and why it is important.
- Challenging students' thinking and current knowledge supports learning and the development of metacognitive processes that include reflection and self-monitoring.
- Both procedural knowledge and conceptual understanding need to be developed in order to promote the use of efficient, appropriate and accurate methods in mathematics.
- There is a need to incorporate both mental and written computation skills as well as drill and practice in mathematics lessons.
- Acknowledging the social context of the learning environment and accommodating students' needs are critical for promoting learning in mathematics; this includes the recognition of students' mathematical understandings on entry to school and the role played by parents and carers in developing these understandings.
- Students' confidence, motivation and attitudes to mathematics need to be considered when planning for teaching and learning.
- Outcomes enable teachers to focus on what children can do and support preparation of further learning opportunities: rich tasks can provide greater evidence of achievement of outcomes and should be explicit in syllabus documents.
- There is a significant gap between the highest levels and the lowest levels of student achievement in mathematics: focusing on the needs of those students who are making slower progress through the curriculum is essential.

- Acceleration and extension of students should continue with the possibility of lateral extension to enrich learning opportunities: many teachers and others have indicated that they are pleased with student achievement at the highest levels.

Curriculum Framework

- All students have the right to engage in a curriculum that offers individually appropriate, high quality tasks.
- There is a need to allow for different starting points and pathways to learning; this may require a paradigm shift in thinking if there is to be a commitment to high standards for students and to varying the curriculum in practice.
- There needs to be some flexibility in time for delivery of content if all students are to obtain the necessary skills and understandings to effectively participate in society.
- Most frameworks in other Australian States and Territories provide a continuum of learning with no differentiation of courses; however, the needs of more able students appear to be accommodated through the provision of extension, or additional, outcomes that aim to engage students in learning beyond a core set of outcomes.
- There was considerable variation of opinion on the pedagogical and ideological basis for the differentiated course structure in Stage 5 Mathematics (Advanced, Intermediate, Standard, Life Skills); however, consultation indicates that the vast majority of secondary mathematics teachers are in favour of the retention of this course arrangement.
- There was general agreement with the removal of areas of unnecessary overlap between Stages while ensuring that students have the opportunity to revisit mathematical concepts at a higher conceptual level.
- The "big ideas" that need to be considered in curriculum development include encouraging argumentation and proof, using models and concrete representations when appropriate, developing profound understanding of fundamental mathematics, supporting algebraic reasoning, enhancing number sense and mental computation, focusing on proportional reasoning, developing spatial and geometric thinking, incorporating data and probability sense from an early age, and making connections between ideas and concepts.
- There is a need to emphasise and develop a valid sequence of computational, procedural, and problem-solving skills — components that are not separate and are mutually reinforcing; as a consequence, working mathematically should be integrated.

- Syllabus documents need to be easy to use, define key terms, describe processes and skills that are appropriate for each Stage, provide a rationale for teaching mathematics, be grounded in theories of how students learn, offer suggestions for teaching mixed-ability groups, and have less focus on discrete knowledge elements and more focus on the acquisition of skills.
- In the development of the syllabus/es, mathematical language needs to be used consistently across Stages.

Teachers

- Teachers need more information about how students learn and how to adequately assess student understanding (recognising that external assessment programs provide one means of reporting and a snapshot of student achievement).
- The provision of suitable assessment information supports teachers in their efforts to differentiate the curriculum to meet individual student's needs.
- In order to cater for the diverse needs of learners in every classroom, there needs to be a focus on differentiated teaching: ready access to the range of K to 10 outcomes should be provided for this process.
- Developing teachers' knowledge is critical for supporting the introduction of a new syllabus/es. This can be achieved through the development of appropriate support documentation. In addition, appropriate information in preservice courses as well as substantial inservice opportunities will need to be provided.
- Pedagogy should be established within the curriculum. While there are different views about the use of particular teaching strategies, it is appropriate to consider the judicious use of problem-solving approaches, rote learning, practice, textbook exercises, worksheets, group work, technological approaches, etc.

Parents

- Parents should be consulted for the valuable information that they can provide about their children's early mathematical understandings.
- Parents need to be informed about curriculum changes and one method to achieve this is to develop suitable support materials.
- Parents should be provided with worthwhile and meaningful assessment information regarding their children's progress.

Technology

- The use of technology has the power to change teaching and in turn can affect what students learn and how learning is accomplished; technology tools include a range of software packages and calculators (including graphics calculators).
- There were divergent views about the use of calculators in K-8 classrooms. There was some suggestion that using calculators interferes with the acquisition of computation skills whereas others believe that calculators can be used in a range of ways to enhance understanding.

Assessment and Reporting

- Teachers need to be able to identify indicators and their relationship to particular outcomes: parents need meaningful information.
- Assessment tasks need to be carefully constructed with attention to language use, context, and the cultural backgrounds and perspectives of students.
- In order to provide appropriate learning experiences for students, as they advance along the continuum of learning, the communication of their achievement across key transition points (eg. entry to school, 6 to 7) is crucial: the Board could provide more support in this regard.