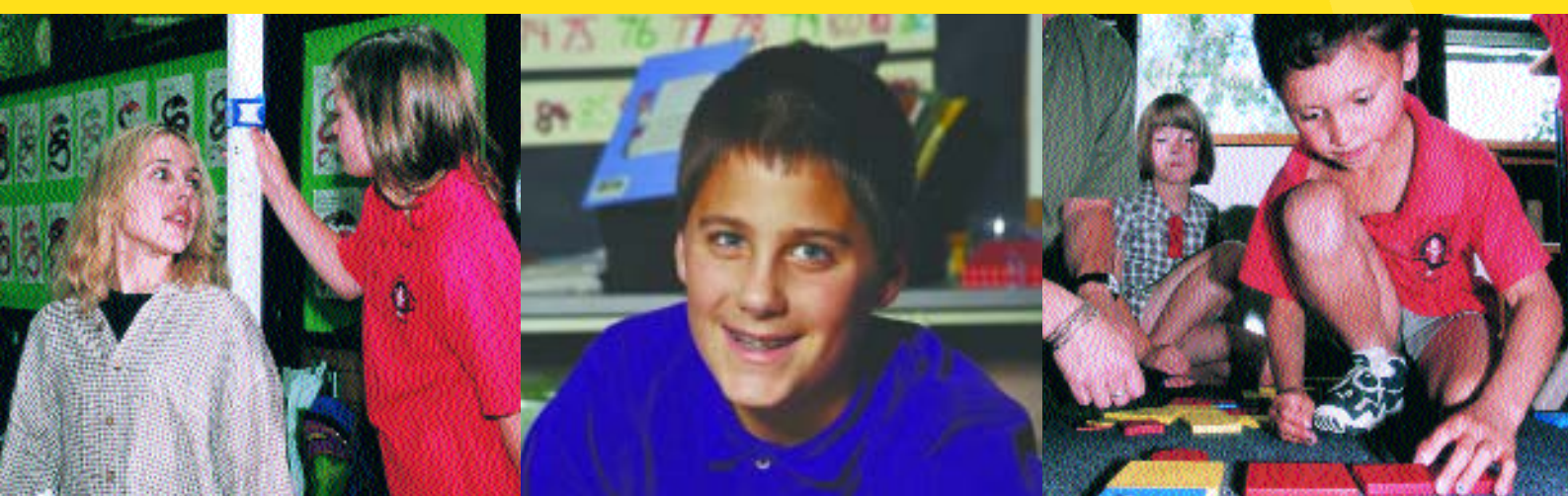


Numeracy, A Priority for All:

Challenges for Australian Schools



Commonwealth Numeracy Policies for Australian Schools

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**NUMERACY, A PRIORITY FOR ALL:
Challenges for Australian Schools**

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Executive summary

The Commonwealth Government's policies for literacy and numeracy in schools are directed towards strengthening the educational achievements of all Australian children. It is a major policy objective, and now a nationally agreed priority, to ensure that all students attain sound foundations in literacy and numeracy. This is driven by a strong belief that all students can and should acquire the essential skills for life in modern society.

This paper sets out the Commonwealth's numeracy policies in the context of its support for the National Literacy and Numeracy Plan. The paper's major focus is on numeracy in primary schooling, reflecting the emphasis of the National Plan on the vital role of early education.

Numeracy, like literacy, provides key enabling skills essential for achieving success in schooling. Sound numeracy skills acquired in schooling support effective participation in personal, economic and civic contexts. The increase of globalisation and the use of technology have generated increased demands for a more numerate Australia. There is a need to provide effective assistance to students who need extra support, as part of ensuring that all students gain a level of numeracy essential for successful participation in schooling, in work and in everyday life. There is also a need to ensure that all students are given opportunities to attain high standards of mathematical knowledge, skills and understanding.

Numeracy education in Australia has entered a phase of significant development, reflected in vigorous professional discussion and in the wide variety of programmes and initiatives which education authorities are strengthening and establishing in order to enhance numeracy outcomes in schools.

The national literacy and numeracy goal, that *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* now forms part of The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century, agreed in April 1999 by the Ministerial Council on Education, Employment, Training and Youth Affairs.

The focus on literacy and numeracy for all students is a crucial element in the wider spectrum of nationally agreed goals for schooling in The Adelaide Declaration. The Declaration emphasises the vital responsibility of schools to develop fully the talents and capacities of all students and to ensure that students attain high standards of knowledge, skills and understanding in the agreed key learning areas, including mathematics and English. While the delivery of school education, including curriculum, is a State and Territory responsibility in Australia, the Commonwealth provides major support for education authorities and schools to attain these goals and to strive for quality schooling outcomes.

The National Literacy and Numeracy Plan has been agreed and provides a coherent framework for working towards the achievement of the national literacy and numeracy goal, through a coordinated approach by the Commonwealth, States and Territories to improving students' literacy and numeracy outcomes. An important basis of the Plan is the belief that all students can make progress and can achieve in literacy and numeracy.

The National Plan includes a focus on the crucial early years of schooling, recognising the importance of all students gaining sound foundations in numeracy in these years. Key elements of the Plan include the

assessment of all students by their teachers early in schooling, and the provision of intervention for those students identified as being at risk of not making sufficient progress. The need for ongoing support for students' numeracy is also recognised.

A part of the National Plan is developing nationally agreed performance standards for literacy and numeracy at particular school year levels. Benchmarks for Years 3, 5 and 7 have been developed for use in national reporting by States and Territories of student performance against agreed minimum acceptable standards. This reflects the resolve across the nation to ensure that the highest priority in education is given to ensuring that all children acquire the essential skills in literacy and numeracy. Objective information about student performance in terms of common standards is important in building parental and community support for schools and enabling the public to know that education systems are delivering key outcomes for its major investment in education. Public reporting also acts as an incentive for improving educational programmes.

Professional development is a crucial element of the National Plan, acknowledging the critical influence that teachers' beliefs, knowledge, understandings and skills have on students' numeracy development.

The Commonwealth's framework provides major support for schooling in Australia, including targeted support for literacy and numeracy. The Government provides significant funding to State and Territory government and non-government education authorities for schools, complementing funding provided by State and Territory governments. The Commonwealth's funding under the Literacy and Numeracy Programme has been increased to total \$1,104 million in the five years to 2003/2004. Funding includes support for research and development projects.

The Government has announced a new initiative, the Commonwealth Numeracy Research and Development Initiative, which aims to boost research and development which will support improved numeracy outcomes, focussing on the primary school years.

The priority given to numeracy education in Commonwealth education policies represents a significant challenge to education authorities, schools, principals, teachers and parents to work in partnership towards the achievement of the national goal of ensuring numeracy for all Australian students.

In this paper, **The Introduction** outlines the scope of the paper, noting the emphasis on primary schooling, and the different roles of the Commonwealth and the States in schooling. It also sets out the Commonwealth's priority for numeracy within the context of its wider support for quality outcomes in schooling. Broad principles underlying literacy and numeracy policy are described.

Part 1 The Priority for Numeracy Education outlines why numeracy is a priority for all and indicates the range of approaches to numeracy and the importance of mathematical knowledge, skills and understandings. Existing evidence on achievement nationally is outlined.

Part 2 The National Literacy and Numeracy Plan provides information on the national literacy and numeracy goal and the nature of the National Plan agreed by all Education Ministers in 1997 to address literacy and numeracy as a national priority in schooling. Links between the Plan and quality outcomes more broadly in schooling are outlined. The important equity and accountability dimensions of the Plan are also discussed.

Part 3 Commonwealth Funding Strategies to Support Literacy and Numeracy outlines the Government's funding support for specific programmes which target literacy and numeracy outcomes, in the context of the Government's significant funding for schooling.

Part 4 The Contextual Framework for The National Literacy and Numeracy Plan looks more closely at areas of particular focus under the National Plan. These include: the support for numeracy in the early years; early assessment, intervention and the establishment of sound foundations; the nature, role and use of national benchmarks; and the importance of professional development for teachers. Key links into the middle years of schooling are noted.

Part 5 Aspects of Effective Numeracy Education provides information on some key aspects of and developments in numeracy education which need attention in the current context. These include effective teaching and learning practices, the interaction between technology and numeracy learning, the importance of home, school and community partnerships and the diversity of students' experience and learning needs.

Part 6 Further Development and Conclusions. This part draws conclusions and looks at further support by the Government for literacy and numeracy achievement, including the National Indigenous English Literacy and Numeracy Strategy, the middle years initiative, the Quality Teacher Programme and the Commonwealth Numeracy Research and Development Initiative.

Introduction

The Commonwealth Government's policies for literacy and numeracy in schools are directed towards strengthening the educational achievements of all Australian school children. This paper sets out the Commonwealth's policy framework for school numeracy education and for the enhancement of numeracy outcomes for all students. An earlier paper, *Literacy For All: The Challenge for Australian Schools*, focused on literacy.

The Commonwealth Government works cooperatively with the States and Territories to secure better educational outcomes from schooling. School education is a shared responsibility, with the State, Territory and non-government school authorities having primary responsibility for funding. Under the Australian Constitution, the responsibility for the delivery of school education, including school curriculum, rests with the States and Territories.

The Commonwealth Government is a key partner in setting and achieving national goals and priorities for schooling. It seeks to improve quality in schooling and enhance educational outcomes for all students by: providing support for education systems and schools through its general recurrent, capital and other specific purpose programmes; and through its policy development and research in relation to nationally significant educational issues.

All Australian Education Ministers have recognised the priority for schools to ensure that all children gain appropriate literacy and numeracy skills. They have agreed to a literacy and numeracy goal, that *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*. They have also agreed to seek to ensure that all children *achieve a minimum acceptable literacy and numeracy standard*. In seeking to realise these aspirations, Education Ministers have agreed to boost existing efforts to address students' foundational literacy and numeracy skills through a National Literacy and Numeracy Plan (National Plan).

The scope of this paper

This paper outlines the Commonwealth's policies and programmes to support improved student numeracy outcomes in the context of its focus on progressing the National Plan. It sets out the rationale for the national priority for numeracy in schools and provides information on the National Plan and its broader context. The paper outlines the ways in which the Commonwealth supports the National Plan and contributes to achievement of the national literacy and numeracy goal. The paper provides information on some key aspects of and developments in numeracy education and points to further directions, indicating Commonwealth support for improving student numeracy outcomes through research and development.

Reflecting the National Plan, which includes a strong focus on achieving sound foundations in numeracy early in schooling, numeracy in primary schooling is the major focus of this paper, with some key links into the middle years of schooling. The paper is intended primarily for an audience with an interest in students' numeracy development at primary school level.

Commonwealth support for national priorities

The Commonwealth works with the States and Territories to secure the outcomes embodied in the National Goals for Schooling in the Twenty-First Century agreed by Commonwealth, State and Territory Education Ministers as The Adelaide Declaration (1999). The goals focus on enhancing educational outcomes for all students, acknowledging the role of schooling in developing fully the talents and capacities of all students. They support the pursuit of excellence, seek to enable a diverse range of educational choices and aspirations, and reflect the entitlement of all young Australians to high quality schooling.

The 1999 national goals replaced the Common and Agreed National Goals for Schooling in Australia which had been endorsed as The Hobart Declaration in 1989. In The Adelaide Declaration (1999), Education Ministers re-affirmed their commitment to high levels of educational achievement. The goals state that, in terms of the curriculum, *students should have attained high standards of knowledge, skills and understanding through a comprehensive and balanced curriculum in the compulsory years of schooling encompassing the agreed eight key learning areas*, including English and mathematics. Catering to the full range of student capabilities and seeking the best possible outcomes for all students in the key learning areas, is a vital and ongoing concern of all States and Territories.

To support enhanced educational outcomes, the Commonwealth supplements funding provided to Australian schools through a significant financial contribution to schooling of some \$5 billion a year through its general recurrent, capital and other specific purpose programmes.

In The Adelaide Declaration Education Ministers also affirmed the national literacy and numeracy goal. The goal is supported by the National Plan agreed by Education Ministers. The Plan has a significant equity dimension, seeking to ensure that all students attain at least the essential literacy and numeracy skills they require to make progress in their schooling. A significant proportion of the substantial funding the Commonwealth contributes to Australian schools is provided through grants to State and Territory government and non-government education authorities under the Literacy and Numeracy Programme. This funding has a particular focus on students who are educationally disadvantaged in terms of their literacy and numeracy outcomes.

Principles underlying Commonwealth literacy and numeracy policies for schools

Effective literacy and numeracy play a key role in enabling all Australian young people to successfully participate in a range of courses in schooling until the completion of Year 12, and in further study, training or work. Overcoming educational disadvantage is the focus of the Government's literacy and numeracy policies. Because literacy and numeracy are vital in enabling students to access learning generally, the first priority of schooling and of school funding must be to ensure that all children acquire appropriate skills in literacy and numeracy. Strong foundations need to be established early, or further progress in learning is at risk. For this reason, primary schools play a particularly important role in this work.

The Government's numeracy policies and programmes are part of the wider schooling context. In addition to ensuring that children have essential literacy and numeracy skills, schools have important and widely recognised responsibilities – to address the needs of all students, to challenge all students to achieve to their capacity through high expectations and to assist them to develop to their full potential.

Australia's social, cultural and economic development in local and global contexts is reliant on these responsibilities being met.

Several broad principles underpin Commonwealth policies for literacy and numeracy in schools.

Educational opportunity for all students

Equity in educational opportunities for all students is a central principle. If schooling does not seek to overcome educational disadvantage, reflected in student outcomes, individuals, governments and the community all bear real costs, in important personal, social and economic terms. The Commonwealth provides targeted funding for educationally disadvantaged students by supplementing the funding of Australian schools to achieve specific national objectives.

Preparing students for work and for lifelong learning

It is essential that school education takes increasing responsibility for the outcomes of all students, including preparation of students for tertiary education and for work. Facilitating the maximum development of individual abilities is important. Preparation for lifelong learning will be increasingly important as work and society undergo rapid change.

Better information on educational outcomes for the community

Improved educational accountability is important in terms of the crucial nature of student outcomes and in terms of the community's major investment in school education. Accountability should be established cooperatively in ways which provide information to schools, to teachers and to parents as well as to governments. As a nation we need to examine and encourage improvement in education by collecting information about a range of key schooling factors, such as literacy and numeracy, and using this information for developing future strategies to improve student outcomes.

Diversity and choice in schooling

A diversity of schools is important, with each school having the flexibility to develop approaches most suited to its students' strengths and needs. Choice is an important value in a democratic society and is a key factor which encourages responsiveness to the needs of students and parents, provides a foundation for school improvement and facilitates innovation. Many Australian school systems are moving to give schools and principals the autonomy needed to promote effective teaching and learning.

1. The Priority for Numeracy Education

Some key areas provide important background and context for the national focus in Australia on numeracy and the Commonwealth's commitment to numeracy achievement for all students. They are: the importance of numeracy to individuals and to society; the varied and evolving approaches to numeracy in Australia; the importance of mathematics; and current information on Australian students' performance in this area.

1.1 The Importance of Numeracy

Changing economic realities in the last 15 years, with increasing globalisation and use of technology, have seen the demand for unskilled labour fall markedly. This has prompted the recognition that high quality basic education reflected in the knowledge, skills and attitudes of the workforce is vital for countries like Australia in maintaining national prosperity and social stability. The acquisition by all students of appropriate numeracy skills is now much more crucial than in the past.

Numeracy, like literacy, provides key enabling skills for individuals to participate successfully in schooling. Furthermore, numeracy equips students for life beyond school, in providing access to further study or training, to personal pursuits and to participation in the world of work and in the wider community.

Numeracy and learning

Numeracy is fundamental to learning at all stages of school and across curriculum areas. As is the case with literacy, numeracy requires sufficient timetabling emphasis, focus and leadership. Effective teaching and learning practices and effective home, school and community partnerships, are critical.

In the early years of schooling the development of numeracy skills provides a crucial foundation for the later years to support and enhance future learning, at school, in the workplace and in everyday life. Within the school context, numeracy is needed to support learning in various curriculum areas. Interpreting data in graphs or tables, using a scale on a map or making critical judgments based on text containing quantitative information all require students to be numerate. Numeracy skills are also important to access vocational education courses in schools.

Ongoing support for students' numeracy development after the primary years of schooling is important as the conceptual demands of all curriculum areas increase and as students prepare for settings beyond schooling. This is recognised by the National Plan, and in the Commonwealth's extension of funding of literacy and numeracy initiatives into the middle years of schooling.

The numeracy demands of post-compulsory general and vocational courses can be significant. Tertiary students in a wide range of courses of study are also expected to 'use the necessary skills, including numeracy skills, at a high level, to think critically about the material presented and to be able to present convincing and logical arguments of their own' (Kemp, 1995: 377).

Numeracy and work

Studies in the UK have indicated the impact of poor numeracy skills on employment experiences (NFER & The Basic Skills Agency, 1998). For example, even for those with good literacy skills, poor numeracy

skills have been found to be associated with reduced employment and training opportunities and progress in jobs (Parsons & Bynner, 1997). Research in Australia reported by the Australian Council for Educational Research (ACER) found, from longitudinal data, that poor number skills at school were associated with early school leaving and with a greater likelihood of being out of work and experiencing sustained periods of unemployment at age 19 (ACER, 1997a). The study concluded that:

While raising levels of literacy and numeracy will not necessarily guarantee young people well-paid jobs, it will improve their chances of completing school and accessing a wider range of post-compulsory pathways, which, in the longer term, may help young people establish more secure livelihoods. (ACER, 1997a: vii)

The nature of work is changing and there is no longer an expectation of one career for life. Workplaces are demanding flexibility, problem-solving and trainability. The numeracy demands made on people in their careers have been described as varying from specific occupational competencies to flexible analytic abilities, deemed of increasing importance within a society where multi-skilling and vocational change may become the norm (Galbraith et al, 1992: 574). Adapting to such demands and changes requires numeracy as well as literacy for all.

Capability in mathematics is important in the national context. High level mathematical expertise contributes to the economic wellbeing of the nation, with benefits to business, industry and other areas. The development of technology and the information industry in Australia requires significant mathematical capacity.

Flexibility and lifelong learning

The Commonwealth Government, in common with a number of governments internationally, is aware of the importance of lifelong learning as a way to address rapid economic, social and technological changes in society and the effects of these changes on the demands of work, including its numeracy demands. Flexibility in applying and developing prior learning, together with orientations which support further learning are critical. The role of mathematics, as the underpinning facilitator of problem-solving and quantitative analysis at all levels, is vital in this context. Command of foundation skills, including literacy and numeracy, is the cornerstone of lifelong learning. Without them, access to the global information economy will be denied.

Numeracy for personal and community needs

Being numerate enables adults to function effectively in their everyday lives. A wide variety of personal contexts involve numeracy, ranging from routine activities such as shopping, to tasks where a greater range of numeracy skills may be involved, such as planning a holiday or budgeting. The increasing availability of information technology means that the numeracy demands of everyday tasks are continually evolving. Students must gain appropriate levels of numeracy to cope with the demands of everyday living and the lifelong learning skills to cope with changes effectively.

In a modern democracy, the quality of civic life is also linked to a numerate community. The ability to make sound judgments and deal analytically and critically with information presented in varied forms and often involving complex data, is important for informed citizenship.

1.2 Approaches to Numeracy

The concept of numeracy is much debated, having different meanings across time and contexts. *Numeracy* is a relatively recent term, first used in the United Kingdom in 1959 by the writers of the Crowther Report, in which numeracy was seen to be the mirror image of literacy. It implied ‘on the one hand ... an understanding of the scientific approach to the study of phenomena’ and ‘on the other hand ... the need in the modern world to think quantitatively, to realise how far our problems are problems of degree even when they appear to be problems of kind’ (Ministry of Education, 1959: 270).

Some forty years later, various terms and definitions for numeracy have been proposed. The goal of finding a single definition acceptable to all may not be feasible or even desirable. What follows provides a flavour of some of the current discussion and different perspectives in this area from national and international sources.

In the final report of the United Kingdom’s National Numeracy Task Force (1998), numeracy focuses mainly on numerical aspects of mathematics, requiring:

an understanding of the number system, a repertoire of computational skills and an inclination and ability to solve number problems in a variety of contexts. Numeracy also demands practical understanding of the ways in which information is gathered by counting and measuring, and is presented in graphs, diagrams, charts and tables. (Department for Education and Employment (DfEE), 1998: 11)

In Australia, numeracy is interpreted more broadly than number, as reflected in the national numeracy benchmarks. The report of a national numeracy conference in Australia in 1997 funded by the Commonwealth suggested that numeracy involves using ‘some mathematics to achieve some purpose in a particular context’ (AAMT, 1997: 13). While number sense is seen as crucial, the report suggests that other aspects of mathematical understanding such as measurement and data sense and spatial sense are also important. It proposed the following description:

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. (Australian Association of Mathematics Teachers Inc. (AAMT), 1997: 15)*

Expressing some similar ideas, the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) uses the term ‘mathematical literacy’ and describes this in the following way:

Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgements and to engage in mathematics, in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen. (OECD, Paris, 1999: 41)

Reflecting on varied definitions, Willis (1998) synthesised major perspectives as having one of three foci: 1) on mathematics itself, with numeracy used more or less synonymously with mathematics; 2) on the contexts in which people are expected to function where numeracy is seen to be quite context specific; and 3) on the processes needed to choose and use mathematics, where numeracy is described in terms of strategic mathematical processes and the capacity to bridge the gap between mathematics and the real world. She considers that 'to develop numeracy as practical knowledge would seem to require a blending of these three interpretations [mathematical, contextual, strategic]' (Willis, 1998: 38).

Although numeracy and literacy are underpinned by different areas of learning, it is well established that language and mathematical development are mutually supportive. Cumming (1996) explains:

researchers and practitioners in mathematics and numeracy education are well aware of the significance of language in mathematics and numeracy learning. Language is not, however, seen as the overriding discipline within which numeracy is subsumed. (Cumming, 1996: 16)

Literacy and numeracy can be viewed as complementary areas of endeavour. Numeracy educators can learn from the literacy experience and there is potential for work in literacy to be informed by work in numeracy.

Concepts of numeracy evident above illustrate that there is ongoing discussion as well as diversity in the field. State and Territory education authorities in Australia have a range of approaches to numeracy education in schools which are reflected in a variety of programmes and initiatives for the development of students' mathematical skills and numeracy. Numeracy education in Australia is also undergoing a period of significant development and approaches to teaching and learning in numeracy are evolving.

The nature of numeracy education in schools may be interpreted widely. Current Australian approaches in the early and middle years of schooling broadly include the development of students' mathematical knowledge, skills and understandings, and the fostering of students' capacities and disposition to make effective use of this learning. Approaches tend to emphasise providing support for learning and enabling students to effectively deal with the general demands of their lives.

1.3 The Importance of Mathematics

The *1996 Strategic Review of Mathematical Sciences and Advanced Mathematical Services in Australia* (Barton, 1996) indicated that mathematics is pervasive throughout all aspects of our knowledge-based society – medicine, commerce, industry, life and physical sciences, social sciences, engineering and technology. The Review found that mathematics is essential to the economic competitiveness of the nation. It also identified mathematics as a generic and enabling technology, essential to the prosperity of many value-adding industries in Australia.

Mathematics is one of the identified key learning areas in the curriculum for schools. In Australia, the development and delivery of mathematics curricula in schools rests with State and Territory government

and non-government education authorities. Learning in this key area is essential to the development of students' numeracy and also extends learning beyond foundational numeracy learning. It plays important roles in laying the foundations for the professional and technical uses of mathematics and in fostering an appreciation of the role of mathematics in the functioning of society and an understanding of the nature of mathematical investigation and thinking. These broad mathematical understandings also strengthen students' numeracy.

Effective mathematics teaching, promoting depth of understanding, is vital. The provision of high quality teaching of mathematics and the fostering of high achievement for students supports Australia's competitiveness in the contexts noted above. In The Adelaide Declaration (1999), Education Ministers recognised the importance of sound mathematics learning with students attaining high standards. Programmes to address student outcomes in the mathematics key learning area have an established and continuing focus in all States and Territories.

1.4 Student Numeracy Performance

To date there has been limited information at a national level on student performance in numeracy or mathematics, including information which would enable nationally comparable monitoring of progress over time and assessment of whether all students, including identified groups of educationally disadvantaged students, are gaining essential skills. The following assist in developing a national picture of students' performance in numeracy and mathematics to date.

State and Territory data

Within Australia, each State and Territory education system has its own assessment policy for mathematics and numeracy, with testing of the full year group of students in particular years undertaken by education authorities to monitor student performance. The *Report on Government Services 2000* has collated some information on student performance in these tests over recent years. In most cases, State/Territory information is provided on student performance in terms of the proportion of students who achieved the different levels in the State/Territory curriculum or outcomes framework. Where reported, the performance of girls and boys is similar, but the performance of Indigenous students is lower than that of the general population of students. Performance outcomes reported under the Commonwealth's Indigenous Education Strategic Initiatives Programme (IESIP) by government and non-government school authorities on the numeracy achievements of their Indigenous students support these findings, with the outcomes for Indigenous students on average significantly below those of non-Indigenous students.

National and international performance data

The Longitudinal Surveys of Australian Youth (LSAY) and associated studies provide results from linked assessments of numeracy achievement over a period of approximately 20 years for samples of Year 9 students. The aspects of numeracy assessed by the survey involve computational, practical and conceptual items. ACER found that over the 20 years to 1995, there was a slight increase in the percentage of Year 9 students who achieved 'mastery' of numeracy. The study defines mastery as achieving the level of competence necessary to function in adult society. Approximately 85 per cent of the Year 9 students in the survey achieved mastery of numeracy in 1995. Performance was lower for students whose home language was not English, compared to those of English speaking background (ACER, 1997b).

The Australian Bureau of Statistics' *Survey of Aspects of Literacy* was part of the International Adult Literacy Survey which assessed aspects of the literacy skills of people aged 15 and over, including quantitative literacy skills, an important part of numeracy. The latter involved making sense of printed material which included arithmetic and computational demands and being able to follow through on the demands. Participants were required to be able to read and understand text and embedded mathematics. The survey suggests that 16 per cent of 15 to 19 year-olds (almost 200,000) were at the lowest level of quantitative literacy skills, indicating that they would experience considerable difficulties in handling the demands of everyday life (ABS, 1997).

International studies assist in gauging the competitiveness of Australian education systems in the context of increasing economic globalisation. The Third International Mathematics and Science Study (TIMSS) is an international study of the achievement of half a million students in 45 countries in school mathematics and science education. In 1994–95 three student populations were tested, 9 year-olds, 13 year-olds and students in the final year of secondary education. The mathematics assessment included basic knowledge and computation as well as higher order skills such as problem solving.

Generally, TIMSS results show Australian 9 year-old students being outperformed in mathematics by students from Singapore, Korea, Japan and Hong Kong, performing on a par with students from the United States and a number of European countries and performing significantly better than students from most other English-speaking countries (Canada, Scotland, England and New Zealand). Generally Australian 13 year-olds were outperformed by students in eight countries including Singapore, Korea, Japan and Hong Kong, performed on a par with students from thirteen other countries including the Netherlands, France and Canada, and performed better than students from most other English-speaking countries, including the United States. Performance was uneven across the six content areas and there was variability in results at the State level.

In order to expand TIMSS assessment beyond short pencil-and-paper items, additional 'hands-on' performance assessment was undertaken by a smaller number of countries including Australia. Australia performed better than the international average on these tasks for 9 and 13 year-olds, and very well on some items (Harmon et al, 1997).

The Australian results for both 9 and 13 year-old students showed no gender differences. Performance was correlated with students' home background variables. Generally, non-English speaking background students who spoke mainly English at home performed better in TIMSS than other non-English speaking background students. Results for Indigenous students were significantly lower than for non-Indigenous students.

While assessment approaches used by test developers vary, the available national and international information on achievement in mathematics and numeracy suggests that whilst there is some evidence of good achievement, there is also no room for complacency in this key area of school education. It will be important for schools to continue to challenge students to achieve in this area and it appears that some students require more focused assistance than has been available in the past, to enable them to gain a sufficient level of numeracy to participate effectively in schooling and in their lives.

The future

Further information on aspects of Australian students' numeracy performance is expected to be available over time. The OECD's PISA studies will produce internationally comparable indicators of student achievement on a regular basis, with a cycle of tests to commence in 2000 and every three years thereafter. Thirty-four countries, including Australia, are participating in sample testing of 15 year-old students in 2000. PISA assesses 'mathematical literacy' and test items are being targeted not only at the school curriculum, but also include wider knowledge, skills and competencies needed in adult life.

Commonwealth, State and Territory Education Ministers have agreed that, from 2000, their annual *National Report on Schooling in Australia* will include chapters reporting student outcomes in literacy and numeracy, and a separate chapter concentrating on Indigenous outcomes.

Nationally agreed standards at a minimum acceptable level for numeracy, or national numeracy benchmarks, will also play a vital role in providing information to the Australian community on progress in this key aspect of student development.

1.5 Conclusion

Appropriate skills in numeracy are vital for all Australian young people, to access learning broadly at school and to participate fully and effectively in adult life. Approaches to numeracy education vary in terms of definition, with all approaches recognising that mathematical knowledge, skills and understandings are essential for all students. Whilst at this stage nationally there is some evidence of good achievement in mathematics and numeracy in the primary and middle school years, as a nation we need to take action to ensure that all students attain appropriate skills and are able to develop their skills to their full capacity.

2. The National Literacy and Numeracy Plan for Schools

In order to address the need for literacy and numeracy to receive the highest priority in Australian schools, Commonwealth, State and Territory Education Ministers have agreed on a national plan. The National Literacy and Numeracy Plan (National Plan) reflects the commitment of all Education Ministers to literacy and numeracy as essential for all learning and makes it clear that it is crucial for children to develop the foundations of literacy and numeracy early in the school years.

2.1 The National Literacy and Numeracy Goal

The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century, agreed at the April 1999 meeting of the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA), provides broad directions to guide schools and education authorities in securing the best possible educational outcomes for Australian students. This statement of national goals for schooling replaced The Hobart Declaration (1989), which embodied the original Common and Agreed National Goals for Schooling in Australia. The 1999 national goals were developed within a framework of national collaboration by a taskforce established by MCEETYA in 1997. The National Goals Taskforce comprised nominees of all States and Territories, the Commonwealth and the non-government school sector.

The Adelaide Declaration contains the national literacy and numeracy goal, that *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.* This affirmed similar commitments in 1996 and 1997. The goal represents community expectations for all schools in literacy and numeracy.

Ministers have also made a commitment that *every child commencing school from 1998 will achieve a minimum acceptable literacy and numeracy standard within four years.*

These statements are inclusive of all children, but recognise that a very small percentage of students have severe educational difficulties.

2.2 Supporting the National Literacy and Numeracy Goal through the National Plan

To support achievement of the national literacy and numeracy goal, State, Territory and Commonwealth Education Ministers agreed in 1997 to the National Plan which provides a coherent framework for achieving improvement in student numeracy outcomes, and a clear commitment to the achievement of the national goal. The Government supports the National Plan because it provides a specific and focused boost to existing initiatives by education authorities and schools to address the literacy and numeracy needs of all students.

Education authorities have a firmly established and vital commitment to seeking to maximise all students' capacities and to seeking quality outcomes in the key learning areas, including English and mathematics. These important priorities in education were reaffirmed in The Adelaide Declaration (1999) which included as its first goal, the commitment that: *Schooling should develop fully the talents and capacities of all students.* The second goal affirms that students should have attained high standards in the agreed key learning areas.

The National Plan builds on and strengthens these commitments. Quality outcomes in education require sound foundations for all. The National Plan ensures that there is an enhanced focus nationally on the

development of essential skills in literacy and numeracy for all students as the basis for their progress in future schooling and their successful participation in adult life. It recognises that proficiency in literacy and numeracy is a central equity issue in education today. Ensuring all students gain at least a minimum acceptable standard of literacy and numeracy is critical in overcoming educational disadvantage.

2.3 Elements of the National Plan

The National Plan calls for a coordinated approach by the Commonwealth, States and Territories to improving literacy and numeracy outcomes and achieving the national goal. The Plan was developed in 1997 and includes the following key and interrelated elements:

- assessment of all students by their teachers as early as possible in the first years of schooling;
- early intervention strategies for those students identified as having difficulty;
- the development of agreed benchmarks for Years 3, 5, 7 and 9, against which all children's achievement in these years can be measured;
 - the measurement of students' progress against these benchmarks using rigorous state-based assessment procedures, with all Year 3 students being assessed against the benchmarks from 1998 onwards, and all Year 5 students being assessed against the benchmarks as soon as possible;
 - progress towards national reporting on student achievement against the benchmarks, with reporting commencing in 1999 within the framework of the annual *National Report on Schooling in Australia*;
- professional development for teachers to support the key elements of the Plan. (DETYA, 1998)

The focus of professional development is support for teachers to effectively address the needs of all students.

The National Plan represents agreement to a national effort which builds on existing State and Territory initiatives. Efforts to lift numeracy and mathematics achievement in the early years are an established focus in every State and Territory. The National Plan recognises the wide range of approaches used to improve students' numeracy across the country, this diversity reflecting:

- the differences between States, Territories and systems;
- the differing needs of individual students;
- the diverse nature of schools and their communities; and
- the range of teaching and learning styles that are necessary to serve a heterogenous community.

Part 4 provides further information on developments in relation to the National Plan.

2.4 Key Dimensions of the National Plan

The agreement to the National Plan by all Education Ministers in Australia represents an historic commitment to focus on achieving improved outcomes in literacy and numeracy and to address educational disadvantage.

The equity dimension

A major aspect of the National Plan is its strong equity dimension. By giving all students access to the enabling skills of literacy and numeracy, which underpin learning at school, the Plan seeks to give all students access to educational opportunities. Setting minimum acceptable national standards as benchmarks assists education authorities to ensure that all students have the level of literacy and numeracy skills they need in order to make further progress at school.

An important basis of the Plan is the belief that all students can make progress and can achieve in literacy and numeracy. Through special support and focused teaching, all students, including those who have traditionally been most disadvantaged in education, are to have a sound start in schooling.

The paths to numeracy achievement need to be culturally appropriate for all students. It is recognised in mathematics education that students bring a range of understandings to school. It is important for teachers to draw on the cultures and contexts in which these understandings have been developed to assist students to consolidate previous learning and to access new knowledge and skills.

The focus on a national outcomes and improvement framework

A second key dimension of the National Plan is its provision of a national framework which focuses on education outcomes and improvements in literacy and numeracy. The agreement to the national goal is the first part of this framework. The development of nationally agreed standards, or benchmarks, adds to this framework by enabling education authorities to measure the achievement of students against these standards and to report on the outcomes to the Australian community.

Commonwealth and State and Territory governments are committed to delivering educational outcomes in the key areas of literacy and numeracy and to reporting their progress. The public nature of this process provides an impetus for all education authorities to work towards achieving the national goal. Effective resourcing of areas of need and effective programmes are essential in improving students' outcomes.

2.5 Conclusion

The national literacy and numeracy goal and the National Plan represent important elements of national efforts to enhance educational outcomes in schooling in Australia. The National Plan recognises the importance of the early and primary school years in developing literacy and numeracy as the basis for students' progress in future schooling and effective participation in adult life. It strengthens educational accountability for student outcomes and emphasises professional development to support the work of teachers. The National Plan builds on and strengthens existing commitments to quality outcomes in school education, which cannot be achieved without essential literacy and numeracy skills for *all* students.

3. Commonwealth Funding Strategies to Support Literacy and Numeracy

Facilitating access to appropriate educational outcomes and opportunities for all Australian children is a key part of the Commonwealth Government's policies for schools. The Commonwealth supplements the funding of Australian schools to achieve national objectives in schooling, complementing the funding provided by State and Territory governments.

To support enhanced educational outcomes, the Commonwealth makes a significant financial contribution to schools of some \$5 billion a year through general recurrent, capital and other specific purpose programmes.

3.1 The Commonwealth Government's Commitment to Literacy and Numeracy

The delivery of literacy and numeracy education in schools, including teaching and assessment strategies and programmes, is essentially the responsibility of State and Territory education authorities and school principals, but is of concern to all governments. The Commonwealth's role in achieving the national goal for literacy and numeracy includes:

- promoting national collaboration and coordination to achieve overall improvements in literacy and numeracy levels among Australian school children;
- promoting and funding school literacy and numeracy research;
- promoting appropriate teacher professional development;
- supporting the process of developing and reporting agreed national literacy and numeracy benchmarks.

A significant proportion of the Commonwealth's funding for schooling is provided through the Literacy and Numeracy Programme. Other initiatives and programmes, such as the Quality Teacher Programme, discussed in Part 6, also contribute to improving literacy and numeracy outcomes.

3.2 Commonwealth Funding: the Literacy and Numeracy Programme

The aim of the Literacy and Numeracy Programme is to foster the acquisition of appropriate literacy and numeracy skills by all students. Funding under the Literacy and Numeracy Programme has been increased to total \$1,104 million for literacy and numeracy in the five years to 2003/2004.

State and Territory government and non-government education authorities are responsible for the detailed administration of the Literacy and Numeracy Programme funding in their systems and schools. Since 1998, education authorities have been required to target funding to students who are educationally disadvantaged in terms of their literacy and numeracy outcomes, taking account of relevant school and system level information on student outcomes.

Grants to Schools to Foster Literacy and Numeracy Development strand

This strand of the Programme provides \$1,084 million in the five years to 2003/2004. This is paid to government and non-government education authorities to support appropriate strategies and

programmes designed to achieve the Literacy and Numeracy Programme objectives. This includes support for the National Plan and assistance for students in the middle years of schooling.

Education authorities are now required to provide sector wide strategic literacy and numeracy plans which outline how funds are being used to support:

- the implementation of the National Plan; and
- the realisation of the agreed national literacy and numeracy goal.

The plans indicate that there is a very high level of commitment to the principles which underpin the National Plan. The plans are purposeful documents which demonstrate how resources are being used to meet the literacy and numeracy needs of the most educationally disadvantaged students.

Grants for National Literacy and Numeracy Strategies and Projects strand

This strand of the programme provides approximately \$20 million over four years to identify, research and implement strategic national initiatives and developments in literacy and numeracy. Funding for priority research and national strategies is not a grant programme directed at individual schools, although education authorities may apply to undertake projects through a tender process.

Under this strand the Commonwealth provided \$7 million over three years (1997–1999) for professional development for junior primary teachers, to assist education authorities to implement the National Plan.

The Commonwealth regards a programme of research and strategic national work as important in supporting national numeracy initiatives, including components of the National Plan. The Commonwealth has announced in 2000 a Numeracy Research and Development Initiative. Further information on this initiative is provided in Part 6.

The Commonwealth also makes a contribution to areas such as the Mathematics Olympiads and the Mathematics 2000 Festival. The Olympiads provide high quality developmental opportunities for senior secondary students and facilitate the selection of students to compete in international competitions. The Mathematics 2000 Festival at The University of Melbourne aimed to promote and increase awareness of the importance of mathematics in society and to provide teachers with a range of up-to-date applications to enrich their teaching during World Mathematical Year 2000. Research to support quality mathematics teaching and learning in the mathematics key learning area, as part of facilitating the development of all students' capacities and talents, will form part of the Commonwealth's research programme.

3.3 Commonwealth Funding: Indigenous Education Strategic Initiatives Programme (IESIP)

IESIP is one of the Commonwealth's principal supplementary funding programmes targeted specifically at addressing the educational disadvantage of Australia's Indigenous people. IESIP supplements mainstream Commonwealth, State and Territory education funding and is provided through the *Indigenous Education (Supplementary Assistance) Act 1989*. In 1999/2000 the Commonwealth has allocated \$139.6 million.

All recipients of IESIP funding must report annually to the Commonwealth on their Indigenous education outcomes. Performance indicators have been developed, with targets mutually agreed between the Commonwealth and each recipient of IESIP funding, to measure progress in the areas identified by MCEETYA in 1995 as national priorities. The priority areas include literacy and numeracy, and education providers report annually on baseline levels of performance and progress towards meeting targets established for the remainder of the IESIP funding triennium.

3.4 Conclusion

The Commonwealth supplements the funding of Australian schools to achieve national objectives in schooling, complementing the funding provided by State and Territory governments. To support enhanced educational outcomes in schools, the Commonwealth makes a significant financial contribution to schools through its general recurrent, capital and other specific purpose programmes. A significant part of this funding is provided through the Literacy and Numeracy Programme. From 2000, a coordinated Commonwealth initiative will focus on research and development to support enhanced numeracy outcomes.

4. The Contextual Framework For the National Literacy and Numeracy Plan

This part of the paper looks more closely at areas of particular focus under the National Plan. These include the importance of support for numeracy in the primary years, the nature and role of national benchmarks and the vital importance of professional development for teachers. The importance of maintaining and enhancing numeracy as students move into secondary schooling is also noted.

4.1 Numeracy in the Early Years

The National Plan recognises the vital importance of learning in the early childhood years in laying the foundations for later achievement. It aims to give all children a good start in school. The early years usually refer to the period of life from birth to eight years of age. This is a period when rapid development and learning take place (Raban, 1995).

In Australia, responsibility for pre-school provision rests with States and Territories, although through the *Indigenous Education (Supplementary Assistance) Act 1989* the Commonwealth provides supplementary funding to eligible providers for Indigenous students attending pre-schools. Programmes designed to foster the development of children's skills prior to entering school have been introduced in the States and Territories.

Numeracy learning in the early years provides crucial preparation for successful schooling and adult learning. Young-Loveridge (1993) notes that levels of achievement in mathematics are relatively stable over the primary and secondary years. Children who enter school well prepared tend to stay ahead throughout the school years, while those who are less prepared remain behind. Efforts to address this gap early in schooling are important for a significant group of students whose later development may otherwise be detrimentally affected. The work of Young-Loveridge (1993) and others including Wright et al (1996) and Pearn (1998b), indicates that early numeracy programmes can be effective in providing a head start for such students.

Children start school showing great diversity socially, culturally, emotionally and in their expectations (Hill et al, 1998). Before children arrive at school, much learning of numeracy has occurred, often on an informal or incidental basis. To be effective, early numeracy programmes need to recognise this diversity and build on it. Hill et al argue that it is important for 'teachers in the first years of school to understand the different experiences, attitudes, stumbling blocks, physical abilities, fears and talents children bring to school with them' (1998: 12) to ensure the development of a curriculum which addresses cultural differences in knowledge and a variety of teaching approaches where all children can participate and make use of new knowledge.

Perry (1999) notes several key principles underlying young children's learning which have been established through work in the United Kingdom (Ball, 1994), the United States (Bredenkamp & Copple, 1997) and in Australia (Dockett, 1995).

Some of these principles (Perry, 1999) relate to children's development and their own and others' expectations of their capabilities. Early learning is seen as very important, in itself and for the future. Children develop at varying rates but in a relatively orderly sequence, with later learning building on abilities, skills and knowledge acquired in the early years. The principles indicate that all children are able

to learn and need to see themselves and be seen as competent learners. Children need to be challenged to learn just beyond their existing level of mastery and given opportunities to practise newly gained skills.

Other principles relate to the varied contexts of children's lives. Children learn actively, constructing understandings of their world from physical and social experiences as well as from culturally transmitted knowledge. Children learn from play, conversation and social interaction with adults and other children. Partnerships between parents and teachers and the development of connections between home and school environments are important factors in children's learning. These are important principles which can inform understandings about effective numeracy teaching and learning in the crucial early years.

4.2 Identification and Intervention in the Early Years of Schooling

Early identification

The National Plan acknowledges the need for students to be assessed by their teachers early in their schooling, in order to identify those students who may be at risk of not making adequate progress in numeracy.

Teachers in the early years use a range of effective approaches to plan and implement their classroom programmes and to monitor student progress. Increasingly, as the National Plan is implemented, there are programmes operating at a State and Territory and school level that integrate early identification and focused learning assistance. A variety of identification processes is used, including assessment against developmental continua or learning sequences. Some procedures are intended for use with all students, others are used to obtain detailed information about students experiencing difficulties.

The Commonwealth funded project *Assessing Literacy and Numeracy in the Early Years of Schooling* (Curriculum Corporation, 1999) provides information to assist schools, teachers and education authorities to select early assessment tools consistent with their numeracy policies. The project report describes the wide range of approaches to entry assessment evident in schools in the States and Territories. Following the examination of both national and international assessment approaches the report recommends some suitable materials for use in schools and systems around Australia.

ACER has commenced a Longitudinal Literacy and Numeracy Study (LLANS) involving a national sample of children who started school in 1999. Part of this work involves the development of numeracy assessment materials for children in the early years of school. Typically, the kinds of assessment processes identified by the *Assessing Literacy and Numeracy in the Early Years of Schooling* project and those being developed by LLANS involve teachers working with individuals or small groups using specific assessment tasks and/or teachers' observations of students undertaking everyday mathematical activity.

Through assessing their numeracy skills early in students' school careers, teachers can assist children in their learning before difficulties are experienced, preventing the low self esteem that can often result from school failure (Young-Loveridge, 1993).

Early intervention

The National Plan not only stresses the importance of identification but also 'intervention' as early as possible, to ensure that all children are able to make satisfactory progress.

While noting the different starting points of children in the early years of school, it is essential to avoid perspectives which confuse difference with deficit. The terms ‘at risk’ and ‘intervention’ imply an expectation that all children are capable of experiencing success in learning when effective support is provided where it is most needed. Effective intervention implies effective teaching, focused on meeting all students’ learning needs, drawing on students’ interest in mathematical ideas, challenging them and fostering their confidence. For some students, specific attention is needed and this can involve a range of teaching approaches.

The importance of early assistance in numeracy has been highlighted both internationally and in Australia. In the United Kingdom the final report of the Numeracy Task Force (1998) made recommendations for focused numeracy teaching in primary schools, drawing on aspects of the National Numeracy Project. Focused and daily mathematics teaching for all pupils, professional development and school and local support frameworks are part of the overall strategy (DfEE, 1998).

Some significant research-based numeracy intervention programmes have been developed by researchers in Australia and provide foundation work in this area. The Mathematics Recovery programme developed and implemented by Wright, drawing on international research, is a one to one withdrawal programme for at risk students (Wright, 1992). Evaluations have indicated its effectiveness (Wright, Stanger, Cowper & Dyson, 1996) and its potential in terms of whole class teaching programmes, and the work has been adopted both nationally and internationally.

The *Mathematics Intervention* programme is used in some schools in Victoria and is underpinned by similar research bases to *Mathematics Recovery* (Pearn, 1998a; Pearn, Hunting, Merrifield & Mihalic, 1997). Teachers in Years 1 or 2 use a clinical interview to assess the child’s mathematical understandings and work with small groups of children of similar ability, observing and interpreting the child’s actions as he/she works on a set task. Evaluation shows the programme is effective (Pearn, 1998b) but a small group of participating students appears to require further intervention in later primary years, as is the case with literacy intervention programmes.

In the context of Australia’s federal system, the National Plan provides a significant impetus to a number of initiatives and programmes developed in recent years, aimed at developing sound foundations in mathematical understandings and numeracy in the early years of school. Government and non-government education authorities in the States and Territories have or are developing or refining a growing range of strategies for supporting and strengthening numeracy in the early years. The following programmes are illustrative of the important ongoing work in this area in the States and Territories.

Count Me In Too (CMIT) commenced in New South Wales government schools in 1996 and expanded to involve over 300 schools and 15,000 students in 1999. It is research-based, drawing on national and international research, and supplementing the theory and methods of Mathematics Recovery. The programme is being expanded to include measurement and space as well as number. CMIT enhances teachers’ assessment strategies used in the early years of schooling and strategies to improve mathematics performance. Professional development in CMIT schools is important and includes a focus on children’s solution strategies, reasoning, reflection, problem solving and conceptual understandings. Children are challenged to move forward with appropriate support. CMIT has been successful in improving students’ outcomes (Bobis & Gould, 1999) and other education systems have drawn on the programme. The ACT

Department of Education and Community Services (DECS) trialled aspects of CMIT in 1999. ACT DECS has also entered into a collaborative research/professional development project with the University of Tasmania. The project involves Years K to 6 in several schools, and focuses on mental computation strategies and the issues around student talk in the learning of mathematics.

In Victoria, the Department of Education, Employment and Training's *Early Years* strategy for government schools includes the development of the Victorian *Early Years Numeracy Program* which aims to provide an effective whole school approach for enhancing students' mathematics learning in Years Prep to 4. The *Early Years Numeracy Program* will be informed by the *Early Numeracy Research Project* which commenced in 1999. This project is examining strategies in mathematics teaching and learning in the first three years of schooling that can lead to significant improvements in students' numeracy. These strategies relate to classroom structure, ongoing assessment, a framework of developmental stages, leadership and coordination, parent participation and professional development.

The *First Steps in Mathematics* programme is being developed by the Education Department of Western Australia to improve the mathematics outcomes of primary school students, particularly students at risk of not achieving their potential, by improving primary teachers' understandings of teaching and learning mathematics within a developmental framework. In Tasmania, the *Flying Start* programme, which commenced in 1997, includes a focus on numeracy development in the early years. While the programme is designed to assist all students, it also targets individual students through an explicit cycle of assessment, planning, intervening, monitoring, recording and reporting. The Tasmanian Department of Education is also investigating the appropriateness of CMIT in the Tasmanian context.

The numeracy initiative of the Victorian Catholic Education Commission has been developed to reflect on current numeracy provision and to support implementation of the National Plan. In 1998 phase one of the initiative focused on curriculum leadership and action research in key areas of numeracy, including assessment and intervention; phase two of the initiative builds on the findings of this research by developing a set of professional development modules and training school-based numeracy focus teachers. The South Australian Commission for Catholic Schools is implementing a range of numeracy projects with a focus on action research as well as research of current literature. An *Early Years Assessment Project* is exploring and identifying the range of students' numeracy development in their first years of schooling and developing an early assessment strategy, including an assessment tool.

Such examples of education authorities' and schools' work are illustrative and by no means exhaustive. Whether the programmes implemented to build sound foundations involve one to one teaching or in-class strategies to address the needs of all students, some key features include a research basis, assessment procedures informing teaching and learning, and a consideration of the importance of success, confidence and motivation in student learning. Professional development and teachers' understandings of students' learning strategies are integral to the implementation of these programmes. It is important that evidence of the effectiveness of such programmes continues to be gathered and demonstrated, to support further successes. It is expected that further development will occur in this key programme area as education systems and schools continue work to implement the National Plan.

There are continuing and significant hurdles as students develop mathematical concepts and skills at school. In addition to ongoing quality teaching which caters to the full range of student abilities and

which builds on a sound base, some children will need further intensive support at key learning points. Commonwealth Literacy and Numeracy Programme funding extends through the early years in primary schooling and from 2000 it includes an increased focus on the middle years. This is discussed further at 4.5 below.

4.3 National Benchmarks

The role and nature of the benchmarks

The National Plan recognises the importance of measuring progress towards the achievement of the national goal – particularly ensuring that all students attain at least the minimum level of numeracy they need to make progress at school. National benchmarks reflect the equity intentions of the National Plan.

State, Territory and Commonwealth Education Ministers agreed, as part of the National Plan, to develop national benchmarks to be used for reporting on literacy and numeracy performance in support of the national literacy and numeracy goal. They have agreed that benchmark standards for this purpose for Years 3, 5 and 7 should articulate nationally agreed minimum acceptable standards in literacy or numeracy.

Numeracy benchmarks for Years 3, 5 and 7 have been approved by all Ministers for Education. The benchmarks will be used to enable States and Territories to report nationally comparable aggregated student performance data against the common standards to the Australian community. This information will be published in MCEETYA's annual *National Report on Schooling in Australia*.

The numeracy benchmarks for Years 3, 5 and 7 are summaries of student performance at the minimum level, written so as to be understood by the general community. The benchmarks do not attempt to describe the whole of numeracy learning. In particular, they are quite distinct from curriculum statements setting out what students will be taught, and they do not seek to reflect the full range of student achievement. Instead, they represent important and essential elements of numeracy at a minimum acceptable level.

In using a minimum acceptable benchmark level for reporting to the Australian community in the context of the National Plan, Ministers have agreed to report progress in ensuring that all children attain 'a minimum acceptable literacy and numeracy standard' It is vital that education authorities and schools give first priority to ensuring that all students attain at least this level, the level of literacy and numeracy required to make progress in their schooling. That said, the wider context of continuing work in schools and classrooms remains crucial. Education authorities, schools and teachers have ongoing and vital responsibilities in their professional implementation of the State, Territory or local mathematics or numeracy curriculum. Essential features of this work include challenging all students to achieve to their capacity through high expectations, catering to the full range of student abilities and fostering excellence in achievement.

The numeracy benchmarks for Years 3, 5 and 7 incorporate aspects of students' developing understanding of and competence with number and quantity (i.e. measurement), shape and location, and the handling and interpretation of quantitative data. The benchmarks are organised into three strands (Number Sense, Measurement and Data Sense and Spatial Sense).

Professional elaborations have also been developed to amplify the benchmarks. These provide more detailed descriptions of student performance at the minimum standard, for use by those within the profession, for example when preparing assessment materials. To help clarify and illustrate each standard, the descriptions of student performance are supported by student work samples and other materials, showing performance at the minimum standard.

Agreed development of the benchmarks

The benchmarks for Years 3, 5 and 7 were developed under the authority of a Benchmarking Taskforce, comprising nominees of State, Territory and Commonwealth Ministers, the National Catholic Education Commission, the National Council of Independent Schools' Associations and Curriculum Corporation. The Corporation has also had carriage of the development work.

The setting of the numeracy benchmarks has been assisted by reference to empirical data on student performance (as demonstrated in the Third International Mathematics and Science Study and in State and Territory assessment programmes), curriculum frameworks in each State and Territory, and professional judgement about appropriate and necessary standards. Similar work from overseas has also been consulted.

Consultation has taken place on successive drafts of the numeracy benchmarks. Groups with significant involvement include State and Territory curriculum and assessment authorities, the Commonwealth, the Catholic and independent sectors, independent curriculum and assessment experts (including academics), teacher professional associations and parent organisations.

Implementation of the benchmarks

Australian Education Ministers have agreed that data will be reported in relation to the attainment or non-attainment of the minimum acceptable standard. They have also agreed that information to enable national reporting against benchmarks will be gathered by rigorous State-based assessment procedures. School authorities are working through an agreed national process to locate the benchmark on the different tests, to enable nationally comparable reporting of aggregated performance data by States and Territories.

Education authorities are expected to report nationally comparable data against the Years 3 and 5 benchmarks in 2001 based on 2000 outcomes, and to commence reporting of Year 7 results in 2002 based on 2001 outcomes. Ministers have also agreed that benchmarking for Year 9 or 10 will be postponed, pending information from the OECD PISA project, which involves the collection of data in 2000 on the achievement in mathematics, science and reading of a sample group of 15 year-olds from Australia and other countries.

In Australia, State and Territory government and non-government education authorities and schools have the responsibility for reporting to individual students' parents or guardians on their child's achievement at school. Parents seek as much information as possible about their child's progress (Cuttance, 2000). Parents also expect that their child should be challenged to achieve to his or her full potential. In this context, the work of education authorities, schools and teachers in reporting to parents is vital, with schools continuing to provide full and rich information to parents on their child's achievement in relation to the full range of the curriculum and in terms of the full range of student performance.

Accountability to the Australian community

The public has a significant investment in education and has a right to know that education systems are delivering key outcomes. Systematic assessment and reporting is the feature of the National Plan which provides an accountability framework for reporting on student learning outcomes and public expenditure on education. Within this framework, the community is able to receive objective information about student performance in relation to common standards. The Government believes that the dissemination of information about educational outcomes is central to building parental and community support for schools. Without this, there cannot be full community and parent recognition of the important role of schools. Public accountability by education systems also acts as a significant incentive for improving educational programmes.

In summary, reporting student performance against agreed benchmarks represents an important step forward in national accountability to the Australian community for student outcomes and achieving the national literacy and numeracy goal.

4.4 Professional Development and Teacher Education

The National Plan recognises the key role of professional development in supporting teachers to enhance the numeracy outcomes of all students. Primary teachers and teachers of mathematics have prime responsibilities in developing their students' numeracy skills. In addition, other teachers can contribute, at different levels of schooling and in different curriculum areas, to the development of students' literacy and numeracy skills.

Professional development

Teachers' beliefs, knowledge, understandings and skills are critical factors in students' numeracy development. Professional development which builds on teachers' current knowledge and understandings, which draws on sound research and which provides professional support for teachers' work in their own classrooms is an important means for teachers to gain further skills and confidence to enhance students' numeracy.

The primary responsibility for implementing professional development programmes in support of the National Plan lies with State and Territory government and non-government education authorities and schools. These programmes have a diverse range of applications including collaboration between universities and education authorities or individual schools and professional associations and liaison between district consultants and classroom teachers. While the nature of the support offered to teachers to support improved numeracy outcomes varies greatly in type and scope across States, sectors and schools, these professional development initiatives indicate the increasing national focus on numeracy.

A national survey of primary school principals was undertaken in 1998 by The University of Melbourne in conjunction with the Australian Primary Principals Association (APPA & CAER, 1998). The findings of the survey indicated that principals saw a strong link between student progress and professional development. They considered that increased access for teachers to appropriate professional development was one of the most positive actions that could be taken to ensure that numeracy is given priority within the school curriculum.

In 1997 the Commonwealth provided grants for additional support to education authorities over three years to conduct strategic professional development activities for primary teachers in support of the National Plan. Activities and strategies under the initiative have been committed to effective practice, comprehensiveness and innovation.

Examples of numeracy work under this initiative have included the involvement of all education authorities in Queensland in the project *Supporting Literacy and Numeracy in Queensland Schools*. The project has augmented the existing *Year 2 Diagnostic Net* materials developed for Reading, Writing and Number and provides complementary early intervention materials. An intervention resource, *Support a Maths Learner: Number*, has been developed to support students with numeracy difficulties; the project has developed the resource *Common Learning Sequences in Space, Measurement and Data*, which facilitates monitoring children's learning and development. In South Australia the cross sectoral project *National Literacy Programme: Literacy and Numeracy Professional Development* has assisted Reception to Year 5 teachers to extend their repertoire of assessment techniques, to adapt teaching strategies to be more responsive to students' identified needs and abilities, and to focus on links between assessment and teaching. Linking with this project, the Department of Education, Training and Employment in South Australia has introduced a school entry assessment programme which assesses numeracy and literacy in students' first term at school.

Quality Teacher Programme

From 2000, the Commonwealth Government is providing funding for a Quality Teacher Programme. The programme is designed to help update and improve teachers' skills and help lift the status of the teaching profession in both government and non-government schools. Focus areas include numeracy and mathematics teaching in both primary and secondary schools. Further information on the initiative is provided in Part 6. The initiative recognises the importance of teachers having opportunities to access professional development, as education authorities and schools place increasing emphasis on students' numeracy outcomes as part of their outcomes based educational frameworks and as part of the National Plan.

Teacher education

It is important that considerable support for improving students' literacy and numeracy outcomes emerges through pre-service and inservice teacher education. Teacher education courses should include an emphasis on the relationship between numeracy and success in a range of learning areas and on the importance and value of developing students' numeracy, to enhance their life opportunities and participation in work and in society.

Primary teachers and, as children move into secondary school, teachers of mathematics require sound understandings and appreciations in mathematics and a sound understanding of how students learn, including children's thinking and their learning stages. They require an understanding of the key conceptual foundations children need for further learning, as well as a good understanding of effective teaching practices. Current initiatives to prepare effective teachers in this area include an emphasis on critically reflective practice, encouraging pre-service teachers to examine their own beliefs and attitudes about mathematics, and to acquire the skills to access and develop research-based knowledge (Bobis,

1999). Close links between universities and schools are also important if preservice courses are to be responsive to the needs of systems and schools.

MCEETYA has established mechanisms to monitor teacher supply and demand and to advise on teacher preparation and recruitment. The Council has agreed to consider reports on teacher supply and demand on a biennial basis. The first of these reports was prepared by a working group of the Council of Education Systems Chief Executive Officers (CESCEO) in 1998 and presented to MCEETYA. A second report is being drawn up in 2000. The former MCEETYA Teacher Recruitment Taskforce has completed its task and developed materials that can be used by individual jurisdictions to address specific recruitment needs. A new MCEETYA Teacher Preparation and Recruitment Taskforce has now been established and will provide advice to Ministers on issues such as teacher preparation, retraining, recruitment and professional standards.

4.5 Maintaining and Enhancing Numeracy

The National Plan acknowledges that while establishing the foundations for numeracy is important in the early years of schooling, there are continuing challenges for students in terms of the mathematical knowledge, skills, understanding and appreciation required, and in terms of the conceptual transitions students are required to make as they progress. Maintaining and enhancing numeracy also enables students to deal with the increasingly complex numeracy demands of the curriculum and provides an important foundation for their lifelong learning.

Numeracy programmes in the early years increasingly reflect the application of research in children's learning of mathematical understandings and concepts to teaching and learning practice. Similar work to assist teachers to apply the existing research about mathematics learning in the later primary years will also play a role in improving numeracy outcomes in these years. After the early years, additional and focused support is important for students who may experience difficulties.

Changes in retention rates towards the end of schooling in recent years are reflected in the changing composition of school populations. There is a broader range of capabilities and interests among students. A range of courses in the compulsory years to enhance numeracy is needed to recognise this diversity of students in secondary schools and students' different needs and interests as they prepare for a range of initial post-schooling paths. Teaching approaches which emphasise maintaining interest, confidence and a positive orientation to mathematics learning provide an environment where numeracy is most likely to flourish.

An increased emphasis on numeracy across curriculum areas may also assist in enhancing students' numeracy after the early years. Whilst teachers of mathematics have prime responsibilities in developing students' numeracy, there are numeracy demands in many curriculum areas in secondary schools and teachers in those areas can play a significant role in fostering students' numeracy (AAMT, 1997). Cross-curricular approaches and practices may also be a valuable element in enabling students to view mathematical knowledge and understanding as worthwhile and relevant to their lives.

The middle years

The 'middle years' of schooling are usually seen to include Years 5 to 8 plus and it is increasingly recognised that these years present important challenges for schools. Transition from primary to

secondary schooling raises important issues in terms of schools ensuring that students' existing attainments are recognised and effectively built upon. There is evidence that some students' learning at school in these years can plateau or even decline and that enjoyment of school can also decline (Hill & Russell, 1999; Barber, 1999). A number of studies, including that of the Australian Curriculum Studies Association (ACSA, 1996), indicate that many students can lose motivation and become disengaged from learning in these years. The ACSA study recommended greater cooperation and links between the early and later years of schooling in the implementation of middle school programmes.

As part of a broad framework for reform in the middle years and in terms of learning outcomes generally, Hill & Russell (1999) suggest that the middle years require more emphasis on student centred approaches to teaching and learning, with clear specification of core content needed by students. They suggest making time for in-depth learning, having a curriculum which emphasises thinking, problem solving and autonomous learning, and challenging individual students.

The Commonwealth Government is concerned that all students' numeracy development be supported effectively in the middle years. A range of courses, programmes and teaching approaches which challenge all students and which recognise and develop individual strengths are important. Also crucial within efforts to address the range of issues in these years are continuing efforts to ensure that all students attain the sound understandings and skills they require to deal with numeracy demands across curriculum areas.

In 1999, the Commonwealth Government announced funding to support innovative and nationally significant initiatives in literacy and numeracy for students in the middle years. Details of this initiative are in Part 6.

Programmes for the middle years of schooling in numeracy have also received increased focus under the National Plan through programmes such as the Commonwealth funded Secondary School Literacy and Numeracy Initiative. \$5 million over three years from the Quality Outcomes Programme is being provided to government and non-government education authorities. Cross-sectoral projects are focusing on improving the development of literacy and numeracy for low achieving secondary school students. Projects commenced in mid 1998 and will be completed by the end of 2000.

Under this initiative, numeracy projects include the *Junior Secondary Numeracy Project* in South Australia. This project engages teachers in school based action research and documents learning through case studies, with each school developing structures to support numeracy learning across all learning areas. In particular the project focuses on strategies to improve learning for low achievers. The Education Department of Western Australia's *Transition Numeracy Project* provides professional development to assist teachers to identify students at risk at the primary/secondary interface and to plan appropriate intervention strategies. In Tasmania, authorities have collaborated on the project *Planning and Teaching for Numeracy in Years 7 to 9* to identify teaching strategies and develop support material to supplement the existing mathematics programme in Tasmanian schools. The project is also developing identification and assessment strategies for students at risk and strategies to support numeracy programme leaders in schools. In Queensland, literacy and numeracy intervention resources and associated professional development are being developed.

4.6 Implementation of Numeracy Initiatives

The aim of the national survey of primary school principals referred to in Part 4.4 was to determine the place of literacy and numeracy in the primary school curriculum, looking at trends over the three years 1996–1998 (APPA & CAER, 1998). The survey results established that over the three years, in response to pressures from parents, school systems and the wider community, schools have sought both to broaden the curriculum and to place a greater emphasis on literacy and numeracy. The study found a high level of commitment to enhancing intervention programmes and special assistance for at risk students. The greatest curriculum changes over the past three years have been an increased emphasis on literacy, especially in the early years, followed by an emphasis on the use of computers and technology in the classroom. The survey established that there has been a degree of ‘overcrowding’ of the curriculum, but that this has not adversely affected the time or importance attached to literacy or numeracy. It also indicated that the major emphasis of schools to date has been on literacy, especially early literacy, rather than on numeracy.

With implementation of the National Plan well under way and with many literacy initiatives firmly established, it is expected that increasing attention will be devoted in schools to numeracy as well as to literacy. A number of numeracy initiatives are undergoing development and trialing, with implementation expected after these stages. The approval of numeracy benchmarks for Years 3, 5 and 7, the commitment of Education Ministers to reporting outcomes to the community, the increasing emphasis on teacher professional development and the Commonwealth’s Numeracy Research and Development Initiative are expected to give a further impetus to programmes to improve students’ numeracy outcomes.

4.7 Conclusion

Many factors will contribute to achieving quality educational outcomes for all students. Students’ literacy and numeracy learning is central to this. Efforts to strengthen numeracy teaching and learning in the primary school years, to strengthen public accountability for student outcomes and to enhance professional development for teachers are key factors. A continuing focus on enhancing numeracy as students move into the middle years of schooling is also critical. Many initiatives at State, Territory and Commonwealth levels are building on existing programmes and contributing in different and complementary ways to this work. Further work in support of the National Plan will be vital in achieving the national literacy and numeracy goal.

5. Aspects of Effective Numeracy Education

The National Plan focuses on improving students' numeracy outcomes and therefore provides an impetus for the implementation of effective programmes and practice at both the system and school level.

Many aspects of numeracy education will be important in achieving the best possible educational outcomes for all students. This section examines some key areas which are of interest nationally in the improvement of students' numeracy outcomes in the future. These include teaching practices for effective learning; using technology to enhance numeracy learning; home, school and community partnerships; and addressing the needs of diverse groups of students. Research relating to effective mathematics learning provides valuable insights for educators seeking to improve students' numeracy, as sound and flexible mathematical understandings underpin students' confidence and capacity to effectively apply their learning.

5.1 Effective Teaching and Learning for Numeracy

Effective teaching for numeracy is a complex task. There is a wide range of approaches to enhancing numeracy teaching and learning which can inform thinking and future work to improve student numeracy outcomes in Australia; some recent developments are outlined here.

School effectiveness

Whole-school design approaches are increasingly a focus in the United States in programmes which aim to reform school education to achieve improved educational outcomes. Such approaches have also contributed to the United Kingdom's national literacy and numeracy strategies, which include a range of integrated elements to support school improvement. Whole school design approaches draw on a combination of discipline based knowledge and knowledge about improving key elements of schools.

Hill (1999) argues that the whole-school design approach which characterised the Victorian Department of Education's *Early Literacy Research Project* (ELRP), and which he indicates has been successful in terms of improving early literacy outcomes, can help inform efforts to enhance students' numeracy.

Central to the ELRP approach are teachers' beliefs and understandings about teaching and learning, with teachers critically reflecting on their practice. High expectations of student achievement are reflected in explicit standards, and assessment information is used to determine whether standards have been met and to ensure that students are working at an appropriate and challenging level of difficulty. Teachers are assisted in developing a deep understanding of what constitutes good practice, focusing on the learning needs of each student in the class. Whole class and small group instruction are elements of classroom management, with the most at-risk students receiving extra time and support. A crucial aspect of the approach involves support for teachers through ongoing whole-school professional development and strong leadership from principals and curriculum coordinators. Home, school and community partnerships are fostered, and the design draws on volunteers assisting in classrooms (Hill, 1999).

The Victorian Department of Education's *Early Numeracy Research Project* commenced in 1999 and is paralleling the work of the ELRP in examining the effectiveness of the design approach for numeracy in the early years. This three year project has the potential to provide useful information for numeracy educators in Australia.

Effective teachers

A recent UK report provides valuable perspectives on aspects of effective teaching to develop students' numeracy in the primary years. *Effective Teachers of Numeracy (ETN)* (Askew et al, 1997) contains broad findings which have relevance for Australian schools.

The ETN study examined characteristics of 'highly effective' teachers, defined in terms of their students' relatively high average gains in numeracy, and found that these teachers had a particular set of coherent beliefs and understandings which underpinned their teaching. The highly effective teachers believed that almost all students can achieve in numeracy and that being numerate requires a rich network of connections between different mathematical ideas. They saw class discussion as an important factor in developing the 'connections' students need and intervened to assist them to work more efficiently. They used strategies which challenged all students, built upon students' existing mental strategies and encouraged purposeful discussion in whole classes, small groups and with individuals, expecting students to explain, listen and solve problems. The teachers were more likely to have undertaken extensive discipline based professional development (Askew et al, 1997). Common threads can be seen in the importance of teacher beliefs, understandings and classroom strategies in this study and in the ELRP model described above.

Effective classroom practice

The final report of the UK's Numeracy Task Force (DfEE, 1998) draws on work in the National Numeracy Project. One of the many strategies recommended in primary schools involves a classroom framework emphasising whole class teaching supported by various groupings working on tasks or problems. The report proposes that teaching should include instruction which illustrates and sets work in different contexts, as well as maximising opportunities for pupils to talk and be listened to, to receive feedback, to explain their knowledge, thinking and methods and to suggest alternative ways of tackling problems. The report also states the importance of teachers using their professional judgement to determine the activities, timing and organisation of lessons to suit their teaching objectives (DfEE, 1998).

Some common threads can also be seen between aspects of effective teaching practice in mathematics proposed in the UK report and seen in the ETN study, and types of instruction seen in some Japanese classrooms, of interest given that country's high performance in the TIMSS. A video study of teaching practices in some United States, German and Japanese eighth grade mathematics classrooms, as part of the TIMSS, found that the Japanese lessons studied combined a relatively high level of teacher directed instruction with a small number of carefully constructed tasks for students. Challenging content, a focus on thinking and problem solving, and an emphasis on students developing alternative solution methods and sharing their thinking were important features of the classrooms. In contrast, the more usual methods of instruction in the United States classrooms revolved around individual students practising procedures and skills which were taught comparatively briefly at the start of the lesson (Stigler & Hiebert, 1997).

Two complementary studies using video recording of classroom practices are currently being undertaken. With funding from Commonwealth, State and Territory and United States governments, Australia is participating in the TIMSS-Repeat Video Study. This study is recording, examining and comparing the interactions of students and teachers in Year 8 mathematics and science classrooms across 100 schools in

each of seven countries, in order to assess the relationship between teaching practice and student performance. The ACER is conducting the Australian part of the study and reports of the study are expected to be released in late 2002. The Australian Research Council is providing funding for a smaller video study of the classroom practices of four countries from the perspective of the student learners. Both studies are likely to provide valuable guidance about effective teaching for Australian educators.

Studies such as those noted above can provide valuable perspectives on effective teaching and learning practices to develop students' mathematical understandings and can inform further efforts to improve students' numeracy.

Numeracy across the curriculum

Timetabling to ensure that the learning of mathematics receives appropriate time and emphasis in schools does not preclude efforts to additionally enhance students' numeracy development through learning across the curriculum. Research suggests that numeracy demands occur in all phases of schooling, across learning areas and on a regular basis. These situations include opportunities for teachers to enhance students' numeracy by encouraging them to access and appreciate the value of their mathematical ideas and techniques in their learning across the curriculum. Where such strategies are used after the primary years, liaison with teachers of mathematics is a key part of this work to promote congruence between methods and learnings.

Projects to foster numeracy teaching and learning across the curriculum include the Northern Territory's system-wide project, *Numeracy in Schools*, and the South Australian Department of Education, Training and Employment's numeracy professional development pack, *Making the Links Numeracy – R-3*. Murdoch University and the Education Department of Western Australia (EDWA) are undertaking a project, *Numeracy Across the Curriculum*, with Commonwealth funding through the Australian Research Council and funding from the EDWA. This work is developing a model to assist both primary and secondary schools wishing to adopt a cross-curricular approach to numeracy learning including strategies to collect information, to develop skills in recognising numeracy demands in their classrooms and for developing their students' numeracy (Hogan & Kemp, 1999). With similar funding, Curtin University and the EDWA have recently concluded a three year study on the integration of mathematics, science and technology during the middle years of schooling (Venville et al, 1999). The study's report suggests the value of enhancing numeracy through integration with other curriculum areas, and provides case studies of successful practice in Years 6 to 9.

A Commonwealth funded project investigated the literacy demands of the curriculum in post-compulsory schooling and noted the value of this type of research for numeracy (Cumming, Wyatt-Smith, Ryan & Doig, 1998). It will be important, as work progresses in this developing area, to support enhanced teacher awareness of the numeracy demands and possibilities across curriculum areas, and to foster teachers' confidence and capacity to address these more explicitly.

Assessment

Another important and integral aspect of effective numeracy teaching and learning is effective monitoring and assessment of student achievement. The broad aim of assessment is to contribute to the improvement of student learning and outcomes, whether at the system level or more directly at the classroom level.

As Lokan et al (1999) indicate, there is a continuum of purposes and needs for assessment, and different assessment forms and approaches are appropriately used to meet these needs. For example, state-wide assessments may be used for a number of purposes including national or State reporting to the community on whole-cohort student numeracy achievement. Other forms of assessment involving smaller groups or individuals also play a key role in assisting teachers to identify students' strengths and weaknesses, and help ensure that all students' numeracy development remains on track.

Effective assessment by teachers at the classroom level is an integral part of a number of early years numeracy programmes, as discussed in Part 4, which include strategies and models such as observations and clinical interviews. A range of rich classroom assessment practices can also play a significant role in the subsequent years of schooling, particularly in assisting students experiencing difficulties in mathematics learning. Such practices assist teachers to establish what students know and to use this information to develop appropriate classroom programmes in order to meet the needs of the full range of students.

The range of assessment procedures used by teachers reflects State and Territory education authorities' and schools' curriculum emphases and local needs. Assessment which is linked to learning frameworks can assist teaching to be focused on students' development needs. Local numeracy programmes and learning targets for students can inform the effective use of such assessments. Opportunities also exist at classroom level for the inclusion of varied assessment approaches and tasks, such as more practical or 'hands-on' tasks and more tasks linked closely to the knowledge and experience of individual students from various backgrounds, including Indigenous students. For Indigenous students, such approaches and tasks may be linked to students' capacity to demonstrate competence in mathematical concepts in their first language.

The communication of mathematical ideas is an important numeracy goal. Assessment practice needs to take into account equity issues, including issues for students with English as a second language. Some research suggests that forms of assessment such as extended projects and portfolios of work, can lead to greater inequities for disadvantaged students. However, analysis undertaken of student background and results on the different types of TIMSS tasks, including multiple choice, short answer, extended response and practical tasks suggested that this appeared not to be the case with TIMSS results (Lokan et al, 1999). Nevertheless, cautions regarding equity must always be kept in mind in assessment design (Lokan et al, 1999).

Information technologies also provide scope for expanding the styles and means available for assessment at system and school levels in ways that are yet to be fully explored, particularly in terms of potential to assist assessment approaches emphasising the application of mathematical knowledge and understandings.

As the national priority for students' numeracy continues to be implemented in Australia, further research and development in the area of effective teaching and learning practices will be important. Professional development to support teachers' confidence and skills to effectively apply such understandings is also a key part of developing and improving students' numeracy. Each of these areas is an identified priority area for research and development under the Government's Numeracy Research and Development Initiative.

Numeracy learning and technology

The interactions between technology and numeracy learning are complex. Technology is continually impacting on society and work and on the ways learning can be achieved. With much information now presented in tabular and visual forms, the technological world is increasingly visual and oral (Cumming, 1999). The development of students' numeracy will play a significant role in preparing them for this world and engaging effectively with it.

A range of technological tools, including computer hardware and software, video, and electronic communications media can play a valuable role in developing students' numeracy. Technologies can potentially assist learning by providing students with new ways of examining information and undertaking learning tasks. There are opportunities for students to have more control over their learning, working independently at their own pace and developing confidence.

Research in Australia and elsewhere indicates the role which calculators can play as a teaching aid in the early years. In reviewing relevant research and issues, Stephens (1999) suggests that effective use of calculators in the early and subsequent primary years depends on programmes and frameworks to support good teaching, for example, by affirming the importance of developing number concepts and of teaching students how to select between mental, written and calculator-based approaches. In Australia, State and Territory government and non-government education authorities have their own approaches and policies in relation to the use of calculators in early schooling. The increasing use of a range of software as students move into secondary schooling opens opportunities for greater emphasis in learning on problem solving and application of knowledge, with students engaging more immediately with mathematical concepts and investigating processes.

In recent years, Australian researchers have begun to explore the use of online resources and interaction. For example, a study of middle school students' exploration of questions with a mathematical base using internet data showed that, through working in this medium, students can be challenged to make connections between mathematical processes and the wider curriculum (Dengate & Mulligan, 1999).

In considering the opportunities offered by technologies, it needs to be remembered that software must be appropriate and that both students and teachers need to be supported to use technologies for effective learning. A key initiative in facilitating the effective use of technology is Education Network Australia (EdNA), involving the Commonwealth and education and training authorities including government and non-government schools. EdNA Online is a website (<http://www.edna.edu.au/EdNA>) which provides improved access for students and teachers to an extensive range of numeracy resources, materials and references. The site offers many features, including information on resources and access to numeracy and mathematics information sources, as well as discussion groups and collaborative projects.

The ways in which technologies relate to numeracy and can contribute to students' numeracy development need to be further explored through research. One possible model for this is provided by a Commonwealth funded project (Lankshear et al, 1997). The researchers investigated the relationship between literacy and technology as areas of learning and across the curriculum, as well as the impact of technology on the nature of literacy. The report presents a framework for education authorities, schools and teachers to work with in developing effective practices.

As the potential for effective use of technologies is increasingly recognised, equitable access to technology is important, as is professional development to support and enhance the skills of teachers in this area. It will also be important to ensure that girls are fully involved in the use of new technologies for learning. The Commonwealth's Quality Teacher Programme includes a focus on teacher skills and understanding in numeracy, mathematics and information technology as key areas for attention. Under the Government's Numeracy Research and Development Initiative, technology is also one of the identified priority areas for project work.

5.2 Home, School and Community Partnerships

There is strong research evidence to demonstrate the vital influence parents, caregivers and the community have on students' educational outcomes (Cairney et al, 1995; Delgado-Gaitan, 1991). Parents and home exert at least as strong an effect on children's educational outcomes as do schools or teachers. The inclusion of parents as partners in the educational process is crucial if students' significant experiences are to be identified and appropriate learning planned.

In the early years, parents influence and guide their children through much initial learning (Horne, 1998). The prior to school years are recognised as a period of considerable growth in all areas of learning, and this is relevant to the development of children's numeracy skills and understandings. A Commonwealth funded study, *100 Children Go To School*, looked at the prior to school year and the first year of schooling. It emphasised the importance of teachers developing a curriculum responsive to the needs of local communities. It also suggested that the curriculum in the early years should be 'seamless', bridging the historical divide between pre-school and school (Hill et al, 1998).

At the school level, comprehensive and ongoing partnerships with families and communities can assist in achieving optimum educational outcomes. *The Effects of Early Mathematics Intervention: The EMI-5s study* conducted in New Zealand provides one example of research based support for parental participation in early numeracy education (Young-Loveridge, 1993).

Research in the area of literacy indicates that communication between home and school needs to be more than a one-way transmission of school expectations to support the purposes of school. There needs to be a genuine two-way communication with parents that allows both teachers and parents to exchange and share their experiences, beliefs and values. This research has relevance for numeracy educators in establishing productive partnerships with parents in a range of social and cultural settings. Further, parental involvement in reading programmes has been found to lead to improvement in children's learning in that area. In a study of over 260 existing family and community literacy initiatives in Australia, Cairney et al (1995) confirmed the potential value of family and community involvement in children's literacy learning. It is reasonable to expect that parental involvement in numeracy may have similar effects.

The *Family Mathematics Project of Australia* (FAMPA) has developed a range of models for involving parents in mathematics learning in schools. FAMPA involves parents and their children in programmes designed to give parents a better understanding of the methods being used in the school's programme. Parental participation in FAMPA has been shown to generate significant improvements in some attitudes towards mathematics, with a positive response by most parents to the programme (Horne, 1998).

In the United Kingdom, the Basic Skills Agency conducted a pilot study of a Family Numeracy programme in 1997–1998. The aim of the pilot programme was to investigate the effectiveness of an intergenerational numeracy programme, for both parents and their children. The pilot programme focused on methods of raising the level of home support for numeracy; offering a quick-start and immediate gains in numeracy for 3–5 year-old children at risk of underattainment; and a re-start for parents' numeracy learning (NFER & The Basic Skills Agency, 1998). The evaluation of the pilot programme identified positive results for the programmes. Major findings included the statistical significance of the children's progress in both number and mathematical language, and a statistically significant increase in a wide range of numeracy related activities at home. A key feature of the programme was the provision of joint and separate sessions for both adults and children.

Improving parental dispositions towards, and knowledge of, numeracy in schools is vital as parents tend to be more confident about supporting their children's growth in literacy than they are about supporting their children's development of numeracy skills (Stephens, 1999). Long-term and multi-faceted programmes and policies are required to improve parental confidence and knowledge about mathematics learning for more lasting effects and improved outcomes (Horne, 1993; 1998). This is particularly true for parents whose first language is not English, where strategies such as translation and interpreter services, provision for family outreach programmes and working appropriately with communities need to be included in strategies for parents. Programmes should also provide opportunities for parents to share their numeracy experiences, knowledge and skills.

A range of work to promote parental involvement in, and knowledge of, students' numeracy development is occurring in education systems and schools. This includes the use of varied materials and parent-school programmes outlining activities in everyday life which can support numeracy development, focusing, for example, on concepts such as time, estimation, direction and location, as well as number facts and counting.

Horne (1998: 132) argues that 'research and common sense both indicate that parents are a factor in their children's sociocultural environment which, in turn, influences children's learning, attitudes and decision making with respect to learning.' For this reason, further exploration of effective partnerships between schools, parents and the community will be important to support students' numeracy. The Government's Numeracy Research and Development Initiative includes home, school and community partnerships as a priority area for projects to be undertaken.

5.3 Meeting Diverse Needs

Some groups of students, including Indigenous students, students whose first language is not English, and students from some socio-economic backgrounds may require special assistance to gain appropriate numeracy skills. The National Plan's focus on numeracy for all students reflects an equity focus and recognises that a range of diverse and well focused programmes are required to effectively meet the needs of all students.

Building on diversity

Numeracy development is influenced by children's different social and cultural contexts. It is important for numeracy teaching and learning to recognise the diversity of students, communities and educational settings in Australia. Students' experiences are the foundations for further learning and it is important for

teachers to observe their students' existing knowledge, skills and understandings and build upon these in inclusive ways, providing opportunities to challenge students' thinking and facilitate success for individual learners.

To ensure success for all learners, students experiencing learning difficulties in numeracy need consideration. The Commonwealth project, *Mapping the Territory – Primary Students with Learning Difficulties: Literacy and Numeracy* (Louden et al, 2000), identified several characteristics of successful programmes to ensure appropriate progress in numeracy for students with learning difficulties. The project indicated that while difficulties with numeracy have had a relatively lower priority than difficulties with literacy in Australian primary schools, support for students with numeracy difficulties was likely to increase as schools responded to the range of early numeracy and intervention programmes being implemented by various State and Territory systems.

Hill (1999) argues that teacher and school expectations of students from disadvantaged backgrounds have frequently been set too low, and that effective schools expect all students to achieve. This is reinforced by the major UK study referred to in Part 5.1 which found that effective teachers believed that almost all students could be numerate (Askew et al, 1997).

Indigenous students

The achievement of Indigenous students as reported in a number of contexts, including state-wide assessments and TIMSS, is on average lower than that of non-Indigenous students in all areas of mathematics.

A number of programmes are being developed by education authorities to assist in enhancing the numeracy achievement of Indigenous students. The Commonwealth has provided funding which contributes to the *Numeracy in Schools Project* in the Northern Territory, which, for example, at the instigation of schools, includes support for schools to develop and implement culturally inclusive numeracy programmes and focuses on improving numeracy outcomes for all. The Australian Association of Mathematics Teachers' *Indigenous Students Achieving in Numeracy* (ISAN) project was funded under the Strategic Results Projects element of the Commonwealth's Indigenous Education Strategic Initiatives Programme (IESIP) in 1998. ISAN established projects in five school communities in northern and central Australia. Results indicate that collaboration between all elements of the school community and attention to the development of students' understanding and use of the language of mathematics in English can be very effective in achieving numeracy gains.

The literacy and numeracy achievement of Indigenous students is now a particular focus in the Commonwealth's Literacy and Numeracy Programme. A National Indigenous English Literacy and Numeracy Strategy has also been established. The Strategy provides additional support for the National Plan and the national goals in this crucial area. Further information on the Strategy appears in Part 6 of this paper.

Teaching and learning for ESL (English as a Second Language) learners and bilingual students

Students whose first language is not English represent a significant, heterogenous group within the total Australian school population. The National Plan, in providing the impetus for gaining appropriate numeracy outcomes for all children, requires consideration of the needs of ESL learners.

The links between language and numeracy learning are well recognised. Developing the language of mathematics is seen as a fundamental aspect of numeracy programmes. Focusing on the use of mathematics language in classrooms and providing opportunities for children to develop their own mathematical language assists in building connections and links in children's understanding (Stephens, 1999). Research also suggests that both direct instruction in the terminology of a subject and exploration of ideas and meanings until common understandings have developed are important aspects of student learning (Cumming et al, 1998).

Language demands increase as students explore the contexts of problems and discuss the range of strategies they use. It is important for ESL learners to be able to understand numeracy tasks and access numeracy learning. To be effective, numeracy teaching and learning must consider students' language backgrounds and experiences and implement strategies to accommodate and support the numeracy development of ESL learners.

The further enhancement of programmes and strategies to meet the specific needs of all students will play a key role in achieving the national literacy and numeracy goal. Under the Government's Numeracy Research and Development Initiative, equity is one of the identified priority areas to be addressed.

5.4 Conclusion

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 practices. Further research and development in these areas will be important in realising the national goal for all students.

6. Further Development and Conclusions

All students must be challenged to fully develop their talents and capacities. Mathematics learning is a vital part of this and excellence in this area supports Australia's capabilities as a nation. Further to this, the importance of both literacy and numeracy, as essential and complementary foundations for all students entering modern society, is now widely recognised by educators throughout Australia. Numeracy for all young Australians is a priority.

Through the framework of the National Goals for Schooling and the National Plan, a clear commitment has now been made by the Commonwealth and by States and Territories to realise this vision.

6.1 Further Support for Literacy and Numeracy Achievement

The National Plan calls for all school education authorities to set priorities for resources which give literacy and numeracy the highest importance. The Commonwealth's commitment to literacy and numeracy, supplementing State and Territory funding, includes a significant and increased level of funding through the Literacy and Numeracy Programme, with funding totalling \$1,104 million for literacy and numeracy over the five years to 2003/2004.

From 2000 the Commonwealth has introduced new initiatives targeted to extend and support the work already being undertaken by education authorities and schools to support literacy and numeracy improvement.

National Indigenous English Literacy and Numeracy Strategy

Indigenous students are clearly the most disadvantaged students in terms of their learning outcomes in numeracy and mathematics. To help address this, the National Indigenous English Literacy and Numeracy Strategy was launched in March 2000. \$27 million will be allocated to support the implementation of the Strategy. The Strategy supports the identification and dissemination of effective practice models and teaching methods drawn from pilot projects undertaken in 1998 and 1999. The Strategy also has a major element aimed at improving school attendance. The Strategy will assist the achievement of the aims of the Literacy and Numeracy Programme and the National Goals for Schooling by addressing the specific needs of Indigenous education. A MCEETYA Taskforce on Indigenous Education provided advice to the Commonwealth on the development of the Strategy. As part of Strategy implementation, the Commonwealth will work with State and Territory education systems to develop initiatives in key areas of greatest need to enable Indigenous students to attain the benchmark standards in literacy and numeracy and increase school attendance.

The middle years

The Government is providing \$47 million over four years under the Literacy and Numeracy Programme to improve literacy and numeracy outcomes in the middle years of schooling. \$42 million of this funding has been allocated to State and Territory education authorities to support students who have not developed appropriate literacy and numeracy skills and who therefore have difficulty coping with the demands of the school curriculum. Funding will support initiatives to improve literacy and numeracy in the transition from primary to secondary school, intervention strategies and classroom based research into effective teaching practice in the middle years of schooling. The remaining funds will be provided

for national strategic research projects which will research and implement strategic national initiatives related to improving literacy and numeracy development in the middle years.

Quality Teacher Programme

The Commonwealth is also providing funding of \$77.7 million over three years for the Quality Teacher Programme. This is intended to help update and improve teachers' skills and help lift the status of the teaching profession in both government and non-government schools. Programme activities commence in 2000 and run until 2002.

The programme will focus on the renewal of teacher skills and understanding in literacy, numeracy, mathematics, science, information technology and vocational education in schools. The programme includes teaching in both primary and secondary schools. It will target teachers who have completed formal training ten or more years ago, casual teachers and teachers who are re-entering the teaching profession.

The programme will support the provision of targeted professional development activities by government and non-government education authorities and other organisations. A small proportion of the funds, some \$6 million over the life of the programme, will be retained to support strategic national projects.

Numeracy Research and Development Initiative

This paper has noted a number of key aspects of numeracy education which contribute to effective learning. Research and development in such areas underpin effective numeracy acquisition for students and open the way for improved practice to enhance children's numeracy outcomes.

The Government has consulted with stakeholders as part of establishing priorities and directions for strategic work in numeracy focusing on the primary school level. The Numeracy Priority Areas identified by the Commonwealth for research and development to support improved numeracy outcomes are: national coordination and dissemination activities; early numeracy; effective teaching practice; equity; home, school and community partnerships; technology; and professional development.

The Government has announced a \$7 million initiative under the National Strategies and Projects strand of the Literacy and Numeracy Programme, aimed at boosting research and development nationally to support improved numeracy teaching and learning. Two strands of the Numeracy Research and Development Initiative will enable the priority areas to be addressed nationally in important complementary ways:

Strategic research and development projects

The initiative will provide up to \$5 million over two years for priority area strategic numeracy research and development projects which are linked closely to improved practice at the state and regional level in schools. Projects will be undertaken by education authorities and partnerships will be encouraged with research organisations such as universities and with other organisations such as parent groups and professional associations. Projects commence in 2000.

National research and development projects

The Commonwealth will also undertake strategic numeracy research and development in the identified priority areas, directed to research and development activities which are most effectively organised on a national basis. Projects are commencing in 2000.

Research to support quality mathematics teaching and learning in the mathematics key learning area, as part of facilitating the development of students' capacities and talents, will form part of the Commonwealth's research programme.

6.2 Conclusion

The Commonwealth Government is committed to working in cooperation with State and Territory governments to achieve improvements in education for all young Australians. Literacy and numeracy are at the core of these efforts and are a priority for all in school education.

The Government recognises the importance of numeracy learning in the context of the broad national goals for schooling agreed by all of Australia's Education Ministers in April 1999. These include the development of high standards of knowledge, skills and understanding in mathematics in the compulsory years. They also include the development of students' confidence and positive orientations to learning, skills in analysis, problem solving and communication and positive orientations to further education, employment and lifelong learning.

The Government recognises that all schools must have strong educational leadership from principals, effective organisation and partnerships with parents. No less important are quality teaching and learning practices, a focus on students' diverse needs and appropriate curriculum and timetable attention to core outcomes. These outcomes include literacy and numeracy.

The Commonwealth is working with government and non-government education authorities to support implementation of the National Literacy and Numeracy Plan, a major and comprehensive initiative agreed by all Commonwealth, State and Territory Education Ministers. The National Plan is designed to ensure that all Australian students develop appropriate levels of literacy and numeracy. It represents a commitment to ensuring that all children, with the exception of a very small proportion experiencing severe learning difficulties, will develop foundational numeracy skills in the primary school years and that those at risk will receive focused assistance. These early skills must provide a sound basis for further learning and a productive, confident engagement in later learning across the curriculum.

The establishment of national minimum acceptable standards in numeracy represents a commitment by Australia's education authorities to educational accountability and taking action to ensure that all students have the level of numeracy recognised as necessary for effective participation in schooling. The National Plan recognises the diversity of students' experiences, needs and interests and encourages a range of teaching approaches best attuned to this diversity. The focus on professional development to support teachers in their literacy and numeracy work is also vital.

The National Plan provides a framework for action from all education authorities and schools to address the national literacy and numeracy goal in the context of the broader goals of The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century. The Commonwealth's policy, programmes

and initiatives in literacy and numeracy are directed towards helping to realise this goal. All stakeholders – parents, teachers, educators, principals, education authorities and governments – will need to continue their important work as partners in this endeavour, to ensure that all children’s learning at school will equip them well for their futures in this new century.

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