

Research into the numeracy development of Aboriginal students: Implications for the NSW K-10 Mathematics Syllabus

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The views expressed by the authors do not necessarily reflect the views of the Office of the Board of Studies NSW.

Introduction

The planned revision of the NSW Years K-10 Mathematics syllabus provides a timely opportunity to reflect on research into the numeracy development of Aboriginal children, and to identify key factors which affect their achievement. The numeracy achievement of Aboriginal students in NSW continues to be on average significantly lower than of non-Aboriginal students.

The reasons for this are many and complex. Poorer educational outcomes for Aboriginal students have been attributed to inappropriate curricula and pedagogical practices, and students' lower average attendance and participation in schooling. Many come from low socioeconomic or rural and remote areas; many live in poverty and they or their families suffer health problems which in turn impact on their education.

Low attainment in foundational skills such as English literacy and numeracy can significantly contribute to lower overall achievement, non-engagement, poorer attendance and lower retention levels for Aboriginal students in later years of schooling. Numeracy skills enable individuals to participate successfully in school and beyond: in further studies, training, personal pursuits, in the world of work, and in the wider community.

An acceptance that the lower achievement of Aboriginal students is largely to be founded in aspects of their life experiences might lead to a conclusion that it is outside the scope of a syllabus document to improve outcomes for Aboriginal students. However, the small body of research in this area suggests that when culturally inclusive curricula and pedagogy are adopted by schools and teachers, and delivered in a way which accounts for the diversity of student backgrounds and starting points, and formative assessment (which is culturally and contextually appropriate) is used to rigorously monitor student progress, the achievement of Aboriginal students improves significantly. There are limitations to ways in which a syllabus will challenge long-established pedagogical practices of many teachers - particularly in a learning area such as mathematics that is traditionally seen to be largely culture- and value-free. The statements made in the syllabus about the knowledge, skills and understandings expected of the learners provide a important base from which to effect change in curriculum and pedagogy. Curriculum, pedagogy and assessment are all inter-related so that change in any one requires a multi-level and holistic approach. It is only through such an approach that learning outcomes for Aboriginal students can be improved.

In essence, a syllabus is needed that encourages and empowers teachers to reflect on how they value and build on the diverse experiences, knowledge, cultural and linguistic backgrounds that all students bring with them into the classroom. Such a syllabus is one that actively encourages teachers to implement inclusive curriculum programs and cross-cultural teaching and learning strategies.

Purpose

As specified in the project guidelines, this paper is intended to present an overview of the literature and identify critical issues related to the acquisition and on-going development of numeracy skills among Aboriginal students in the compulsory years of schooling in New South Wales. The scope of the research reviewed is intended to reflect the diversity of Aboriginal circumstances and communities across NSW and to take into account rural, remote and urban situations.

The aim of the paper is to identify significant issues which arise from the literature which could profitably form the basis for recommendations to inform the review and development of NSW syllabuses for Years K-10 Mathematics.

Methodology

The report follows the project brief that specifies five main components of the project, which are to:

- identify and critically analyse existing research, reports and projects;
- develop a framework to analyse the critical issues indicated in the research;
- develop a database of all reviewed literature;
- develop a literature review of current research around the critical numeracy issues which impact on Aboriginal student numeracy skills; and
- provide a list of recommendations, based on this review, for discussion in an Aboriginal Numeracy symposium.

The literature reviewed in the report *Resources and Teaching Strategies to Support Aboriginal Children's Numeracy Learning* (Frigo, 1999) provides the foundation for the database of literature reviewed in this paper. A number of recent reports and materials, both published and unpublished, have been added to this database which is included as an appendix to this paper.

Reference is also made to numeracy programs and resources currently being used in schools that focus on Aboriginal students. While in many cases there is little empirical evidence regarding their effectiveness, there are anecdotal reports of their successful use with Aboriginal students.

It is essential that more research, including longitudinal research, is carried out to gather much needed empirical evidence not only on the effectiveness of programs and resources but on factors that contribute to the low levels of achievement of Aboriginal students in the area of numeracy.

Context for Syllabus Review

There are a number of parameters and contexts that need to be taken into account in developing recommendations for the revision of the syllabuses. The review of the syllabuses takes place in the context of building on the strengths of current syllabus documents and of taking into account current trends in mathematics education. Where appropriate, reference is made to this broader context and the implications of this for Aboriginal students in light of the research.

The planned revision of the NSW Years K-10 Mathematics syllabuses also takes place within a broader discussion which has resulted in the commitment of State, Territory, and Commonwealth governments to policies regarding:

- improving the numeracy achievement of Australian school students across the country;

- achieving equitable educational outcomes for Aboriginal and Torres Strait Islander students; and,
- a commitment to assist schools in adopting more culturally inclusive schooling practices.

Numeracy for All

The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century (MCEETYA, 1999), agreed to by all State and Territory Ministers of Education, states that all students should have:

... attained the skills of numeracy and English literacy; such that, every student should be numerate, able to read, write, spell and communicate at an appropriate level.

In this context, the following definition of what it is to be numerate applies:

To be numerate is to use mathematics effectively to meet the general demands of life at home, in paid work, and for participation in community and civic life.

In school education, numeracy is a fundamental component of learning, performance, discourse and critique across all areas of the curriculum. It involves the disposition to use, in context, a combination of:

- *underpinning mathematical concepts and skills from across the discipline (numerical, spatial, graphical, statistical and algebraic);*
- *mathematical thinking and strategies;*
- *general thinking skills; and*
- *grounded appreciation of context.* (DEETYA, 1997, p 15)

In support of this 'national numeracy goal', there are a number of programs and research projects being undertaken across the country. The paper, *Numeracy: A Priority for All*, (DETYA, 2000) provides an overview of some of the policies intended to support the achievement of this goal. The paper also provides an insight into the range of recent research that has been conducted into effective teaching and learning of numeracy in the key learning area of mathematics.

While numeracy skills may be taught across the curriculum, school subject mathematics is acknowledged as a key area for the development of numeracy skills.

Equitable outcomes for Aboriginal students

The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century further states that

Aboriginal and Torres Strait Islander students [should] have equitable access to, and opportunities in, schooling so that their learning outcomes improve and, over time, match those of other students.

Reports on state-wide and national assessment programs indicate that the English literacy and numeracy achievement of Aboriginal students continues to be lower on average than that of non-Aboriginal students. In New South Wales, this is reflected in the results of the Basic Skills Tests undertaken by students in Years 3 and 5 and in performance outcomes reported by school authorities under the Commonwealth's Indigenous Education Strategic Indigenous Program (IESIP). International surveys such as the Third International Mathematics and Science Survey reinforce this

finding. Concerns about poor English literacy and numeracy achievement levels of Aboriginal students continue to be a national priority.

To further support Aboriginal students, the *National Indigenous English Literacy and Numeracy Strategy 2000-2004* was released by the Commonwealth Government earlier this year. The strategy identifies six key elements, based on programs that were found to effectively improve educational outcomes for Indigenous students and were made target areas for additional funding:

- lifting school attendance rates of Indigenous students to national level;
- effectively addressing the hearing and other health problems that undermine learning for a large proportion of Indigenous students;
- providing, wherever possible, pre-schooling opportunities;
- training sufficient numbers of teachers in the skills and cultural awareness necessary to be effective in Indigenous communities and schools, and encouraging them to remain for reasonable periods of time;
- ensuring that the teaching methods known to be most effective are employed; and
- instituting transparent measures of success as a basis of accountability for schools and teachers.

The identification of these target areas was largely based on a recent evaluation of the IESIP Strategic Results Projects, *What works: Explorations in improving outcomes for Indigenous students* (McRae et al., 2000). In that report, successful projects were identified as those that focused on cultural recognition, acknowledgment and support, skill development, levels of participation, home/school partnerships, and holistic approaches. While these factors may initially appear to be outside the scope of this paper, it is important to keep them in mind while considering the implications for syllabus revision.

Culturally Inclusive Schooling Practices

The planned review of the syllabuses also takes place in the context of a series of Aboriginal Education Policies that have been implemented at both State and Commonwealth levels of government since the 1980s.

More recently the State, Territory and Commonwealth Ministers of Education released the *National Statement of Principles and Standards for More Culturally Inclusive Schooling in the 21st Century* (MCEETYA, 2000a). The Ministers committed their efforts to assisting schools to provide curriculum which:

(i) *is free from the negative forms of discrimination based on sex, language, culture and ethnicity, religion or disability; and of differences arising from Indigenous students' socio-economic background or geographic isolation,*

(ii) *allows Indigenous students to share in the same educational opportunities experienced by other Australian students and at the same time allows them to be strong in their own culture and language and to reposition their cultures, languages, histories, beliefs and lifestyles in a way which affirms identity and the ability to operate in cross-cultural situations,*

(iii) *supports all students to understand and acknowledge the value of Aboriginal and Torres Strait Islander cultures to Australian society and to possess the knowledge, skills and understanding to contribute to, and benefit from, reconciliation between Indigenous and non-Indigenous Australians.*

The paper published alongside the above 'Statement' and also supported by the Ministers, the *Model of More Culturally Inclusive and Educationally Effective Schools* (MCEETYA, 2000b), notes the importance of:

... a dynamic and responsive curriculum that contributes to the development of essential knowledge, skills and attitudes in all students and builds on their capacity to view the world critically and to act independently, cooperatively and responsibly [and that effectively responds to the] needs, interests and concerns of students, with appropriate use of explicit teaching, self-directed learning and emerging technologies. Any new approach needs to be congruent with the prevailing curriculum and standards framework of the system and with student/parent/care-giver/teacher/community expectations.

Both the 'Statement' and the 'Model' comment on the importance of school and community partnerships, and of involving Indigenous parents and educators in implementing culturally inclusive schooling practices – a principle which has consistently featured in Aboriginal Education Policies. Some of the research referred to in this paper indicates that such practices also contribute to improved outcomes for Indigenous students. With this in mind, the ways in which the revised syllabus (and the revision process) might encourage practices and procedures that involve Aboriginal people in educational issues at systemic and school levels, and make non-Aboriginal people more aware of traditional and contemporary Aboriginal culture, are also considered in this paper.

Overview of the research

The key issues which emerged as critical to numeracy skill development of Aboriginal students have been grouped under the following headings to provide a basis for the recommendations for syllabus review put forward in this paper:

1. supporting a learner-centred curriculum;
2. scope and sequence of learning outcomes;
3. school, home and community partnerships;
4. linguistic matters;
5. equity issues;
6. teaching strategies;
7. an inclusive curriculum;
8. assessment; and
9. implementation and evaluation.

1. Supporting a learner-centred curriculum

To be effective, numeracy teaching needs to focus on the learning needs of each student, to acknowledge and build on students' diverse backgrounds, and to promote flexibility, problem solving and effective use of technology. No single approach to teaching numeracy will be effective for all learners. However research and current effective programmes both within Australia and overseas provide a valuable base for the continuing development of effective numeracy teaching and learning practice. (DETYA, 2000)

This statement concludes a review of research on aspects of effective numeracy education in the report *Numeracy, A Priority for All*. Fundamentally, it acknowledges the importance of a learner-centred curriculum for all students.

While a syllabus is essentially a generic statement about the knowledge, skills and understandings expected of learners, schools and teachers are challenged to implement it in a way which will be meaningful, relevant and appropriate for their particular students. This approach is supported in the broader context of contemporary learning theories which emphasise the importance of acknowledging the influence of students' social and cultural contexts, the importance of the teacher-student relationship, the importance of a learner-centred curriculum and the incorporation of meaningful contexts into learning activities.

Exploring the implications of what a learner-centred curriculum looks like for Aboriginal children was an underlying theme emerging from the literature review conducted for the report on *Resources and Teaching Strategies to Support Aboriginal Children's Numeracy Learning* (Frigo, 1999). The key issues which emerged from that report centred on the need for teachers to make themselves aware fully of the complexity of the cultural and social contexts in which their particular Aboriginal students learn mathematics. The report found that if numeracy resources were to be used effectively in the classroom, then a student-centred approach suggests that they should:

- *encourage teachers to become aware fully of the complexity of the cultural and social contexts in which Aboriginal students learn mathematics;*
- *encourage teachers to explore and use the particular contexts, especially numeracy ones, for their Aboriginal students;*
- *encourage teachers to identify the particular learning needs and preferred ways of learning of each of their Aboriginal students;*
- *invite teachers to reflect on their practice and to identify and build on what works for their Aboriginal students; and*
- *reinforce the critical relationship between high teacher expectations, a positive classroom climate and student achievement.*

Rather than teaching approaches that focus on how to make the learner fit the system, a preferred focus is on how the system can better meet the learner's needs. The challenge for the syllabus is that it should be written in a way that is seen to provide flexibility and encourage teachers to implement a program which is learner-centred. That is, the focus remains on the learner, identifying and valuing the learner's background experiences, their learning style and any special needs.

Accordingly, introductory notes and suggested strategies embedded in the syllabus should consistently refer to the importance of exploring individual learner backgrounds and needs in relation to their mathematical learning. Modern conceptions of learning acknowledge that knowledge is constructed, that students bring with them diverse experiences and bodies of knowledge, a broad range of knowledge and understanding of mathematical language and concepts, and have different ways of learning. Aboriginal learners are no exception.

There has been some debate surrounding conceptions of 'Aboriginal ways of learning' and the way this has been implemented in the classroom, reflecting stereotypical views of how Aboriginal students learn. However, Aboriginal students have diverse learning styles which need to be identified and acknowledged on an individual basis – a teaching strategy which is increasingly being taken up in the context of a broader educational trend. The Mathematics syllabuses should therefore be framed in a way that encourages and empowers teachers to provide learning experiences and assessment activities for all students in line with their learning styles and multiple intelligences.

It is not clear the extent to which sample learning activities will be incorporated into the syllabuses. However many learning outcomes are able to be achieved through a range of activities which are relevant to students in terms of their content and their context; this diversity, and the need for teachers to explore a range of strategies, should be emphasised.

Recommendation 1

1.1 *That the new syllabus support and encourage teachers to develop programs which reflect the learning needs and diverse learning styles of their students.*

1.2 *That the syllabus contain examples that represent good practice in providing meaningful and relevant mathematical learning experiences for Indigenous students.*

1.3 *That numeracy and literacy should not be isolated from one another. Literacy is an integral part of numeracy and requires a high level of consideration when teaching mathematics. Areas for consideration include Aboriginal English, Aboriginal languages, ESL, Otitis Media.*

1.4 *That systems provide opportunities for teachers to become informed about Indigenous culture so that they develop sensitivity to cultural issues that impact upon the Indigenous student's learning. This may be provided through the following means:*

- *compulsory pre-service training by subject(s) on Indigenous issues in education;*
- *compulsory inservice training for ALL teachers who have not had pre-service training on Indigenous issues in education.*

2. Scope and sequence of learning outcomes

It is assumed that the revised Years K-10 Mathematics syllabuses will continue to be based on an *outcomes approach*. There are many positive aspects to this approach - a focus on outcomes can encourage teachers to develop their knowledge and understanding of the student as well as their knowledge of the discipline. The focus on student development along a continuum also encourages teachers to have high expectations of the learning potential of all students.

The scope and sequence of learning outcomes which are defined in the current Mathematics syllabuses are generally consistent with those outlined in other States' syllabus documents and are largely based on a common understanding of numeracy development arising from long-established teaching practices. The appropriateness of the scope and sequence of learning outcomes is not something that has been rigorously questioned in the research literature in general, let alone in research with Aboriginal students.

One research project relating to learning outcomes with respect to 'number' was conducted by Willis (2000), who observed that some Aboriginal students were able to distinguish the number of items in a small collection (a process called 'subitising') without being able to count. Although this research was inconclusive due to small sample size, it does call into question the assumptions regarding the nature and sequence of some students' mathematical learning. Willis suggests that, rather than

just differences in the pace of learning, there may be differences in the nature and sequence of some students' mathematical learning. She also argues that a syllabus and teaching practices that do not allow for this possibility to be explored may well put some students at educational risk. Similarly, research based on current assumptions about the scope and sequence of student learning which measures only extent of knowledge rather than the range of strategies that students might use will continue to reinforce current assumptions about developmental sequences.

The appropriateness of the expected levels of achievement for young students in NSW has been called into question by research associated with the 'Count Me in Too' project which looks at the teaching and assessment of mathematics in the early years of school (Stewart et al, 1998).

The main focus of the 'Count Me in Too' project has been to enhance teachers' understanding of the mathematical strategies that their students use, and to support students' progress from less sophisticated to more sophisticated strategies. Assessment tasks were undertaken in a number of trial schools in 1997. Kindergarten students from urban and rural areas were assessed using the schedule for early number assessment at the beginning and end of the year. Results showed that while there was a great diversity in achievement, the majority of students reached the expected level or higher by the end of the year. The same findings emerged for both Aboriginal and non-Aboriginal students, suggesting that many students, both Aboriginal and non-Aboriginal, are under-challenged in their first year of schooling.

It should be noted that personal discussions with the researchers demonstrated that there was a general problem with analysing the data from Aboriginal students as they comprise a small sample to begin with and in many instances missing data leads to these students being omitted from the analysis. However, these findings do suggest scope for further research into the appropriateness of learning outcomes for all students.

This finding is also noteworthy in that while the achievement of Aboriginal students in their first year of schooling seems to be on a par with non-Aboriginal students, Basic Skills Testing indicates that achievement of non-Aboriginal students sinks rapidly below the average by Year 3.

Recommendation 2

2.1 *That the trialing and implementation of the new syllabuses support ongoing research into the scope and sequence of learning outcomes and their appropriateness for both Aboriginal and non-Aboriginal students.*

2.2 *That research conducted in projects such as 'Count Me in Too' should be modified to consider the differences in pace, nature and sequence of learning for Indigenous students. Where possible, oversampling of Indigenous students should occur and Indigenous communities should be encouraged to support the inclusion of their students in such research projects.*

2.3 *That research be conducted to determine the factors that contribute to the decline in mathematical performance of Indigenous students between their first year of schooling and the Year 3 basic skills testing.*

3. School, home and community partnerships

The importance of encouraging partnerships between the school, home and local communities has been stressed in the wider body of research relating to effective numeracy teaching. While the syllabus will outline State (and national) expectations in learning outcomes, research supports the need for meaningful learning experiences. The syllabus therefore needs to be written in a way that gives schools the flexibility to make curriculum decisions based on an understanding of local community needs and expectations.

Contemporary learning theories emphasise the need for educational experiences which are meaningful for the learner and which reflect the learner's background. The teacher-student relationships can be significantly enhanced where teachers are encouraged to develop their knowledge, understanding and appreciation of their students' backgrounds, and to be more inclusive of local communities in developing their teaching programs. For Indigenous students, this is particularly important. Many of the curriculum programs which have been reported to be effective with Indigenous learners are those which have been developed in partnership with local Indigenous educators and or communities (Efthymiades et al, 2000; McRae et al, 2000; South Australian Education Department, 1991).

In reality, the degree of teachers' knowledge of Indigenous culture, particularly local cultures, ESL issues and cross-cultural pedagogical issues is often questionable. While teacher training and professional development can enhance their understanding in a general sense, true understanding of students' home cultures in order to build on home experiences can only be gained at a local level and in partnership with local communities. Community members and Indigenous educators have an important role to play in helping educators to identify and understand local community needs.

The challenge is to produce a syllabus that enables and encourages schools to develop programs that meet local needs: that is, a syllabus that focuses classes to suit student interests and makes them interesting and challenging to the diversity of students, both Indigenous and non-Indigenous. We suggest that introductory notes and teaching examples embedded in the syllabus document should encourage greater interaction with students' homes and communities.

Recommendation 3

3.1 *That the revision of the syllabuses include consultation with and input from Indigenous educators at all stages through writing, trialing and evaluation.*

3.2 *That the syllabus explicitly encourage schools and teachers to develop partnerships with its local Indigenous communities and provide suggestions as to ways this may be achieved.*

3.3 *That professional development be provided to schools and community leaders so they can explain the new syllabuses to parents and care-givers.*

3.4 *That support materials be developed to explain the new syllabuses to parents and care-givers*

In order for the above to happen it will be necessary for:

- *individual schools to take responsibility for involving the Indigenous*

community in its school;

- *schools to put in place initiatives to involve the Indigenous community in the decision-making processes within the school. This might include membership of the school P & C, School Council and/or any other relevant committees; and*
- *schools to consider organising social events both inside and outside of the physical structure of the school and invite the Indigenous community to attend.*

4. Linguistic matters

General research in the area suggests that while most teachers acknowledge that language is important in mathematics classes, some teachers do not know what to do with this understanding. Teachers may not have the strategies to deal with difficulties with language, particularly in secondary school where teachers have specialised in their field. Discussion in the mathematics classroom is important; so too are activities that involve problem-solving and open-ended questions where students are encouraged to explain their strategies and explore different solutions to problems. The quality of this discussion depends on the expertise of the teacher to rephrase questions when necessary so the child is not hindered by the lack of good language skills.

Much has been written on the diverse linguistic backgrounds of Indigenous learners and the different opportunities that they have to develop oracy and literacy in standard Australian English. In the area of mathematics, language issues operate on a number of levels, including the differences in the language of mathematics and everyday uses of mathematical terms, and the extent to which the differences between home and school language influence learning outcomes.

Many Indigenous children have low English literacy levels, and many speak English as a second language or dialect, although this is not always apparent to the teacher. In many instances, teachers are unaware that students come to school speaking a non-standard dialect of English (Aboriginal English) outside of school. Research suggests a two-stage sequence. The development of literacy skills in standard Australian English is enhanced when the students' home language is valued and supported, and the development of numeracy skills is enhanced when attention is placed on the development of oracy and literacy skills in standard Australian English (Efthymiades, 2000; Flavel and Cathart, 1999; McRae et al, 2000; Knight, M, Hurley, R and Flavel, S, 1994).

With this in mind, a syllabus should continue to encourage opportunities and activities for students to develop literacy skills that include the explicit teaching of language. The current K-6 syllabus recognises the importance of language as students develop mathematical literacy. In many of the units, mention is made of the specific words and concepts of which students need to have a clear understanding in order to understand the mathematical use of such terminology.

Further and more detailed research that explores the relationship between literacy and numeracy development is needed to enhance understanding of language issues in mathematics.

Recommendation 4

4.1 *That the revised syllabuses identify significant mathematical terms that need to be explored with students. This should include examples where the everyday English language meaning of a word differs from its meaning when used mathematically.*

4.2 *That the revised syllabuses should include a range of mathematical language activities for teachers to include in their teaching programs by giving appropriate examples.*

4.3 *That the revised syllabuses highlight the need for an emphasis on oral activities for all students which are then documented by the students in their own words.*

4.4 *That the revised syllabuses encourage teachers to explore why Indigenous students are not achieving equitable literacy standards, including the possible impact of*

- *Aboriginal English*
- *Otitis Media*
- *Indigenous Languages*
- *the risk that Indigenous students are not interpreting the teacher's language in the same way as the teacher, which leads to confusion, resulting in the student's often being unable to comprehend the concept being taught*
- *the extent to which Indigenous students comprehend the language of Mathematics.*

Systems can assist teachers in developing an understanding of the linguistic issues that impact upon Indigenous students in their classrooms through compulsory inservice or pre-service training.

5. Equity issues

Many Indigenous students in NSW live in rural and remote areas. While this has implications for the cultural, social and linguistic backgrounds that students bring with them to classrooms, it also suggests that many Indigenous students are enrolled in schools which may have special needs in terms of teacher turnover and experience, and resources. Accordingly, the syllabuses should continue to provide materials and ideas that support new and inexperienced teachers to develop curriculum programs, and effectively implement them.

Current trends in Mathematics education reflect the importance of access to technology, including graphic calculators, computers and online resources. This being the case, the implementation of a revised mathematics syllabus needs to consider equity issues so students from rural and remote areas, including Indigenous students, have equal opportunity to use these resources.

Recommendation 5

5.1 *That equity issues be considered in the light of any special needs identified in schools with high proportions of Indigenous students in terms of resources and support, especially technological, to implement the new*

syllabuses.

5.2 *That the cultural, social and linguistic needs of the Indigenous students be identified and addressed.*

5.3 *That resources suggested for activities and topics included in the syllabuses be relevant for Indigenous students.*

Systems could support this by:

- *approaching Universities to provide a distance education subject that would provide Indigenous cultural awareness and sensitivity to issues that impact on Indigenous students at school, and that this subject have some accreditation within the School system;*
- *giving teachers working with Indigenous students priority placement into the subject listed above; and*
- *giving all **teachers** the opportunity to gain accreditation in the subject listed above.*

6. Teaching strategies

Research stresses the importance of teachers being able to draw on a range of teaching strategies in order to be able to effectively encourage the numeracy skill development of their Indigenous students (Efthymiades et al, 2000). Resources such as the *Mathematics Task Centres for Aboriginal Students* incorporate lots of hands-on activities which students complete while working in groups, as a whole class, in pairs, and with community and families.

Particular teaching strategies that seem to offer ready support in helping Indigenous students include:

- providing a gradual progression along a learning path, with a lot of practice, ensuring that the student has developed confidence as well as the ability to perform at one literacy level before proceeding to another. This is exemplified by the following sequence: teacher modelling followed by work in a small group or with a partner, before attempting an individual task;
- exposure to a range of tasks, not just to the ones that the students find the easiest;
- code switching exercises (between Aboriginal languages / dialects and standard Australian English), an essential aid to the command of language and literacy;
- group work of various kinds;
- integrated activities that involve, for instance, listening, reading, writing, and speaking about mathematical concepts to enhance the transference of skills; and
- direct or explicit teaching, with the use of modelling and clear explanations of tasks and expectations.

In the mathematics classroom, explicit teaching refers to both the teaching of concepts and of making mathematical 'connections':

Students who are 'naturally mathematically able' make these connections for themselves and therefore view maths as making sense. 'Less mathematically

able' students do not see the interrelationships and view maths as a plethora of isolated number facts. The latter group can be led to see these relationships through explicit teaching. (McRae et al, 2000)

The literature reviewed by Frigo (1999) suggested that effective teaching strategies for numeracy skill development in Indigenous students are ones that:

- *reinforce that teachers' beliefs and understanding of their pedagogical practice is essential for effective numeracy teaching;*
- *equip teachers with a range of teaching strategies to reflect the diverse learning needs and ways of learning of their Indigenous students;*
- *provide a supportive environment in which Indigenous students feel confident as learners and risk-takers;*
- *recognise that mathematics classes are essentially a linguistic exercise and a very complex one for Indigenous students given their diverse backgrounds and language needs;*
- *encourage the provision of positive, non-threatening, language-rich environments in mathematics classrooms; and*
- *support parents and communities in becoming or being further involved in their children's learning.*

While there is some variation in the extent to which teaching strategies are included in the current Mathematics syllabuses, teachers must be encouraged and supported in drawing on an extensive range of teaching strategies and assessment techniques. The need to develop a diverse range of teaching strategies to support student learning, along with examples, could be referred to in the introductory notes as well as embedded in sample teaching units.

Recommendation 6

6.1 That the importance of using a range of teaching strategies be highlighted in the syllabuses, especially in sample mathematical activities.

6.2 Indigenous students sometimes solve problems in unexpected ways - this should be supported and explored rather than 'corrected'.

6.3 Teachers should be encouraged to implement strategies that the Indigenous students are comfortable and familiar with, that is, hands on activities → everyday language → understand concept → mathematical language.

6.4 That research should be conducted to explore the impact of changes to the syllabuses on teaching practice.

7. An inclusive curriculum

Numeracy development is influenced by children's different social and cultural contexts and it is important that teachers are encouraged to determine their students' existing knowledge and skills and to build upon these in inclusive ways. The inclusion of Indigenous perspectives across learning areas not only enhances the students' knowledge and understanding but can enable a supportive learning environment for Indigenous students, increase their confidence and self-worth, and

lead to improved educational outcomes through the provision of a more culturally relevant curriculum.

While Mathematics is viewed by many as culture free, mathematics lessons include the transmission of values and are based on cultural assumptions. The inclusion of content which reflects mathematical understandings from other cultures and which incorporates Indigenous perspectives has been cited as way of engaging Indigenous students and of educating both Indigenous and non-Indigenous students about Indigenous cultures. Frigo's (1999) review of the research in this area found that numeracy activities which effectively engage Indigenous students include content which is able to:

- *value Indigenous students' diverse cultural and linguistic heritages;*
- *make explicit the difference between Western mathematics and Aboriginal mathematics, and value both equally ;*
- *make explicit the link between community, home and school mathematics;*
- *provide realistic and real-life classroom contexts for mathematics activities;*
- *be developed in consultation with local communities and Indigenous education workers; and*
- *be open to and encourage modifications of content and pedagogy to reflect particular students' interests and learning needs.*

There are a number of current examples of mathematics resources which provide examples of locally developed teaching units that include content of both traditional Indigenous culture and contemporary cultural issues. The inclusion of materials dealing with contemporary cultural issues also encourages the use of 'critical pedagogy' in which students are empowered to reflect on and critically analyse their own situations. These have been invariably developed locally by teachers, often in collaboration with Indigenous educators. Anecdotal and empirical evaluations of the materials suggest that they have been used effectively with Indigenous and non-Indigenous students alike.

Aboriginal Perspectives Across the Curriculum

The resource materials known as *Aboriginal Perspectives Across the Curriculum* (APAC) were published in 1995 by the South Australian Department for Education and Children's Services. Since then, similar materials which promote Aboriginal perspectives, viewpoints and information for all key learning areas have also been published by the Tasmanian and ACT Education Departments, and the Victorian and Sydney Catholic Education Offices.

While there is no published research yet which reports evaluations of the effectiveness of the use of these particular materials, they come with affirmative comments from teachers regarding the engagement of their students as well as the learning that they, the teachers, experienced.

The mathematics materials aim to value the similarities and differences between western and Indigenous mathematical concepts and to recognise the ways in which contemporary Indigenous people use traditional cultural concepts related to mathematics. Examples of units and classroom activities across mathematical strands include:

- *Space* - teaching strategies explore the importance of space to Aboriginal peoples; weaving patterns (geometric models); maps/scale drawings and artwork; the design of traditional tools; Aboriginal land maps and population maps (looking at issues such as population shift and land rights).

- *Algebra* - an exploration of what is termed ‘kinship algebra’; examination of Aboriginal statistics, including how they are collected, used and impact on Aboriginal people today; issues of social inequality; and mathematical knowledge for communal survival.
- *Number* - counting in various cultures.
- *Measurement* – different ways of measuring distance (time travelled); measuring time (seasonal cycles; cyclic versus linear time).
- *Chance and data* – using ABS statistics about Aboriginal people (the teacher who designed this activity stressed the importance of obtaining assistance in interpreting statistics from knowledgeable people to avoid stereotyping); discussions of the use and misuse (misrepresentation) of statistics; card games.

It is worth noting that the teachers who designed the South Australian materials warn others against trivialising Indigenous culture by making tokenistic efforts to be inclusive (eg, simply including Aboriginal colours on activity materials). Units such as these should be developed in consultation with Indigenous educators.

Recommendation 7

7.1 *That the content of suggested teaching activities include examples of units which are inclusive of traditional and contemporary Indigenous cultural perspectives, and which make explicit the differences between these and Western ones.*

7.2 *That teachers be informed that Mathematics is not culture free but transmits values and has cultural assumptions—therefore awareness of Indigenous cultural issues is crucial.*

7.3 *That Indigenous perspectives be introduced as a priority to assist in engaging Indigenous students and providing cultural awareness for both Indigenous and non-Indigenous students.*

7.4 *That evaluations be carried out to determine the effectiveness of resources that have been developed in collaboration with local Indigenous communities and educators and have been found to be effective.*

7.5 *That effective resources be made available for other schools to use as a model for developing their own resources. It should be noted that some resources developed by a particular school may have been tailored to its specific community needs, therefore requiring further modification if used in another location.*

8. Assessment

While many reasons are suggested for the lower achievement of Indigenous students, questions are often raised about the appropriateness of measures used to assess their performance. The content and language used in the assessment may reflect a cultural bias that predetermines poor outcomes for some Indigenous students. Inappropriate assessment unfairly labels poor-performing students, underestimates their abilities, and lowers both their expectations and the expectations of their teachers. The implications of this for mathematics learning can

lead to students being allocated to lower ability classes that can limit their future options.

As with teaching programs, assessment tasks should incorporate appropriate and relevant content, reflect effective teaching strategies and provide an insight into the strategies and learning needs of students. Frigo, Adams and West (1999) provide the following summary on the issue, showing the key relationship between school atmosphere, effective teaching and responsive styles of assessment and reporting. These assessment tasks and reports:

- *are administered in a supportive environment in which Indigenous students feel confident as learners;*
- *are developed in consultation with local communities and Indigenous education workers;*
- *are reported in a way which supports parents and communities in becoming or being further involved in their children's learning;*
- *communicate to parents and care-givers the information that they want on their students;*
- *recognise that in many areas, the assessment is essentially a language-based exercise, eg numeracy assessment is assessing language as well as numeracy concepts;*
- *reflect good teaching practice in literacy and numeracy and good teaching practice for Indigenous children; and*
- *reinforce the critical relationship between high teacher expectations, a positive classroom climate and student achievement.*

The learning outcomes which are documented in the Mathematics syllabus are the foundation for assessment and reporting practices developed both at a school level and at a systemic level. As for all students, a thorough assessment of the abilities of Indigenous students is crucial, particularly in the case of highly mobile students – a thorough assessment includes their hearing, literacy levels, and the mathematical strategies that they use, as well as outcomes. It is also important that competence in mathematical strategies is assessed, not just current performance with respect to a learning outcome, as it is the students' strategies that give an indication of their likely progress in the longer term. Subsequent teaching should therefore be aimed at helping students progress to more sophisticated mathematical strategies.

Teachers might also be encouraged to consider monitoring students' attitudes to mathematics and their self-concepts of themselves as mathematical learners.

For the students to come to view themselves as successful mathematicians they needed to feel in control and have ownership of their mathematics. At the beginning of the program the students were happy to complete many repetitive 'sums' rather than be challenged to think about new ideas. As long as the 'sums' were done, whether answers were copied or even wrong, they believed the maths was done. They become agitated if asked to solve a problem or to generalise an idea. They saw the sums as an end in themselves and viewed maths as a series of rote learnt facts (McRae et al., 2000).

Students should be provided with a range of opportunities to demonstrate their achievement of learning outcomes, and this should be noted in the introductory notes to the syllabuses as well as demonstrated with examples in sample teaching units. Opportunities for students to demonstrate their abilities in traditional pen and paper tests should include a range of item types, including multiple-choice, short answer and open-ended questions. Research has found that some Indigenous students are less likely to respond to open-ended questions and questions with a high linguistic loading. Where this is the case, subsequent teaching strategies need to

be adopted to explicitly support students in responding to these types of assessments (Dawe and Mulligan, 1997).

More innovative types of assessment should also be encouraged, such as performance assessment. Callingham and Griffin (2000) report favourably on the use of performance assessment tasks in the project *Improving Numeracy for Indigenous Students in Secondary Schools* (INISSS). As well as being congruent with the philosophy underlying the teaching and learning strategies that were used with the students, a statistical evaluation of the tasks found them to be a sound measurement for assessing numeracy achievement. Students showed increasing confidence and persistence in undertaking assessment tasks, resulting in significant improvements in mathematical learning and attitudes towards mathematics, particularly among the Indigenous students in the sample.

The syllabus revision also invites a more general reflection on statewide assessment tasks in which students are asked to demonstrate their numeracy skills and mathematical ability.

Recommendation 8

8.1 *Statements on classroom assessment and examples of assessment strategies encourage the use of a diverse range of assessment strategies that identify students' solution strategies and their attitudes towards mathematics, as well as current performance against syllabus outcomes. Teachers should be encouraged to use clinical interviews to probe students' mathematical thinking.*

8.2 *Teachers be encouraged to teach their students explicitly how to complete assessment tasks that have a high language dependency, especially open-ended questions.*

8.3 *Statewide assessments used to measure student achievement against syllabus outcomes at a range of Year levels should model a diverse range of assessment strategies.*

8.4 *That all assessment tasks be free of cultural biases. This can be achieved by development and implementation of culturally appropriate assessment tools and tasks.*

8.5 *That assessment be oral as well as written. In pen and paper tests students with poor reading skills may have their real competencies masked.*

8.6 *That there be consistency in the delivery of Mathematics to support mobile students. Strategies to assist this would include:*

- *introducing a system of tracking students between schools,*
- *each school develop individual work folios for each student,*
- *folios be forwarded to the school where the student enrolls.*

9. Implementation and evaluation

The success for Indigenous students of the new syllabuses will ultimately be reflected in assessments of their numeracy levels. The process for implementing the new NSW Mathematics syllabuses provides further opportunities to support the learning of Indigenous children in the State.

The ways in which the syllabus is implemented by existing teachers will very much depend on the information that they receive regarding the differences between the current syllabuses and the revised syllabuses. Realistically, the pedagogical practice of many teachers is not likely to change substantially with the new syllabuses. The response of many is likely to be a perusal of whether or not their existing programs will continue to 'cover the syllabus'.

Support materials and inservicing therefore provide an opportunity to highlight a number of principles which have been the focus of this paper. The inservicing of Aboriginal Education Workers will also be an important factor in supporting the learning of Indigenous students.

The process should incorporate a procedure to evaluate the success of the new syllabuses. If this is to include trialing and piloting the new syllabuses, and any associated support materials, then there is an opportunity for further consultation with Indigenous communities, and Indigenous and non-Indigenous educators of Indigenous children.

If the recommendations in the paper are accepted, part of the overall evaluation will be to examine the extent to which Indigenous students become more numerate; the extent to which Indigenous students, educators and communities are able to be involved in the development of teaching programs; the extent to which learning activities are able to incorporate principles of an inclusive curriculum and pedagogy; and the extent to which non-Indigenous students (and teachers) become more familiar with Indigenous culture, including Aboriginal mathematics, and contemporary Indigenous cultural issues.

This paper has also highlighted the limited amount of research that has been conducted specifically with Indigenous children. In particular, there is an absence of rigorous longitudinal research looking at the ways in which Indigenous students develop numeracy skills. The introduction of the revised syllabuses also provides an important impetus for research studies to explore the ways in which syllabus documents are used in the classroom as well as the extent to which they impact on teaching practice. This research should be ongoing, and form part of the review process as the syllabuses are introduced into schools.

Recommendation 9

9.1 *That there be ongoing evaluation of the implementation of the new syllabuses to increase understanding of the ways in which the syllabuses are implemented and the professional development needs of schools.*

9.2 *That implementation of the new syllabuses should include support documents and inservicing of key school personnel which highlight the changes that are likely to flow through to pedagogical practice and those changes which are likely to benefit Indigenous students, with clear explanations of why the changes have been included.*

9.3 *That the implementation of the new syllabuses include further research as part of an evaluation process. In particular, research should focus on:*

- *determining factors contributing to the ways Indigenous students develop numeracy skills;*
- *monitoring the numeracy achievement of Indigenous students; and*

- *the ways in which teachers use the syllabus.*

9.4 *That opportunities be provided, through courses and/or training, for staff to develop their awareness of issues that impact upon the education of Indigenous students.*

9.5 *That Indigenous educators (to include Aboriginal Education Workers, teachers, academics) across New South Wales be given the opportunity to provide feedback on the syllabus prior to implementation.*

9.6 *That Indigenous communities be provided with the opportunity to be informed about the new syllabuses and their requirements and that they be given opportunities to provide feedback to the Board of Studies prior to implementation.*

1

¹ The Authors wish to thank and note Cath Pearn's contribution to this document.

Annotated Bibliography

The publication *Resource and Teaching Strategies to Support Aboriginal Children's Numeracy Learning* (Frigo, 1999) contains a review and annotated bibliography covering much of the research to be considered for this report. This bibliography contains additional reports and materials, both published and unpublished, which have appeared in the last 12 months. References to the latter are in bold.

Adams, I (1998), 'The educational plight of Indigenous Australian students in the early years of schooling', *Unicorn*, 24(1), 5-15.

An overview of factors influencing the effectiveness of educational provision for Indigenous Australian students and considerations for improving educational provision and enhancing educational outcomes.

Askew, M, Brown, M, Rhodes, V, Johnson D and William, D (1997), *Effective Teachers of Numeracy: Final Report*, London: School of Education, King's College London.

This report presents the findings of a study which explored the knowledge, beliefs and practices of a sample of effective teachers of numeracy. Highly effective teachers were distinguished by their beliefs and understanding which underpinned their teaching of numeracy, their expectations of their students and themselves.

Atweh, B, Cooper, T and Kanes, C (1992), 'The social and cultural context of mathematics education', In Atweh, B and Watson, L (Eds), *Research in mathematics education in Australasia 1988-1991*, Kelvin Grove, Qld: Mathematics Education Research Group of Australasia (MERGA).

Overview of some of the research pertaining to Indigenous students and mathematics during this period.

Australian Education Council, (1991), *National Statement on Mathematics*, Canberra: AGPS.

Bishop, A J (1994), 'Cultural conflicts in the mathematics education of indigenous peoples,' In *Proceedings of South East Asia Conference on Mathematics Education (SEACME - 6) and the Seventh National Conference on Mathematics*, Surabaya, 7-11 June 1993 , pp 402-408.

In this article it is argued that the social dimension of mathematics education operates at different levels, all of which are relevant in considering the situation of Indigenous peoples and mathematics education. Underlying all these influences is the status of mathematics as a form of cultural knowledge. The individual person is influenced in their mathematical education by other people acting at these different levels, and at each level there are particular sources of cultural conflict.

Boulton-Lewis, G M, Neill, H and Halford, G S (1987), 'Information processing and mathematical knowledge in Aboriginal Australian children in southeast Queensland', *Australian Aboriginal Studies*, 2, 63-65.

It was concluded that Indigenous children from rural communities possessed information processing skills similar to non-Aboriginal children on tests of cognitive ability which were designed to minimise the influence of background

knowledge. Test items were chosen which would be familiar to Aboriginal communities.

Boulton-Lewis, G, (1990), 'Young children's thinking strategies and levels of capacity to process mathematical information,' In Steffe, LP and Wood,T (Eds), *Transforming Children's Mathematical Education: International Perspectives*, Hillsdale, NJ: Erlbaum, pp 156—160.

In this study it was found that Aboriginal children had the same capacity to process information as non-Aboriginal children of the same age. A mathematics and non-mathematics test were used. It was concluded that low mathematics achievement is not related to lower skill levels or a lower capacity to conceptualise mathematically but may be attributed to educational and social factors.

Bucknall, G (1995), 'Building bridges between Aboriginal and Western mathematics', *Aboriginal Child at School*, 23(1), 22-31.

The author stresses the importance of recognising and building on the mathematical knowledge that Aboriginal students utilise outside the classroom. It also examines ways of providing experiences and strategies in which students can gain meaning and develop the appropriate language that enables them to extend their skills in Western mathematics.

Callingham, R and Griffin, P (2000), 'Towards a framework for assessment numeracy', In Bana, J and Chapman, A, *Mathematics Education Beyond 2000*. Proceedings of the 23rd Annual Conference of the Mathematics Education Research group of Australasia Incorporated, Fremantle, Western Australia, 5-9 July 2000.

An evaluation of four performance assessment tasks that were used in the INISSS program (Improving Numeracy for Indigenous Students in Secondary Schools). The tasks were found to be a sound measurement for assessing numeracy achievement which reflected effective teaching practice. Across time, students undertook the assessments with greater skill, confidence and persistence.

Christie, M (1987), 'Everyday life in a primary classroom', In Christie, M, Harris, S and McClay, D (Eds), *Teaching Aboriginal children: Milngimbi and beyond*. Mount Lawley, WA: Western Australian College of Advanced Education, Institute of Applied Aboriginal Studies.

This chapter describes the weekly teaching routine of the author in a number of learning areas including mathematics. The Yolgnu children in these classes loved to sing their times-tables but had difficulty making meaning of the mathematics in the real world. The author stresses the importance of discussion in the mathematics classroom to ensure that students understand the questions asked of them and of bringing real-life situations to the classroom.

Commonwealth of Australia,(1989), *National Aboriginal and Torres Strait Islander Education Policy, Joint Policy Statement*, Canberra: Department of Employment, Education and Training.

The policy statement, commonly referred to as the AEP, comprises three sections: the purpose of the policy (responding to Aboriginal needs and aspirations); common goals (educational principles, long-term goals, and intermediate priorities); and arrangements for policy implementation. It was endorsed by all

States and territories in 1989 and has been reaffirmed in subsequent triennia up until 1999.

Currie, J, Kissane, B and Pears, H, (1992), 'An enriched mathematical program for young Aboriginal children', *Aboriginal Child at School*, 20(1), 15-37.

This paper provides early results of a project which explored the use of an intervention program which provided a rich mathematics environment to enhance mathematics learning for students in remote communities. The findings however were inconclusive and the paper outlines some of the difficulties including the selection of an appropriate group for comparison and appropriate assessment techniques.

Dawe, L, (1988), 'The impact of culture in the mathematics classrooms of multicultural Australia', *Cultural Dynamics*, 1(2), 195-209.

This article contrasts the world view, child rearing practices and beliefs about how mathematics should be taught/learned between children of Asian immigrants and Aboriginal families in highlighting the changing culture of the Australian mathematics classroom.

Dawe, L, and Mulligan, J, (1997), 'Classroom views of language in mathematics', In Doig, B and Lokan, J (Eds), *Learning From Children: Mathematics From a Classroom Perspective*, Melbourne: ACER Press.

An examination of BSTP data providing insights into the impact of language factors on large-scale mathematics assessment results, particularly for children from Indigenous and non-English speaking backgrounds.

Dawson, G P, (1991), 'Maths encounters', *Aboriginal Child at School*, 19(4), 37-53.

An article full of ideas for 'Concentrated Maths Encounters' in which teachers are encouraged to make explicit the mathematics present in everyday classroom activities such as bell times, tidying the work area, ordering things for the classroom and organising excursions.

Department of Education and Children's Services (1996), *Aboriginal Perspectives Across the Curriculum* Adelaide: DETYA and South Australian Department of Education and Children's Services.

These resources are designed to assist teachers to include Aboriginal perspectives in their teaching across the eight key learning areas.

Department of Education, Training and Youth Affairs, (2000), *National Indigenous English literacy and numeracy strategy 2000 - 2004: an initiative of the Commonwealth government of Australia*, Canberra: DETYA

The strategy is intended to support the achievement of the aims of the National Goals of Schooling by addressing the needs of Indigenous students, including the attainment of benchmark standards in numeracy.

Department of Education, Training and Youth Affairs (2000), *Numeracy, A Priority for All: Challenges for Australian Schools*, Canberra: Commonwealth of Australia.

This paper outlines the Commonwealth government's numeracy policies which support the National Literacy and Numeracy Plan. The paper includes a broad overview of the importance of numeracy skills, Commonwealth funding

strategies to support specific programs, aspects of effective numeracy education for all students, and strategies and programs which have been effective in meeting the needs of specific groups of students, including Indigenous students.

Department of Employment, Education, Training and Youth Affairs (1997), *Numeracy = Everyone's Business*, Canberra: Commonwealth of Australia.

Report of the Numeracy Education Strategy Development Conference. The outcome of the conference was a series of recommendations regarding what constitutes numeracy, coordinating the implementation of the national plan, identification and intervention for 'at risk' students, assessment in the first years of schooling, assessment and national reporting, research, professional development, teacher education and community education.

Eckermann, A-K (1994), *One Classroom, Many Cultures*. NSW: Allen & Unwin.

In this project, documentation was collected and interviews and classroom observations carried out in 21 government and Catholic schools in rural and urban NSW; many of the former included significant numbers of Aboriginal children. The report provides accounts of policy and practice to assist teachers of classes which have a high percentage of students from culturally different backgrounds.

Education Queensland (1989-1994), *Torres Strait Mathematics Program (TSMP)*, Queensland: Aboriginal and Torres Strait Islander Education Sub Centre Far North, Video and Print Services, Education Queensland.

Developed for use by teachers in the Torres Strait; many topics are Torres Strait specific but can be adapted to suit other surroundings.

Efthymiades, D, Roberts, J and Morony, W (2000), 'Numeracy development of Indigenous students: An introduction to research', In *ACER Improving Numeracy Learning Proceedings of Research Conference 2000*.

The authors provide an overview of two projects designed to improve numeracy learning for Indigenous students: the Indigenous Students Achieving Numeracy project (see *What works*) and the Northern Territory Numeracy in School Project (NISP). A more detailed description of the former project appears in *What Works* (McRae et al, 2000). The common elements in the latter project included: positive attitudes; use of appropriate contexts; understanding mathematical language and 'best practice' strategies such as open-ended multi-level tasks and number-sense strategies. The authors conclude that there is a need for further research in the field of Indigenous numeracy which should be 'local and rigorous - but not hurried'.

Flavel, S, & Cathcart, J (1999), 'Maths?: No fear!', In Scott, N et al (Eds) *Mathematics Across the Ages*, Proceedings of the 36th Annual Conference of the Mathematical Association of Victoria, December 2-3, 1999, Monash University, Victoria.

The Maths No Fear (MNF) project is a professional development strategy for teachers wishing to explore the teaching and learning of mathematics for indigenous students. The focus of the exploration is on the role Working Mathematically and English as a Second Language (ESL) strategies play in developing conceptual understanding of high school mathematics. The MNF team has developed and documented these strategies and associated resources with the very teachers it aims to service.

Frigo, T, Adams, I and West, M (1999), *The nature and appropriateness of current performance measures for Aboriginal children in Western Australian schools*, Unpublished report to the Aboriginal Education and Training Council of Western Australia.

This report provides an overview of the literature relating to assessing and reporting for Aboriginal student achievement in Western Australia and an exploration of the assessment and reporting practices in four Western Australian schools.

Gillespie, K.(1995), 'Mathematics acquisition for Aboriginal students - the importance of contextual teaching', In Richards, A (Ed), *FLAIR, Forging Links and Integrating Resources: Proceedings of the 15th Biennial Conference of the Australian Association of Mathematics Teachers, Darwin, Northern Territory, July 1995*, pp 142-148. Adelaide: Australian Association of Mathematics Teachers.

This paper argues that the framework and methodology used to teach mathematics to Aboriginal students needs to reflect the language needs of the students. It discussed the theory behind the development of a package based on the ELA framework implemented in South Australian schools.

Graham, B (1987), 'Finding meaning in maths: an introductory program for Aboriginal children', In Christie, M, Harris, S and McClay, D (Eds), *Teaching Aboriginal children: Milingimbi and beyond*, Mount Lawley WA: Western Australian College of Advanced Education, Institute of Applied Aboriginal Studies.

The author suggests a number of activities appropriate to classrooms that build on the types of experiences that children have outside the classroom such as classification, space, pattern, and measurement. Where concepts are less familiar, the author argues that teachers must ensure that children are exposed to the concept before it is formally taught.

Graham, B (1988), 'Language and mathematics in some Aboriginal classrooms', *Aboriginal Child at School*, 16(1), 27-32.

The author discusses the importance of language in mathematics, discussing and making explicit mathematical ideas. She gives a number of examples of dialogue between teachers and students to highlight both effective and ineffective exchanges.

Graham, B, (1988), 'Mathematical education and Aboriginal children', *Educational Studies in Mathematics*, 19(2), 119-135.

In this paper, the author reviews the literature available on Aboriginal students and mathematics and argues that acknowledgment must be made of the bi-cultural situation of Aboriginal students, that students need to be given time to develop numerical concepts, and that where visual-spatial skills are a strength of students, this should be recognised and developed. She also warns that the use of concrete materials should not lead to a watered-down version of mathematics.

Harris, J (1987), 'Australian Aboriginal and Islander mathematics', *Australian Aboriginal Studies*, 2, 29-37.

In this paper, the author argues that Aboriginal languages have many more words for numbers than have previously been accepted and that many Aboriginal communities count with some precision. This misconception has led

to false views about the cognitive ability of Aboriginal students and lowered teacher expectations.

Harris, P (1989), 'Contexts for change in cross cultural classrooms', In Ellerton, N F and Clements, M A (Eds), *School Mathematics: The Challenge to Change*, Waurin Ponds, Victoria: Deakin University.

This chapter is concerned with mathematics education in cross-cultural situations, especially remote communities in the Northern Territory, where students are members of a linguistic and cultural minority group, and where teachers are usually members of a dominant majority group. Historical, socio-political, linguistic, cultural and philosophical contexts are related to the classroom context of teaching and learning mathematics in Aboriginal schools. Potential barriers to meaningful communication of mathematics in the classroom are highlighted, as are strategies for change.

Harris, P (1991), *Mathematics in a Cultural Context: Aboriginal Perspectives on Space, Time and Money*, Geelong, Vic: Deakin University.

The author has a long association with Aboriginal education and culture, having taught Aboriginal children in remote areas and researched Aboriginal mathematical thinking. This book draws together the findings of the Mathematics in Aboriginal Schools projects in the Northern Territory. The book aims to highlight conceptual differences between Aboriginal and Western cultures including time, space and money, pointing to ways of teaching which take cultural and linguistic differences into account.

Harris, P, (1992), 'Australian space: pushing back the frontiers', In Southwell, B, Perry, B and Owens, K (Eds), *Space - the first and final frontier: Conference proceedings of the Fifteenth Annual Conference of the Mathematics Education Research Group of Australasia (MERGA) held at Hawkaid Conference Centre, University of Western Sydney, 4-8 July 1992*, pp 55-72. Kingswood, NSW: Mathematics Education Research Group of Australasia.

This edited transcript of a keynote address to this conference contrasts Western and Aboriginal navigation and maps. It draws on work from the Mathematics in Aboriginal Schools Project.

Harris, S (1984), *Culture and Learning: Tradition and Education in North-East Arnhem Land*, Canberra: Australian Institute of Australian Studies.

The author describes the factors which were found to influence the learning of the Yolngu (Aboriginal) students at Milingimbi, in terms of cultural aspects, problem-solving approaches and learning strategies. He identifies five main Yolngu learning strategies and implications for the classroom.

Harris, S (1990), *Two-Way Aboriginal Schooling: Education and Cultural Survival*, Canberra: Aboriginal Studies Press.

A detailed consideration of the principles and practice of two-way schooling as the author has experienced it in Aboriginal schools in remote areas of the Northern Territory, Western Australia, South Australia and Queensland. It explores the theory of biculturalism as it applies to Aboriginal schooling, resulting in a theory of schooling that promotes Aboriginal cultural maintenance and academic success.

Harris, S and Malin, M (Eds) (1994), *Aboriginal Kids in Urban Classrooms*, Wentworth Falls, NSW: Social Sciences Press.

The articles in this book provide an overview of the barriers to achievement by urban Aboriginal children and suggest culturally appropriate teaching strategies and ways to promote a more effective learning environment .

Howard, D (1994), 'Culturally responsive classrooms: A way to assist Aboriginal students with hearing loss in urban schools', In Harris, S and Malin, M (Eds), *Aboriginal Kids in Urban Classrooms*. Wentworth Falls, NSW: Social Sciences Press.

This paper discusses ways of Aboriginal learning and types of teaching strategies which need to be emphasised, particularly with Aboriginal children who experience conductive hearing loss.

Howard, P (1995), 'Listening to what people have to say about mathematics: primary mathematics and the thoughts of one Murri student', *Aboriginal Child at School*, 23(2), 1-8.

This study was undertaken in north west New South Wales and investigates the views of parents, students and teachers about the learning of mathematics in Years 5 and 6. This paper reports on an initial analysis of the views held by one of the students interviewed.

Howard, P (1997), *Aboriginal voices in our schools*, Paper presented at the Annual Conference of the Australian Association for Research in Education (AARE), 30 November - 4 December 1997, Brisbane.

The study reported on in this paper investigated the expressed beliefs of Aboriginal parents, Aboriginal educators, Aboriginal children and their teachers towards the learning and teaching of mathematics in Years 5 and 6 of primary school. This paper reports specifically on the views expressed by Aboriginal educators related to the categories of Learning, Teaching, Context and Family.

Howard, P (1998), *Contextual issues related to Aboriginal children's mathematical learning*, Paper read at Australian Association for Research in Education, at Adelaide.

This study investigated beliefs about teaching and learning in mathematics in the last two years of primary school. This paper explores beliefs related to the category of Context which includes beliefs about Aboriginal children and school, discrimination and racism, community, discipline and behaviour, Aboriginal parents, expectations, teacher's role and language. The author argues that these contexts are critical in Aboriginal students' learning of mathematics.

Jarred, A (1993), 'English Language and Numeracy Program for Aboriginal students', In National Languages and Literacy Institute of Australia (Ed), *Best Practice in Aboriginal and Torres Strait Islander Education*, South Australia: University of South Australia Printing.

The English Language and Numeracy Program for Aboriginal Students (ELAN) was introduced into Western Australian schools in 1991. An ELAN teacher, appointed from within the school, undertakes professional development in First Steps, Aboriginal learning styles and teaching English as a second language. The ELAN teacher then becomes a resource person for other staff members. This favourable review of ELAN relates mainly to the literacy component. *First Steps* continua for Mathematics are currently being developed.

Jones, K, Kershaw, L and Sparrow, L (1995), *Aboriginal Children Learning Mathematics*, Perth, Western Australia: MASTEC, Edith Cowan University.

This is one of a series of monographs on issues in primary mathematics education. This book includes chapters on cross-cultural cognition, ways of knowing, mathematics in remote schools, curriculum elements, two-way Aboriginal schooling, Garma mathematics and technology.

Kepernt, B (1993), 'Aboriginal students communicating mathematics', In Stephens, AWM, Clarke, D and Izard, J (Eds), *Communicating Mathematics: Perspectives from Classroom Practice and Current Research*, Hawthorn, Vic: Australian Council for Educational Research.

This article describes a series of professional development activities conducted by the author with Aboriginal and non-Aboriginal teachers from the Northern region of the Northern Territory. The focus of the activities was to explore ways in which the social contexts could be introduced into mathematics activities.

Knight, M, Hurley, R and Flavel, S (1994), 'Mathematics and language: teaching with an Aboriginal perspective', In *Best practice in Aboriginal and Torres Strait Islander education: NLLIA celebrates the International Year of the World's Indigenous Peoples: proceedings of the conference held in Canberra on 17-18 November, 1993*, pp 48-53, Deakin, ACT: National Languages and Literacy Institute of Australia.

The key features of this program, introduced at Driver High School, included a class of no more than 20 Indigenous students who were taught the same mathematics units as the mainstream classes, by mathematics teachers who rotated on a semester basis and were assisted by an English as a second language teacher who remained in the class as a constant throughout the year. Students cycled through the class according to their needs.

Koorie Teacher Education Program. (1990), 'Access to Mathematics for Aboriginal students', In Clements, MA (Ed), *Whither Mathematics*, pp 305 - 311. Melbourne, Victoria: Mathematics Association of Victoria.

Summarises important social and cultural issues which impact on mathematics learning for the Koorie child.

Malin, M (1994), 'Make or break factors in Aboriginal students learning to read in urban classrooms: A socio-cultural perspective', In Harris, S and Malin, M (Eds), *Aboriginal Kids in Urban Classrooms*, Wentworth Falls, NSW: Social Sciences Press.

This study involved the monitoring of a R-1 reading class which included a number of urban Aboriginal children. Findings indicate that factors beyond cultural differences affected educational outcomes for these students. There appeared to be a differential allocation of resources which could be attributed to 'micro-political processes' in the classroom. This is discussed with reference to broader implications for teachers of Aboriginal children.

Ministerial Council on Education Employment Training and Youth Affairs (MCEETYA) (1999), *The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century*.

MCEETYA (2000a), *National Statement of Principles and Standards for More Culturally Inclusive Schooling in the Twentieth-First Century*.

MCEEYTA (2000b), *Model of More Culturally Inclusive and Educationally Effective Schools*.

McRae, D, Ainsworth, G, Cumming, J, Hughes, P, Mackay, T, Price, K, Rowland, M, Warhurst, J, Woods, D, & Zbar, V (2000), *What works? : explorations in improving outcomes for Indigenous students*, Canberra: Australian Curriculum Studies Association.

This report was prepared for the Commonwealth Department of Education, Training and Youth Affairs by the IESIP SRP National Coordination and Evaluation Team. The requirement for this report was to summarise what all IESIP projects have achieved and learnt about significantly improving Indigenous students' learning outcomes and demonstrating success in Indigenous education. The main project, which was focused on numeracy achievement, was a venture between the Australian Association of Mathematics Teachers and five school sites in the Northern Territory and Western Australia in a project called 'Indigenous Students Achieving Numeracy' (ISAN). The improvement of student outcomes was attributed to the following common factors:

- having a key numeracy person and para-professionals
- community involvement/empowerment/ownership of teaching strategies
- a focus on ensuring understanding of concepts in Aboriginal language – understanding and use of the language of mathematics
- wide repertoire of teaching strategies
- high expectations
- supportive learning environment to encourage risk-taking.

McRoberts, R.W (1990), 'Counting at Pularumpi: a survey of a traditional mathematics and its implications for modern learning', *Aboriginal Child at School*, 18(2), 19-43.

This research study, undertaken at Melville Island, Northern Territory, reports on a survey of traditional mathematics, focusing on numeracy, measurement, applied mathematics in real life situations, and methodological practices in Aboriginal numeracy education.

Maratos, J (1998), 'Reflections on an Aboriginal homework centre: progressive pedagogies and ethnomathematics', *Australian Journal of Indigenous Education*, 26(2), 1-5.

Students' social background, their cognitive development at school and its assessment are three inter-related educational issues. They apply as much to mathematics as to any other subject. The history of mathematics education has been largely one of formal pedagogies justified by decontextualised knowledge and skills. This presents a significant challenge for educators who advocate learner-directed pedagogies which contextualise knowledge and skill. This is a major issue for Aboriginal education, where students' social backgrounds engender unique educational needs. This article reflects on some recent research and identifies some specific implications for an Aboriginal homework centre.

Ministerial Council on Education, Employment, Training and Youth Affairs (1995), *A National Strategy for the Education of Aboriginal and Torres Strait Islander Peoples 1996-2002*, Canberra: Commonwealth of Australia.

This report cross-references the recommendations from the National Review of Education for Aboriginal and Torres Strait Islander Peoples with the 21 goals of the National Aboriginal and Torres Strait Islander Education Policy and details strategies for implementation and performance measures for each outcome.

Munns, G and Connelly, J (1996), *'When are you fellas gunna teach these 'ere little black kids how to read and write?'* *Literacy for Aboriginal students: Learning from past failures*, Paper read at the Annual Conference of the Australian Association for Research in Education, Singapore.

The paper describes Aboriginal students' opposition to school which was linked to a mismatch between the culture of the home and the culture of the school. The authors argue for a non-threatening yet challenging pedagogy, combined with a culturally inclusive curriculum, to enhance Aboriginal students' literacy acquisition.

National Languages and Literacy Institute of Australia (1994), *Best practice in Aboriginal and Torres Strait Islander education: NLLIA celebrates the International Year of the World's Indigenous Peoples: Proceedings of the Conference held in Canberra on 17-18 November 1993*, Deakin, ACT: National Languages and Literacy Institute of Australia (NLLIA).

The purpose of this forum was to identify successful practice and celebrate positive aspects of the education of Aboriginal and Torres Strait Islander students. The collection of papers published addresses a wide range of issues relating to Indigenous education including early childhood education, English literacy programs and Aboriginal studies. One paper specifically focuses on mathematics teaching.

National Review of Education for Aboriginal and Torres Strait Islander Peoples (1995), *Final Report*, Canberra: Commonwealth of Australia.

The principal findings and recommendations of this Review of Aboriginal and Torres Strait Islander education are presented under the following headings: involvement and self-determination; information as a prerequisite for decision-making; equitable access; raising participation; equitable and appropriate outcomes; reporting, monitoring and evaluation; and resources and needs.

New South Wales Department of School Education (1996), *Aboriginal Education Policy*, Sydney: New South Wales Department of School Education.

This policy aims to promote educational achievements by Aboriginal students (including literacy and numeracy achievement) and to educate all students about Aboriginal Australia through curriculum, teaching and assessment programs that are challenging and culturally appropriate.

Nicholls, C, Crowley, V and Watt R (1996), 'Theorising Aboriginal education: Surely it's time to move on?' *Education Australia*, 33, 6-9.

Discusses the theory concerning 'Aboriginal learning styles' and the work of Stephen Harris. The authors argue the importance of clarifying what this very important debate is really about.

Nienhuys, T and Burnip L (1988), 'Conductive hearing loss and the Aboriginal child at school', *Australian Teacher of the Deaf*, 28, 4-17.

This article contains a discussion of the incidence of Aboriginal hearing loss and its educational implications, and suggests strategies to make the classroom a more friendly environment for students with hearing problems.

Northern Territory Department of Education (1993), *Maths in Context*, Darwin: Northern Territory Department of Education.

This teacher resource package consists of three books: *Early Childhood Units of work*, *Primary Units of work*, *Checklists and Worksheets*. Also included is an Australian Geographic poster, Australian Bird Migration, and fact sheets on the Dugong, Sea Turtles and Mangroves.

Northern Territory Department of Education (1994), *Maths Works for Me*, Darwin: Northern Territory Department of Education.

A collection of mathematics activities contributed by a range of schools, institutions and teachers.

Patrick-Rolf, M (1990), 'Creating a good maths learning environment', *Aboriginal Child at School*, 18(5), 15-30.

This paper comprises a table which outlines key factors in establishing a good mathematics learning environment. The table was developed by three students of the Anangu Teacher Education Program and their lecturer.

Potter, C (1994), 'Mathematics and Aboriginality', *Aboriginal Child at School*, 22(1), 3-11.

General discussion of the needs of Aboriginal children in the mathematics classroom.

Putt, I, Henderson, L and Stillman, G (1995), 'Teaching mathematics education at a distance via interactive multimedia, video, and projects', In Hunting, RP., Fitzsimons, GE, Clarkson, PC, and Bishop, AJ (Eds), *Regional Collaboration in Mathematics Education 1995, International Commission on Mathematics Instruction April 19-23, 1995*, Monash University, Melbourne, pp 593-602, Clayton, Victoria: Monash University, Faculty of Education.

The Remote Area Teacher Education Program (RATEP) is delivered, using interactive multimedia and electronic technology, to Aboriginal and Torres Strait Islander students within their home communities. The paper describes units from the mathematics content and curriculum subjects to illustrate ways in which the instructional computer-student interface design can be contextualised in a culturally appropriate way in order to promote learning through interactive multimedia. The pedagogy models ways in which the topics may be taught from a problem-based perspective to primary school children.

Roberts, T (1997), 'Aboriginal maths: can we use it in school?', In Scott, N and Hollingsworth, H (Eds), *Mathematics, Creating the Future: Proceedings of the 16th Biennial Conference of the Australian Association of Mathematics Teachers, Melbourne, July 1997*, Adelaide: Australian Association of Mathematics Teachers.

The author and her son spent a day with an Aboriginal family with whom they were friendly. The paper discusses the mathematics involved in the activities that they participated in which included making a didgeridoo and organising a fishing trip. Where appropriate, the author states that these types of activities should be incorporated into school mathematics programs but cautions that this

should occur only if members of the community determine that these links are appropriate. The original purpose for the skill or important knowledge underlying the skill might be lost.

Robinson, J, & Nichol, R (1998), 'Building bridges between Aboriginal and western mathematics: creating an effective mathematical learning environment', *Weaver: A Forum for New Ideas in Educational Research*, no. 2.
<<http://www.latrobe.edu.au/www/graded/JJRed2.html>>

This article outlines a method of integrating Aboriginal and Western mathematics into an effective learning environment. The authors commence by discussing the characteristics of traditional Aboriginal education and the education of Aboriginals after European occupation. The authors then discuss the characteristics of Aboriginal children as learners and outline various methods to make mathematics more accessible to Aboriginal students. This should incorporate aspects from the social environment, teaching and assessment methods. The authors outline a program 'Garma Maths' which incorporates these features.

Seputro, T T (1998), 'Problem-centred and experimental activities for Aboriginal students', *Australian Senior Mathematics Journal*, 12(1), 35-46.

This discussion arises out of the author's teaching and tutorial work carried out over a semester with students from the Centre for Aboriginal Studies at Curtin University. It involved solving real life problems with Aboriginal bridging course students, taking a constructivist approach.

South Australian Education Department.(1991), *Teaching and learning mathematics. Aboriginal education R 12 resource papers. Theme: Aboriginal students and education*, Adelaide: Education Department of South Australia.

This booklet is one of a series of resource papers produced by the South Australian Education Department to support teachers of Aboriginal children. The focus of this booklet is the teaching of mathematics, and a number of teachers reflect on action research projects where they recount strategies that they have found valuable.

Speilman, E and Mitchelmore, M (2000), 'Change in attitude towards mathematics among Aboriginal adult learners', In Bana, J and Chapman, A (Eds) *Mathematics Education Beyond 2000*, Proceedings of the 23rd Annual Conference of the Mathematics Education Research Group of Australasia Incorporated, Fremantle, Western Australia, 5-9 July 2000.

This study monitored the attitudes of adult Aboriginal students in a year-long mathematics unit. Contributing factors to the positive trends which emerged were identified, including separation of students into ability groups, negotiation of content and learning style, relevance of content, and community visits by the teacher.

Stewart R, Wright, B and Gould P (1998), 'Kindergarten students' progress in the Count Me In Too Project', In Kanen, C, Goos, M and Warren, E *Teaching Mathematics in New Times*, Proceedings of the 21st Annual Conference of the Mathematics Education Research Group of Australasia Incorporated, Gold Coast, Australia, 5-8 July 1998.

This study reports on the progress of 866 Kindergarten students, including 47 Indigenous students, in arithmetical strategies, forward number word sequences and numeral identification. While there was much diversity in levels, many students began Kindergarten with high levels of knowledge and the majority of students met or exceeded expected syllabus outcomes.

Treagust, D F, Malone, J A and Fraser, B J (1991), 'Development of tertiary bridging rights for Aborigines', *Curriculum Perspectives*, 11(4), 26-31.

Describes a bridging program suitable for students who had completed Year 10 and were commencing Year 11. The program consists of discrete units in 12 Chemistry and 17 Mathematics of which students complete a subset depending on the requirements of the tertiary course for which they want to qualify. The chief characteristics of the program were matched to Aboriginal teaching and learning styles.

Trouw, N (1994), 'An effective language program for urban Aboriginal children', In Harris, S and Malin, M (Eds), *Aboriginal Kids in Urban Classrooms*, Wentworth Falls NSW: Social Sciences Press.

An example of a language program designed to acknowledge and account for differences in Aboriginal learning styles. A small group of Indigenous and non-Indigenous students was withdrawn from class each week and lessons incorporated teaching strategies which encouraged the children to learn about the subculture of Western schooling while developing pre- and early reading skills. Evaluation of the program suggests positive outcomes.

Walsh, P (1991), 'Learning needs consultation', In South Australian Education Department (Ed), *Students and schools. Aboriginal Education R 12 resource papers. Theme: Aboriginal students and education*, Adelaide: South Australian Education Department.

This article looks at the relationship - and consultation process - between a district Aboriginal education resource teacher and Aboriginal children and their teachers. The aim of the consultation process was to establish how best to work with Aboriginal children and their teachers. In the course of the consultation process issues such as Aboriginal culture, social and emotional development factors, subject areas, and literacy and numeracy aspects were discussed.

Watson, H (1988), 'Language and mathematics education for Aboriginal-Australian children', *Language and Education* 2, 255-273.

The author argues that attempts to develop mathematics education programs for Aboriginal children have failed because they fail to meet the wide range of individual needs of Aboriginal children. In particular, she highlights the different schemas of meaning that some Aboriginal students bring to their mathematics learning.

Willis, S, (2000), 'Strengthening numeracy: Reducing Risk', In *Improving numeracy learning : Research Conference 2000: Proceedings*, Melbourne : Australian Council for Educational Research, 2000.

The author reflects on observations that some Aboriginal students were able to distinguish the number of items in a small collection (the process of subitizing) without being able to count. Although research at this stage is inconclusive, it does have implications for assumptions about numeracy developmental sequences and the importance of teaching and assessment strategies which

accurately identify and build on students' existing knowledge and skills. The importance of exploring students' underlying understanding of mathematical operations, which has implications for further learning, rather than simply measuring current performance, is also discussed.