A Numeracy Curriculum

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Introduction

This new numeracy and mathematics curriculum framework has been developed for adults and has been widely used across Australia since 1997. The framework offers a style of competency or outcome statement which is holistic rather than fragmented, in that it is based upon realistic purposes and uses of mathematics, and which encompasses a particular perspective on numeracy and its relationship to mathematics. The paper outlines the rationale and development of the curriculum.

Adult literacy and basic education in Australia

Adult literacy and basic education (ALBE) within Australia is an important part of the Vocational Education and Training (VET) system and is offered through a wide range of providers including Technical and Further Education (TAFE) Institutes; community-based providers such as neighbourhood houses, community centres, libraries; correctional institutions; workplaces; schools; and also private providers of education and training. Within adult literacy and basic education, literacy has been the main focus, with numeracy's place being fragile and on the fringe in terms of funding and support. However, recent years have seen significant developments and progress in adult numeracy.

In the past, adult literacy and basic education has been an informal, student focused form of education with no formal accreditation process or system wide curriculum, with students learning reading, writing, mathematical, oral communication and general education skills. But in the 90s the pressure of competency based education and training has meant that the ALBE field too has developed accredited curriculum. It has been the challenge therefore to develop accredited curricula that try to espouse and maintain the principles established for a student-focused and relevant form of education. This paper will describe a recent attempt to develop a numeracy curriculum that meets these principles.

Adult numeracy

In today's advanced technological society it is necessary to absorb, use and critically evaluate large amounts of information, much of which is presented in numerical or graphical form. In order to interpret this information when listening to radio, watching television, reading books, newspapers or magazines, or to understand instructions and diagrams in the workplace, a range of mathematical skills is needed.

Although these activities vary depending on the culture and the context in which they occur, they depend on a range of mathematical skills which include basic number skills, spatial and graphical concepts, use of measurement and problem solving. These skills are essential for participating effectively in society.

Although there are no universally accepted definitions of numeracy or agreement about the ways in which numeracy differs from mathematics, certain emphases can be noted in definitions of numeracy. There are emphases on the practical or functional application and use of mathematics.

> *To be numerate is to function effectively mathematically in one's daily life, at home and at work* (Willis, 1990).

Numeracy was defined by the Australian Beazley committee as

> *the mathematics for effective functioning in one's group and community, and the capacity to use these skills to further one's own development and of one's community* (Beazley, 1984).

The UK Cockcroft Report stated that the word 'numerate' implied

> *We would wish the word 'numerate' to imply the possession of two attributes. The first is an 'at homeness' with numbers and an ability to make use of the mathematical skills which enable an individual to cope with the practical demands of his everyday life . The second is an ability to have some apprehension and understanding of information which is presented in mathematical terms, for instance in graphs, charts or tables or by reference to percentage increase or decrease. Taken together these imply that a numerate person should be expected to be able to appreciate and understand some of the ways in which mathematics can be used as a means of communication .... (Paragraph 39).*
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> *Most important of all is the need to have sufficient confidence to make effective use of whatever mathematical skill and understanding is possessed, whether this be little or much (Paragraph 34)* (Cockcroft, 1982).

Definitions imply certain attitudes as well as skills, an 'at homeness' or 'confidence' with numbers and other maths skills. In other words skills and knowledge can actually be put into practice.

It is clear from these definitions that numeracy does not refer only to operating with numbers as the word can suggest, but refers to a much wider range of skills. It also implies a certain flexibility - dependent on the needs and interests of the individual within the context of the peer group, community or workplace.

In recent years there has been much discussion and debate about the relationship between mathematics and numeracy and to the concept of 'critical' numeracy. Betty Johnston has argued that numeracy in fact incorporates, or should incorporate, this critical aspect of using mathematics. She argues:

> *To be numerate is more than being able to manipulate numbers, or even being able to 'succeed' in school or university mathematics. Numeracy is a critical awareness which builds bridges between mathematics and the real world, with all its diversity* (Johnston, 1994).

She continues:

> *In this sense . . . . . there is no particular 'level' of Mathematics associated with it: it is as important for an engineer to be numerate as it is for a primary school child, a parent, a car driver or a gardener. The different contexts will require different Mathematics to be activated and engaged in* (Johnston, 1994).

So the view of numeracy and mathematics that has developed is one that sees numeracy as making meaning of mathematics and sees mathematics as a tool to be used efficiently and critically.

The Certificates in General Education for Adults (CGEA)

The Certificates in General Education for Adults (CGEA) (ACFEB, 1996) provide a range of educational opportunities for adults wishing to prepare for further study, improve their employment status and enhance their participation in the community. The Certificates allow adults to study for a formal credential which gives them credit for improving their reading, writing, mathematical, oral communication and general education skills. Certificates can be awarded at three levels with the highest level approximating to year 11 of secondary education. There are no formal entry requirements for a student wishing to undertake the credentials. Placement at a specified level in a stream would be made based on students' current skill level.

The Certificates of General Education for Adults (ACFEB, 1993) were first accredited by the Victorian Vocational Education and Training Accreditation Board (VETAB) in 1992. Towards the end of the accreditation period the Certificates were redeveloped for reaccreditation. In December 1996 the redeveloped Certificates in General Education for Adults were reaccredited for the period 1 January 1997 to 31 December 2001. The Certificates are used extensively across Victoria and also used widely in other states of Australia.

The Certificate document provides a curriculum framework covering four streams or subject areas:

- Reading and Writing
- Oral Communication
- Numeracy and Mathematics
- General Curriculum Options. The General Curriculum Options is based on the Key Competencies and provides the means of delivering generic key skills or being a vehicle for subjects such as science, Koorie studies, vocational skills, creative arts, study skills, etc.

These streams can be offered at four different levels. Each level of each stream is called a module. For each module there is a set of competencies, or learning outcomes, which the student must achieve to be seen to demonstrate competence at that level.

	STREAMS			
Level 4	Reading & Writing 4	Oral Communication 4	Numeracy & Mathematics 4	General Curriculum Options 4
Level 3	Reading & Writing 3	Oral Communication 3	Numeracy & Mathematics 3	General Curriculum Options 3
Level 2	Reading & Writing 2	Oral Communication 2	Numeracy & Mathematics 2	General Curriculum Options 2
Level 1	Reading & Writing 1	Oral Communication 1	Numeracy & Mathematics 1	General Curriculum Options 1

Numeracy within the Certificates in General Education for Adults

The original Certificates maths stream was not considered a success. It was based very loosely around some generic statements, and teachers found the competencies and their descriptions very vague, unhelpful and contradictory. At moderation sessions, both regionally and state-wide, the contradictions and vagueness made understanding and agreement very difficult and frustrating. In the review of the original certificate it was recommend that the maths stream be completely rewritten. This was undertaken by the authors of this paper over the first half of 1996.

The new CGEA numeracy and mathematics learning outcomes have been developed with the view of mathematics and numeracy described above in mind, where mathematics is seen as the knowledge and skills to be applied and used for a range of purposes and in a variety of contexts. It has also meant that the naming of this stream of the CGEA has in fact included both the concept of numeracy as well as that of mathematics.

Although each course taught under the umbrella of this certificate will be different - taught by and to different people - there should be many similarities in their general style. Each course should focus on the student group rather than purely on the required content.

During the implementation of the previous version of the certificate it became increasingly apparent that the aspect of presenting maths in relevant and meaningful contexts was vital to the emerging idea of numeracy as distinct from mathematics. So

much so that the purpose and use of mathematics within meaningful contexts was made the focus of the new learning outcomes for this version of the CGEA.

Purposes and functions of mathematics - the new Learning Outcomes

Rather than the Learning Outcomes having traditional maths strands (number; space and shape; data; measurement; and algebra) as their organising structure, the purposes or functions to which the maths may be put, are given prominence. In the reading and writing stream of the CGEA, the learning outcomes were organised around the concept of a number of different literacies, which were based on different social purposes of reading and writing. These four domains have been labeled literacy for self expression, literacy for practical purposes, literacy for knowledge and literacy for public debate. This structure was one of the influences that led to the development of the new structure for the numeracy learning outcomes.

The Learning Outcomes are organised into four different categories or domains, according to different purposes and functions of using mathematics.

Numeracy for Practical Purposes addresses aspects of the physical world to do with designing, making and measuring. There are two learning outcomes: **Numeracy for Practical Purposes - Design** and **Numeracy for Practical Purposes - Measuring**.

Numeracy for Interpreting Society relates to interpreting and reflecting on numerical and graphical information of relevance to self, work or community. The two learning outcomes are: **Numeracy for Interpreting Society - Data** and **Numeracy for Interpreting Society - Numerical Information**.

Numeracy for Personal Organisation focuses on the numeracy requirements for personal organisational matters involving money, time and travel. There are two learning outcomes, one dealing with money and time, the other to do with location and direction.

Numeracy for Knowledge is only introduced at level 3 and deals with mathematical skills needed for further study in mathematics, or other subjects with mathematical underpinnings and/or assumptions. There are learning outcomes to do with problem solving, algebraic and graphical techniques.

The Learning Outcomes still ensure that the skills and knowledge of the maths strands are included but they are arranged under a different structure. The strands are still fairly obvious, but are connected to a purpose or use of the mathematics involved. The exception is the number strand which is treated as a tool that is to be used across the other domains. The specific mathematical skills and knowledge required are embedded in the Learning Outcomes and specified within the assessment criteria. These can encompass mathematical knowledge from more than one strand.

The four levels

Level 1

The initial level of the CGEA in numeracy and mathematics aims to enable students to develop the confidence to perform simple and familiar numeracy tasks and to develop the ability to make sense of maths in their daily personal lives. The maths involved includes measurement, shape, numbers, and graphs that are part of the learners' normal routines to do with shopping, travelling, cooking, interpreting public information, telling the time etc.

At the end of the level learners will be able to perform mathematical tasks which involve a single mathematical step or process. Their communication about mathematical ideas would mainly be spoken rather than written responses.

Level 2

The next level not only looks at maths applied to tasks which are part of the learners' normal routine but also extends the maths of level 1 to applications outside their immediate personal environment such as the workplace and the community, whether first hand or portrayed by the media. The purpose is to enable students to develop everyday numeracy to make sense of their daily personal and public lives.

At exit level 2, learners would be able to attempt a series of operations or tasks with some confidence, be able to select the appropriate method or approach required, and would be able to communicate their ideas both verbally and in written form. They would be at ease with straightforward calculations either manually and/or using a calculator.

At levels 1 and 2 there are six learning outcomes, however it is only necessary to demonstrate competence in five of the six Learning Outcomes. Although it is expected that in most teaching contexts all the six Learning Outcomes would be taught, the aim of achieving only five of the six has been included in order to offer both learners and teachers more flexibility in assessment and, in some specific contexts such as workplaces, one of the Learning Outcomes could be left out if it was not seen to be relevant.

Level 3

Level 3 aims to enable learners to explore mathematics beyond its familiar and everyday use to its application in wider, less personal contexts such as newspapers and other media reports, workplace documents and procedures, and specific projects at home or in the community. The mathematics covered is extended beyond that introduced at levels 1 and 2 and would include measurement, graphs and simple statistics, use of maps and directions and an introductory understanding of the use of formulae and problem solving strategies.

Learners are expected to have the capacity to interpret and analyse how mathematics is represented and used, and to recognise and use some of the conventions and symbolism of formal mathematics.

Level 4

This level of the CGEA with its focus on learning mathematics for further study includes the early stages of knowledge and skills belonging to several formal areas of mathematics. The mathematics involved will include: numerical calculations and analysis of graphical data required for interpreting information about society; the use of formulae and their graphs, algebraic techniques and problem solving strategies; and familiarity with fundamental processes of at least two selected specialist mathematical areas.

At the end of this level learners will be able to confidently perform calculations using a variety of methods. They will be able to interpret and use the formal symbols and conventions of the chosen fields of mathematics in order to solve simple problems, and to communicate their problem solving processes in writing using a variety of informal and formal language.

Examples of the Learning Outcomes

Level 1

1.1 Numeracy for Practical Purposes - Design
Can use everyday informal language of shape, size, colour and other commonly used attributes to identify and recognise shapes in the context of their common usage and application.

1.4 Numeracy for Personal Organisation - Location
Can use simple everyday language of location to give and follow informal oral directions.

1.5 Numeracy for Interpreting Society - Data
Can use simple everyday graphs and charts to interpret public information which is of personal interest or use.

Level 2

2.2 Numeracy for Practical Purposes - Measuring
Can use straight forward measurement and the metric system to estimate and measure for the purpose of interpreting, making or purchasing materials in familiar practical situations

2.3 Numeracy for Personal Organisation
Can use and interpret whole numbers (including large numbers), simple fractions, decimals and percentages to make decisions about money and time in familiar situations.

2.6 Numeracy for Interpreting Society - Numerical Information
Can identify and translate everyday numerical concepts to interpret public information which is in texts of interest or relevance.

Level 3

3.1 Numeracy for Practical Purposes - Design
Can translate between 2 dimensional and 3 dimensional real life objects and their diagrammatic representations for the purposes of measurement, design, and interpretation.

3.3 Numeracy for Personal Organisation - Location
Can use the conventions of distance, location and direction to read, create and use maps.

3.4 Numeracy for Interpreting Society - Data
Can use and create graphs and charts, and calculate and use averages, in order to interpret and reflect on information of relevance to self, work or community.

3.6 Numeracy for Knowledge - Further Study in Maths (formulae)
Can develop and use simple formulae to describe and represent relationships between variables in real life contexts.

Level 4

4.1 Numeracy for Interpreting Society - Data
Can use graphs, charts and measures of central tendency and spread to interpret, analyse and describe information of relevance to self, work or community.

4.3 Numeracy for Knowledge - Further Study in Maths (formulae and graphs)
Can develop and use formulae and their graphs to describe and represent relationships between variables in a range of contexts.

4.7 Numeracy for Knowledge - Further Study in Maths (problem solving)
Can use mathematical problem solving techniques to interpret, investigate and solve mathematical problems.

Numeracy for Knowledge at levels 3 and 4

Numeracy for Knowledge is a new Learning Outcome that is introduced at Level 3 and extended at Level 4. It is introduced in order to provide learners with knowledge about the conventions and techniques of formal study in mathematics.

Exit level 3 is seen as the end of the general education focus of the CGEA and level 4 is seen as the stage where learners are initiated into formal areas of study - hence the title of the level 4 certificate - Further Study. Therefore in the numeracy and mathematics

stream, it is expected that learners at level 3 can recognise and use some of the conventions and symbolism of formal mathematics, while this is extended at level 4 to incorporate the early stages of knowledge and skills belonging to several formal areas of mathematics. This study of formal areas of mathematics becomes a major focus of the Numeracy and Mathematics stream at level 4.

Further Study, the focus of level 4, implies flexibility in the choice of content, dependent on the chosen future areas of study. Hence there is built in flexibility in the level 4 Numeracy for Knowledge - Further Study learning outcomes. There are five Numeracy for Knowledge - Further Study in Maths Learning Outcomes - one for formulae and graphs, one for algebraic techniques, another for problem solving and two unspecified ones for two specialist areas of study. The two optional areas of study could be chosen from areas such as trigonometry, business maths, statistics, probability, formal geometry, etc.

If, for example, learners were aiming to study drafting, then trigonometry and geometry may well be the two chosen areas. Statistics and probability would, for example, be possible choices for students wishing to enter University courses in Social Science disciplines. Whatever the on-going study, formulae and graphs, algebraic techniques and problem solving are seen as core areas.

It should be remembered that only six out of the seven Learning Outcomes are essential for completion of Level 4, so more opportunity exists for flexibility in designing the course to suit particular student interests.

Problem solving

Problem solving has been incorporated in the new Numeracy and Mathematics Stream in two ways. In its general sense problem solving is implied within the whole of the curriculum in that all the maths skills should be applied to real world tasks or problems. However, in addition, problem solving in its formal, mathematical sense, that is, "the ability to solve non-routine problems which require some degree of independent judgement, originality and creativity", has been introduced formally at levels 3 and 4. It is expected at these levels that students will learn to recognise, name and use some of the formal problem solving techniques.

The Assessment Criteria

The assessment criteria give the detailed criteria for satisfying the Learning Outcome. The Learning Outcome is achieved when the learner can demonstrate competence in all the assessment criteria. However, it is **not** expected that one assessment task or activity can or should cover all the assessment criteria. (See Assessment section following for further detail.)

The assessment criteria are grouped according to three categories: Mathematical knowledge and techniques; Mathematical language; and Interpretation

Mathematical knowledge and techniques

The specific mathematical skills, knowledge and techniques required for each Learning Outcome are specified within this category of the assessment criteria.

Within this section specific techniques are not laid down as mandatory requirements in order to allow for the variety of idiosyncratic methods which learners bring to the numeracy classroom. It is hope that such personal techniques will be encouraged, discussed and valued alongside any new techniques learned.
An exception, however, is calculator use which is regarded as a fundamental skill in our modern technological society. Learners should be therefore exposed to a variety of ways to use calculators.
Pen and paper methods are not seen as superior to other methods such as calculators or in-the-head methods.

Mathematical language

The other important aspect of the model mentioned earlier, developing associated mathematical language, is incorporated into the outcome in this category.

Interpretation

There are two important aspects of numeracy and mathematics that are addressed under the **Interpretation** category of the Assessment Criteria. The first is checking results against initial estimates such as: "decides on reasonableness of calculations through rough approximations" and "decides on reasonableness of measurement through visualisation and/or prior knowledge". The second aspect relates to the issue of using mathematics critically. Learners are expected to relate the meaning of mathematical tasks or activities, personal experience, implications, beliefs, and social consequences.

Performance range

Another section that has been included is titled "Performance Range". This section has been used to illustrate possible contexts; appropriate instruments, materials and/or texts that are suitable for use at that level; and is also used to clarify and refine specific mathematical content and language appropriate to the level.

Conditions of Assessment

The Conditions of Assessment section has been developed for each level. They describe the conditions under which assessment should take place and give some general guidelines regarding types of texts and materials to use; the degree of support available from teachers; the types of calculations - in the head, pen and paper and calculator - to be used; and the degree of use of oral and/or written language.

Sample Learning Outcome

Learning Outcome 2.5: Numeracy for Interpreting Society - Data

Can use and create everyday graphs and charts to represent and interpret public information which is of interest or relevance.

Assessment criteria

Not all assessment criteria need to be met in the one assessment task or activity

Mathematical Knowledge & Techniques

(a) interpret the key features, conventions and vocabulary of everyday graphs or charts, including the concept of scale
(b) use whole numbers, percentages, decimals and simple ratios found on charts and graphs
(c) collect, sort and record data in a table using simple techniques
(d) interpret and discuss meaning of text that incorporates graphs or charts
(e) mark scales and axes appropriately
(f) represent data in simple bar or line graphs

Language

(g) use the descriptive language of graphs and charts such as maximum, minimum, increasing, decreasing, going up, constant, changing, slope, etc.

Interpretation

(h) relate meaning/information of graph or chart in terms of personal implications and/or social consequences
(I) decide on the fairness or bias of the data in response to teacher prompting.

Performance range

- The types of graphs or charts could include simple pie charts, bar graphs, line graphs, pictograms, etc. of the kind found in newspapers, on household bills, information leaflets, etc.
- Scales created should count in 1's, 2's, 5's or 10's.
- Scales interpreted from public information not limited to the above simple scales - can interpret from more complex scales available on public information.

Conditions of assessment:

The conditions of assessment apply to all learning outcomes in the module.
They are:

- concrete, relevant, familiar contexts and materials where the maths content is predictable and easily accessible
- relies on context, prior knowledge and personal experience to derive meaning and check reasonableness
- performs where access to mentor/teacher and advice/modelling is available and recourse to first/other language is acceptable.
- uses a blend of personal "in the head" methods, pen and paper and calculator procedures
- uses a combination of oral and written general, and some mathematical, language, symbols and abbreviations.

Assessment

Assessment should be undertaken as an ongoing process which integrates knowledge and skills with their practical application over a period of time. It will require a combination of evidence collected mainly through teacher observations and some collection of written records of students' attempts at tasks.

It is not expected that all assessment criteria for an outcome can be assessed within one single task e.g. it would be unlikely that both the money and time aspects of the personal organisation learning outcome (1.3) could be demonstrated within one task. Therefore it might require a number of observations or tasks to completely assess any given outcome.

It will often be possible to assess aspects of more than one learning outcome within one assessment task e.g. a task which involves the practical application of measurement knowledge and skills (practical purposes - measurement) may also allow demonstration of ability to calculate with money (personal organisation).

It would be ideal for level 1 students to be assessed actually undertaking a real task such as purchasing goods in a shop and checking change, measuring ingredients for cooking, following directions in outside locations, etc. Some of these tasks such as shopping may be able to be simulated in a classroom but it is preferable that students gain the skills and confidence through undertaking the task in a real situation.

Where assessment criteria include a list of items of mathematical knowledge (e.g. in 1.2 Numeracy for Practical Purposes - Measuring "uses appropriately common units of measurement such as centimetres, metres, kilograms, litres, degrees Celsius etc.") it is assumed that most of these will be included as part of the teaching/learning program. It is not envisaged that all the listed items be assessed individually - competence in one or two being sufficient evidence that the criterion can be met.

A range of assessment options should be used according to the needs of the student group and the learning situation. e.g. in the workplace, assessment could be of observation of students performing on-the-job tasks, whereas these may have to be simulated in a classroom environment.

At Level 1, a folio of evidence could be collected through a combination of the following:

- records of teacher observations of students' activities, discussions and practical tasks
- occasional samples of students' written work
- pictures, diagrams, models, etc. created by students.

At Levels 2, 3 and 4, a folio of evidence could be collected through a combination of the following:

- records of teacher observations of students' activities, oral presentations, practical tasks, etc.
- samples of students' written work
- written reports of investigations or problem solving activities
- student self assessment sheets, reflections, or journal entries
- pictures, diagrams, models created by students.

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