Numeracy in the Middle Years Curriculum

A resource paper—An audit of numeracy in the SACSA Framework
Acknowledgments

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Please note:
This document is an abridged version of the full audit. The full version includes further elaborations for each Learning Area and can be accessed at the DECS website for The Network—South Australian Literacy and Numeracy Network at <www.thenetwork.sa.edu.au>.
Contents

Introduction 1
Arts 4
Design and technology 6
English 8
Health and physical education 10
Languages 12
Science 14
Society and environment 16
Mathematics 18
Summary 20
Planning resource: Identifying numeracy demands in curriculum 22
Bibliography 23
Introduction

This audit was commissioned by the Department of Education and Children’s Services (DECS) to support the work of teachers in the Numeracy in the Learning Areas (Middle Years) Project during 2009. Its purpose was to identify the numeracy demands of the eight Learning Areas of the South Australian Curriculum, Standards and Accountability (SACSA) Framework and elaborate on the ways that numeracy is embedded in each Learning Area.

The SACSA Framework describes curriculum Key Ideas and Outcomes upon which learners from birth to Year 12 in DECS schools, preschools and childcare settings can expect their education to be built. These Key Ideas and Outcomes provide the basis for planning, teaching and assessing the curriculum requirements of educators’ specialist or focus areas.

This audit has been developed as a support for all middle years educators as they extend their personal understanding of numeracy generally and become aware of the numeracy demands of their areas of specialisation or program focus. It is critical that all educators come to understand the numeracy demands of all curriculum areas so they are able to better support improved learning outcomes for their students and children.

The important roles of mathematics and mathematics teachers are critical in the development of the foundations for numeracy and, therefore, the curriculum strands of mathematics are used to highlight the numeracy demands embedded in other curriculum contexts.

Defining numeracy

The National numeracy review report (COAG, 2008) made the following recommendation:

*That all systems and schools recognise that, while mathematics can be taught in the context of mathematics lessons, the development of numeracy requires experience in the use of mathematics beyond the mathematics classroom, and hence requires an across the curriculum commitment. Both pre- and in-service teacher education should thus recognise and prepare all teachers as teachers of numeracy, acknowledging that this may in some cases be ‘subject specific numeracy’. (p xii)*

Yet there is a limited research base into the numeracy demands of learning areas outside of mathematics. *Numeracy* is a term common in Australia and the United Kingdom but rarely found in America or other parts of the world, where expressions like *quantitative literacy* or *mathematical literacy* are used. Some definitions of quantitative literacy focus on the ability to use quantitative tools for everyday practical purposes, while mathematical literacy is understood more broadly as the capacity to engage with mathematics in order to act in the world as a constructive, concerned and reflective citizen (OECD, 2003).

The 1997 Numeracy Education Strategy Development Conference identified the following elements as central to any description of numeracy: ‘numeracy involves using some mathematics to achieve some purpose in a particular context’ (DEETYA, 1997, p 13). From this discussion emerged the following description of numeracy which it was hoped would inform future work in numeracy education: ‘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’ (DEETYA, 1997, p 15, emphasis added). This description was later cited in the Commonwealth’s numeracy policy document Numeracy, a priority for all: Challenges for Australian schools (DETYA, 2000) as reflecting the Australian interpretation of numeracy.
A numeracy model

Recently, however, Goos (2007) has argued that a broader description of numeracy for new times is needed in order to capture the rapidly evolving nature of knowledge, work, technology, social structures, and the changing characteristics of learners in schools. She developed the model shown in Figure 1 to represent the dynamic and multifaceted nature of numeracy, which comprises four elements.

- A numerate person requires **mathematical knowledge**. This includes concepts, skills and problem-solving strategies, as well as the ability to use sensible estimations.

- A numerate person also has positive **dispositions**—a willingness and confidence to engage with tasks, independently and in collaboration with others, and apply his/her mathematical knowledge in flexible and adaptable ways.

- Numerate practice often involves using **tools**. These include: physical tools, representational tools and digital tools (technology).

- Because numeracy is about using mathematics to act in and on the world, people need to be numerate in a range of **contexts**. A numerate person can organise his/her personal finances, personal health needs and leisure time, and think systematically about all public issues which are often presented based on data and projections. In addition, work-related numeracies are always contextual.

Different curriculum contexts also have distinctive numeracy demands, so that students need to be numerate across the range of contexts in which their learning takes place at school.

- This model is grounded in a **critical orientation** to numeracy since numerate people not only know and use efficient methods, they also evaluate the reasonableness of the results obtained and are aware of uses of mathematical thinking to analyse situations and draw conclusions.

The tetrahedral model of numeracy is used as the basis for this numeracy audit of the South Australian Curriculum, Standards and Accountability (SACSA) Framework.
Introduction

Evaluating the numeracy demands of Learning Areas

During the middle years of school, students continue to consolidate the knowledge and skills acquired in their earlier years and they need to see the relevance of what they are doing in the classroom to their lives beyond the school. In addition, research has found that success is a major component in student preparedness to engage in mathematics in the middle years. So, planning for numeracy development needs to incorporate many contexts within mathematics, in other disciplines and in students’ lives outside school.

This audit evaluates the distinctive numeracy demands of all SACSA Framework Learning Areas in the Middle Years Band (Years 6, 7, 8 and 9) and hence is aligned with Standard 3 and Standard 4. Standard 5 has also been considered, as some Middle Years Band students will be working within and towards this level of achievement.

Ways in which mathematics applies in other curriculum contexts can be examined through the five strands of the mathematics Learning Area of the SACSA Framework:

- exploring, analysing and modelling data
- measurement
- number
- pattern and algebraic reasoning
- spatial sense and geometric reasoning.

These mathematics strands have been used as a way of organising the numeracy audit of Learning Areas other than mathematics.

The SACSA Framework’s statement about how students develop their operational skills in numeracy in the Learning Area is presented first, and this is followed by a table highlighting the Learning Area strands that have mathematics strands embedded within the area. Numeracy demands are then evaluated by reference to each element of the numeracy tetrahedron depicted in Figure 1.

Each Learning Area has been considered in the context of the SACSA Framework’s statement about numeracy, which is intended to be an embedded aspect of all curriculum. The figures, which identify the numeracy emphasis in each Learning Area, use shading to indicate low (unshaded), moderate (light shading) and high (dark shading) levels of numeracy learning demands.

The audit concludes with a summary of findings across all Learning Areas to establish numeracy demands of the SACSA Framework as a whole.

All Learning Areas have further examples and elaborations in the full version of the audit of numeracy available at <www.thenetwork.sa.edu.au>.
SACSA numeracy statement

Learners develop and use operational skills in numeracy to understand, analyse, critically respond to and use mathematics in different contexts. These understandings relate to measurement, spatial sense, patterns and algebra and data and number. This learning is evident in arts when, for example, students design products using sequencing and patterning, accurate measurement and a sense of shape, size, dimension and perspective. Gathering, interpreting and analysing data in relation to audience, viewer and user behaviour is another example of numeracy in arts. (DETE, 2001, Middle Years Band, p 13)

Arts numeracy evaluation in arts

Mathematical Knowledge

Figure 2 maps numeracy learning demands in arts onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Mathematics strands</th>
<th>Arts practice</th>
<th>Arts analysis and response</th>
<th>Arts in contexts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
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<td></td>
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</tr>
<tr>
<td>Measurement</td>
<td></td>
<td></td>
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<td>Number</td>
<td></td>
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<td></td>
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<tr>
<td>Pattern and algebraic reasoning</td>
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<tr>
<td>Spatial sense and geometric reasoning</td>
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</tbody>
</table>

Figure 2 – Mathematical knowledge demands within strands of the arts Learning Area

Learning in arts makes many numeracy demands of students in terms of mathematical knowledge.

In arts practice where students create arts works, students draw on elements of the mathematics strands in exploring and analysing data, and using measurement, number and spatial sense as well as patterns (which supports algebra understanding but may not promote algebra understanding specifically).

In arts analysis and response where students analyse others’ arts works, they may conduct research that requires analysis of data and use spatial reasoning to consider elements of arts works.

Through arts in contexts, students ‘understand the economic role of arts by making connections between creative, artistic endeavour and commercial uses of the arts …’ (ibid, p 29).
Students use a range of representational, physical and digital tools in creating and responding to art works. In music, for example, they make notations to symbolise rhythm, melody, harmony and tempo. In the visual arts, they work with materials, implements, images and media to communicate and represent ideas in two and three dimensions. In drama, they make models of performance spaces when they study set design and construction and consider the use of space to suit a scene in a play. They become familiar with print, film and electronic media as well as web-based resources such as virtual galleries and libraries, and they use many types of digital technologies to create new art forms.

Critical Orientation

Arts has the potential to encourage students to move beyond art works for self-expression to art works for social comment and critique. In this way, arts can be the vehicle through which students develop critical orientation; where they use mathematics tools to analyse facts and information about situations and issues. For example, banks have now introduced a range of extra fees associated with the use of automatic teller machines (ATMs). News reports have brought this to the attention of consumers. However, art works have the potential to ensure that the injustice of this situation remains in the public mind. Considering this situation from a variety of perspectives through application of numeracy (eg How much will that cost the average consumer?, How much does this give the banks?, How much profit did banks make last year?) and incorporating this message within art works has the potential to make a stronger statement.
Numeracy evaluation in design and technology

Mathematical Knowledge

Figure 3 maps numeracy learning demands in design and technology onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Design and technology strands</th>
<th>Critiquing</th>
<th>Designing</th>
<th>Making</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Measurement</td>
<td></td>
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<tr>
<td>Pattern and algebraic reasoning</td>
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<td></td>
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<tr>
<td>Spatial sense and geometric reasoning</td>
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</tbody>
</table>

Figure 3 – Mathematical knowledge demands within strands of the design and technology Learning Area

‘Design and technology offers learners a rich blend of knowledge, skills, strategies and dispositions to develop their identities as individuals and to help them design shared, sustainable futures.’ (ibid, p 36)

It is through the curriculum strands of designing and making that the greatest numeracy demands are found. When designing, students consider design elements of products that they are intending to create. Through modelling, students can consider elements of their design and make modifications prior to making the product. In modelling, students construct a set of parameters for their design and consider the impact of such parameters.

When they are using mathematics to create 3-D objects from 2-D designs, they use measuring equipment with precision and consider the impact of errors in measurement upon the final product or system.

SACSA numeracy statement

Learners develop and use operational skills in numeracy to understand, analyse, critically respond to and use mathematics in different contexts. These understandings relate to measurement, spatial sense, patterns and algebra and data and number. This learning is evident in design and technology when, for example, students use spatial understandings, particularly the relationship between shape, structure and function to inform 2-D and 3-D design. Other relevant examples include students applying accurate measurement and mathematical formulae when designing and constructing products. (DETE, 2001, Middle Years Band, pp 39–40)
When critiquing products and systems, students draw upon mathematical tools of data analysis, number sense, estimation and mental computation. They consider form, which immerses them in shape investigation. When designing, students create a design brief. They use mathematics to develop this design brief. They may consider a way of communicating their design brief that involves scale modelling of their product. This will promote understanding of proportional reasoning and scale. They may use a flow chart to show the stages in creation of their product. This relies on time understanding and time management. Their design brief includes statements about the positive and negative impact of their product, and this requires analysis of data to justify their decision-making processes. In making, students must adhere to timelines, which is an aspect of numeracy.

Through designing, students demonstrate numeracy when they consider product improvement, when they communicate their designs using mathematics symbols, drawings and equations.

Learning Area—Design and technology

**Contexts**

Numeracy demands are embedded in the contexts for design and technology learning activities. Through critiquing existing designs and systems, students develop numeracy through analysing cost and architectural design and arrangement. They demonstrate numeracy when they analyse the positive and negative impact of products and systems upon the environment, in terms of safety and material selection. Through designing, students demonstrate numeracy when they consider product improvement, when they communicate their designs using mathematics symbols, drawings and equations. When considering the cost of their designs, they use spreadsheets where mathematical formulae are utilised to show impacts and design variations. In their design brief, they show how their design will benefit particular groups or users, and this analysis requires mathematical tools and techniques. When they are engaged in making, students must adhere to timelines, which is an aspect of numeracy.

**Tools**

When critiquing products and systems, students draw upon mathematical tools of data analysis, number sense, estimation and mental computation. They consider form, which immerses them in shape investigation. When designing, students create a design brief. They use mathematics to develop this design brief. They may consider a way of communicating their design brief that involves scale modelling of their product. This will promote understanding of proportional reasoning and scale. They may use a flow chart to show the stages in creation of their product. This relies on time understanding and time management. Their design brief includes statements about the positive and negative impact of their product, and this requires analysis of data to justify their decision-making processes. In making, students use mathematics tools in context, finding out in authentic situations things such as the importance of planning, of calculating and of exact measuring.

**Dispositions**

In design and technology, students are exploring real situations and creating new products. Because of the subject’s link to their present and future lives, engagement in design and technology can promote positive numeracy dispositions. Application of mathematics occurs in a context, and application of mathematical tools and techniques shows the utility of mathematics. Design and technology draws upon imagination and creative thinking. These processes are also desirable in the study of mathematics. Promotion of these processes through design and technology learning experiences encourages positive dispositions to using mathematics in context.

**Critical Orientation**

The design and technology Learning Area promotes critical orientation. Through the critiquing strand, students consider the impact of technologies existing in our society. As they design, they are empowered to effect change by developing a repertoire of thinking skills and creative dispositions. They learn that there are rarely single or ‘right’ answers when critiquing, designing or making technology. (ibid, p 36)
# Numeracy evaluation in English

## Mathematical Knowledge

Figure 4 maps numeracy learning demands in English onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Mathematics strands</th>
<th>English strands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
<td>Texts and contexts</td>
</tr>
<tr>
<td>Measurement</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td></td>
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<tr>
<td>Pattern and algebraic reasoning</td>
<td></td>
</tr>
<tr>
<td>Spatial sense and geometric reasoning</td>
<td></td>
</tr>
</tbody>
</table>

**SACSA numeracy statement**

Learners develop and use operational skills in *numeracy* to understand, analyse, critically respond to and use mathematics in different contexts. These understandings relate to measurement, spatial sense, patterns and algebra and data and number. This learning is evident in English when students, for example, use graphs and tables in oral and written presentations to support an argument or draw on understandings of spatial arrangement to understand and critique text layout and construction. (DETE, 2001, Middle Years Band, p 66)

The English Learning Area, as described in the SACSA Framework, indicates only minimal numeracy demands and only in some aspects of the mathematics strands.

Through the strand of texts and contexts, students may interpret diagrams, turn texts into tabular form and use a variety of images to present research findings, which links to the mathematics strand of exploring, analysing and modelling data. They examine past, present and future perspectives, which provides an avenue for developing measurement understanding in relation to time and timelines. They examine how the media influences or persuades and explore the conventions used in advertising for this purpose. In this way, students will develop spatial sense through exploration of signs and symbols. In the language strand, students use spoken language to convey their message. Through consideration of rhythm, pace and timing, they are engaging in measurement. When they critically appraise choices of language and modes of communication (eg camera shots), they are extending their spatial sense and understanding of position and perspective. In the strategies strand, students may critically analyse statistics presented in speeches or other media and use tables to communicate or interpret. In this way, they are engaging in the mathematics strand of exploring, analysing and modelling data.
Tools

In English learning activities, students have the potential to develop their tools for numeracy. Through texts and contexts, language, and strategies, they can research situations and analyse real data. They can convert text to table form and consider how various forms of texts communicate messages. When reading maps and instruction manuals, students are considering pictorial text and how this conveys messages.

Critical Orientation

Through English learning activities, students develop critical literacy skills that enable them to challenge and question information presented to them. Using numeracy can support this critical disposition. Through analysis of the construction of texts, students explore information that is presented and consider information that is not presented. When they are presented with text that contains statistics and data, they can explore how they are being persuaded by the text-creator. Bringing numeracy to critical analysis of texts supports development of a critical orientation. A stronger focus on numeracy through English learning activities may reduce the cultural perception that being numerate is dependent upon success in school mathematics.

Contexts

All three strands of the English curriculum have the potential to provide contexts for numeracy development. The extent to which this occurs would be dependent upon decisions made by the teacher or students. Currently, the SACSA Framework for English provides few examples of numeracy experiences, and this tends to under-represent the numeracy demands of the Learning Area. For example, considering the publication date of a piece of text can assist students develop understanding of time and timelines. When students are involved in making magazines, greeting cards, pamphlets, arts works, promotional videos, websites, song lyrics, newspapers and advertisements, they are experiencing numeracy demands. And as students conduct research for their written texts, they encounter numeracy demands associated with analysis of data and statistics.

Dispositions

It is a sad fact that many people in our society will admit to being poor at tasks that involve mathematics. Yet, few people will readily admit to having difficulties with literacy. Many students in the middle years of school have made decisions about their capabilities in relation to English and mathematics and this impacts upon their personal views of their own literacy and numeracy. Through English learning activities having a greater focus on the numeracy demands of this Learning Area, students may have a greater opportunity to develop positively their personal views about mathematics and numeracy. They will become more aware of the ways numeracy empowers and how this can be incorporated in any medium to convey their message.
Health and physical education

Numeracy evaluation in health and physical education

Mathematical Knowledge

Figure 5 maps numeracy learning demands in health and physical education strands onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Mathematics strands</th>
<th>Physical activity and participation</th>
<th>Personal and social development</th>
<th>Health of individuals and communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
<td>Blue</td>
<td>Blue</td>
<td>Blue</td>
</tr>
<tr>
<td>Measurement</td>
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<td>Number</td>
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<tr>
<td>Pattern and algebraic reasoning</td>
<td>Blue</td>
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<tr>
<td>Spatial sense and geometric reasoning</td>
<td>Blue</td>
<td>Blue</td>
<td>Blue</td>
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</tbody>
</table>

Figure 5 – Mathematical knowledge demands within strands of the health and physical education Learning Area

This Learning Area is rich in mathematical knowledge demands, particularly through measurement and the analysis and modelling of data. For example, students can measure and analyse the effects of physical activity on the body, evaluate their food intake in relation to known health risks, and analyse nutritional information on food labels.

SACSA numeracy statement

Learners develop and use operational skills in numeracy to understand, analyse, critically respond to and use mathematics in different contexts. These understandings relate to measurement, spatial sense, patterns and algebra and data and number. This learning is evident in health and physical education when, for example, students use numbering, patterning and ordering in physical activities and when they show understanding of the relationship between time, space and distance to analyse physical achievement. It is also evident when students compare specific measuring techniques and tools for different purposes and analyse data and statistics in relation to health issues. (DETE, 2001, Middle Years Band, pp 99–100)
Throughout this Learning Area, there is an emphasis on critical reflection and analysis of how people view each other, of information available through the media, and of sociocultural and political factors that promote wellbeing. Teachers will also need to explicitly promote a critical orientation to how their students use mathematics to reflect on and analyse issues arising from investigation of health and physical education issues.

Students can measure and analyse the effects of physical activity on the body, evaluate their food intake in relation to known health risks, and analyse nutritional information on food labels.
Languages

In the SACSA Framework, the elaboration of Scope and Standards is presented for three broad groupings of languages: alphabetic languages, non-alphabetic languages and Australian Indigenous languages. In addition, the Framework allows for different Pathways and entry points that recognise the different learning backgrounds that students bring to their learning of languages. Pathway 1 for second language learners is for children and students with little or no prior knowledge of the target language at entry, while Pathway 2 refers to background learners who have some prior learning and use of language at entry. The different entry points distinguish between those who begin learning the language in the Early Years (Entry Point A) versus the Middle Years (Entry Point B, from Year 8).

For the purposes of this curriculum audit, alphabetic languages were selected together with Pathway 1A because it encompasses students across the full Middle Years Band who enter with little or no knowledge of the target language.

Numeracy evaluation in languages

Mathematical Knowledge

Figure 6 maps numeracy learning demands in languages onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Mathematics strands</th>
<th>Communication</th>
<th>Understanding language</th>
<th>Understanding culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
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<td></td>
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<tr>
<td>Measurement</td>
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<td>Number</td>
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<tr>
<td>Pattern and algebraic reasoning</td>
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<tr>
<td>Spatial sense and geometric reasoning</td>
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</tbody>
</table>

The most significant numeracy demands in the languages Learning Area occur in the strands of communication and understanding language. In both cases, students need to be able to compare how notions of time, location and direction, and quantity are expressed in English and the target language. In the understanding language strand, specific attention is given to language structures and conventions, including the use of quantifiers and comparatives,
Critical Orientation

A critical orientation to communicating and evaluating ideas, especially those expressed in the media, is evident in the understanding language strand. Similarly, in the communication strand, students are expected to work with popular texts available in print and online. If the content of these texts is investigated from a numeracy perspective (e.g., investigating advertising claims that have a mathematical basis), then teachers may have opportunities to develop critical numeracy orientations in their students.

Contexts

Contexts for learning languages include students’ ‘own physical environment, the world of learning and knowledge, and environments in which the target language is used’ (ibid, p 133). There is a need here for teachers to make connections with students’ personal interests, family and community life, leisure pursuits, and career aspirations. The study of languages also provides opportunities to explore topics from other Learning Areas, especially society and environment, arts, and design and technology. Each of these real world and school contexts offers situations for developing numeracy in English as well as the target language.

Dispositions

Within the understanding culture strand, students are expected to demonstrate respect for cultural diversity. However, beyond this, there is little explicit reference to development of positive dispositions in the languages (e.g., alphabetic, Pathway 1A) Learning Area of the SACSA Framework.

Tools

In the languages Learning Area, it is recommended that students use digital tools such as CD-ROMs, websites and databases to learn about the target language and the communities and cultures in which it is used. These are generic tools that are not numeracy-specific.

cardinal and ordinal numbers, time expressions (including clock time and dates), expressions of frequency and duration, and prepositions for position, place and direction. Each of these has mathematical significance. For example, the naming of ‘teen’ numbers, numbers beyond 20, and fractions differs between English and many other languages, and these differences can make it more or less easy for students to learn about the base 10 number system or the meaning of the numerator and denominator of a fraction.

Students need to be able to compare how notions of time, location and direction, and quantity are expressed in English and the target language.
Science

Numeracy evaluation in science

Mathematical Knowledge

Figure 7 maps numeracy learning demands in science strands onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Mathematics strands</th>
<th>Earth and space</th>
<th>Energy systems</th>
<th>Life systems</th>
<th>Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement</td>
<td></td>
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<tr>
<td>Number</td>
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<td></td>
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<tr>
<td>Pattern and algebraic reasoning</td>
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<tr>
<td>Spatial sense and geometric reasoning</td>
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</tbody>
</table>

Figure 7 – Mathematical knowledge demands within strands of the science Learning Area

The mathematics strand of exploring, analysing and modelling data is an essential aspect of scientific enquiry. Bound up with a scientific approach to the collection and analysis of data are the essential skills associated with the measurement strand and, by association, the number strand. While students will naturally be engaged with these elements in the processes of investigation and data gathering, it is important to pay explicit attention to the mathematical aspects of such activities.

SACSA numeracy statement

Learners develop and use operational skills in numeracy to understand, analyse, critically respond to and use mathematics in different contexts. These understandings relate to measurement, spatial sense, patterns and algebra and data and number. This learning is evident in science when, for example, students pose hypotheses based on generalisations made from existing data, develop accuracy in measuring and interpreting data, identify patterns in nature and behaviour and use formulae and calculations. (DETE, 2001, Middle Years Band, p 265)
Tools

Scientific approaches to understanding the world through investigation, and other approaches to data gathering, necessitate the use of appropriate tools. These may be tools that are used to gather data in real time investigation situations, to search existing databases for data, and to assist with the analysis of data once they have been collected. Such tools might include:

- various data gathering probes, such as those used to measure temperature, the flow of current and the rate of a chemical reaction
- instruments for the measurement of very large or very small quantities, such as weight scales or micrometers
- online data sources, such as longitudinal records of average temperatures in specific locations
- technological tools, such as spreadsheets or other data processing tools that assist students to interpret data
- presentation tools that provide the opportunity to display the findings that result from a scientific investigation.

Critical Orientation

The increasingly important issue of sustainability demands that students develop a critical perspective on how decisions that affect the quality of the environment are made at the local, national and international level and, as a consequence, the capacity of natural systems and resources to support the demands of human societies. The representational and analytical tools provided by mathematics inform students of the challenges before them and assist them to develop personal contributions to meeting these challenges.
Society and environment

Numeracy evaluation in society and environment

Mathematical Knowledge

Figure 8 maps numeracy learning demands in society and environment onto the SACSA Framework’s Middle Years Band mathematics strands.

<table>
<thead>
<tr>
<th>Mathematics strands</th>
<th>Society and environment strands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring, analysing and modelling data</td>
<td>Time, continuity and change</td>
</tr>
<tr>
<td>Measurement</td>
<td>Place, space and environment</td>
</tr>
<tr>
<td>Number</td>
<td>Societies and cultures</td>
</tr>
<tr>
<td>Pattern and algebraic reasoning</td>
<td>Social systems</td>
</tr>
<tr>
<td>Spatial sense and geometric reasoning</td>
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Figure 8 – Mathematical knowledge demands within strands of the society and environment Learning Area

The Learning Area of society and environment has many inherent numeracy demands. The need to make decisions and adopt positions based on evidence and take a data driven approach to argumentation means the mathematical strands of exploring, analysing and modelling data, measurement, and spatial sense and geometric reasoning are particularly relevant. Students can demonstrate changes to aspects of the environment (eg the rate of deforestation in a number of developing countries) through reference to available data, or consider the advantages of different architectural designs for built environments in hot, dry climates.

SACSA numeracy statement

Learners develop and use operational skills in numeracy to understand, analyse, critically respond to and use mathematics in different contexts. These understandings relate to measurement, spatial sense, patterns and algebra and data and number. This learning is evident in society and environment when, for example, students use and understand the concept of time, when they use spatial patterns, locations and pathways in the form of maps, and they gather and analyse data for social decision-making. (DETE, 2001, Middle Years Band, p 294)
The use of tools to collect and then analyse the information necessary for a critical approach to decision making is vital to this Learning Area. These tools include representational, physical and digital tools such as:

- maps and charts for identifying the characteristics of a specific environment (e.g., contours, type and degree of forestation, proximity of arid zones to other environments, the paths and interconnectedness of river systems, plans for built environments)
- instruments for measuring location and position, such as GPS systems and tools used for surveying
- online data sources, such as archival records of rainfall in specific catchment areas
- digital tools, such as spreadsheets and software applications developed specifically for the analysis and representation of data.

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- digital tools, such as spreadsheets and software applications developed specifically for the analysis and representation of data.

As ‘... the ultimate goal of learning through society and environment is that children and students develop the knowledge, skills and values which will enable them to participate, in a range of ways, as ethical, active and informed citizens in a democratic society within a global community’ (ibid, p 292), a critical orientation to viewing information and an analytical approach to the interpretation of data must be embedded within this Learning Area. Again, specific attention will need to be given to the explicit use of mathematical approaches to interpreting the world rather than assuming such approaches will be simply ‘absorbed’ by students through participation in this Learning Area.
Mathematics evaluation in mathematics

Mathematical Knowledge

The SACSA Framework for mathematics in the Middle Years Band identifies five strands: exploring, analysing and modelling data; measurement; number; pattern and algebraic reasoning; and spatial sense and geometric reasoning. In the rest of the audit, the numeracy demands of each Learning Area were mapped onto these mathematics strands.

From a numeracy perspective, effective mathematics teaching demands that students see connections between the different strands and between mathematics and the real world. While this seems self-evident, it is easy to overlook chances to explore ideas in measurement, for example, while working within the pattern and algebraic reasoning strand. Knowledge of and capacity to make use of the interconnectedness of mathematical ideas, represented here in the strands, is a vital element in being effectively numerate. Investigations into life-related contexts are rich in these types of connections. For example, a student might measure the height of a plant grown from a seed over a series of weeks and then graph these data. Students might also attempt to find a pattern in the rate of growth, based on both numeric and graphing data. The investigation might be extended to investigate the effects on growth of different planting arrangements of the seedlings in a gardening plot. Each of these examples highlights the numeracy demands of the mathematics Learning Area in terms of developing mathematical knowledge.

Contexts

The Learning Area of mathematics aims to empower students, through the capacity to use mathematical ideas critically, to become active and constructive citizens of their society. As stated in the SACSA Framework: ...

... in the SACSA Framework mathematics is broadened through the Essential Learnings. The social, political, economic, historical and cultural aspects of mathematics become a priority. Issues such as understanding the social uses and applications of mathematics, the impact of technological change, and new requirements of the workforce and education/training courses will be the catalysts for mathematics learning. It is imperative that learners are competent users of ICTs, that they are critical and ethical consumers and evaluators of knowledges, and that they develop identities which incorporate a positive sense of themselves as a mathematical learner. (ibid, p 218)

This statement portrays a role for mathematics that is broader than that of the study of a subject for its own sake and more expansive than that of an enabling discipline for other Learning Areas. Numerate citizens must use mathematics in order to explore the cultural and social issues of the world as well as the scientific and economic changes that are taking place in society.
Dispositions

Students’ dispositions towards mathematics are inevitably influenced by their experiences in mathematics lessons. By the middle years of schooling, many students have come to believe that they are not successful at mathematics, or that learning mathematics involves memorising facts and formulae, or that there is always one correct way of solving any problem. These beliefs are not conducive to developing positive numeracy dispositions such as confidence, flexibility, initiative and willingness to take intellectual risks. Emphasising applications of mathematics has a vital role to play in a teacher’s development of numeracy in his/her students. To apply mathematics to the real world requires students to develop as flexible thinkers with the confidence to show initiative and a disposition towards taking calculated risks—to trial an approach, to evaluate the success or otherwise of an attempt and then to make the necessary changes required to improve their response to a task.

Tools

The use of tools in mathematics has a long history, especially in areas that are related to calculation and geometry. More recently, however, the role of digital tools in learning and teaching mathematics has become increasingly important. The following tools are used in mathematics:

- rulers, measuring tapes, trundle wheels and a variety of survey equipment that are used to determine distances, altitudes and relevant positions of landmarks
- geometrical tools that are used for determining comparative distances and angles between objects or landmarks on scaled maps
- data logging devices that collect information in real time on life-related phenomena such as velocity, distance, gas absorption and applied force
- online data sources (eg archival records of athletic performance)
- digital tools, such as software applications or learning objects developed for the exploration of real world phenomena.

Critical Orientation

Mathematics can provide vital analysis tools for the critical examination of claims made or opinions expressed by politicians and policy makers. These tools are also important for citizens to understand and engage with the processes of cultural, social and environmental change that is taking place globally. It is important within mathematics that an outward orientation towards other real world and curriculum contexts is developed so that such issues are brought into the mathematics classroom.
Summary

The numeracy demands inherent in the Learning Areas that comprise the SACSA Framework can be evaluated in terms of mathematical knowledge requirements, contexts for learning, dispositions developed, tools used, and critical orientations. This section presents an overview of the audit findings as a whole in order to establish the numeracy demands of the intended curriculum as represented by the Framework.

Mathematical Knowledge

Figure 9 synthesises the mathematical knowledge requirements of the seven Learning Areas apart from mathematics itself.

<table>
<thead>
<tr>
<th>Learning Area</th>
<th>Arts</th>
<th>Design and technology</th>
<th>English</th>
<th>Health and physical education</th>
<th>Languages</th>
<th>Science</th>
<th>Society and environment</th>
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<tbody>
<tr>
<td>Mathematics strands</td>
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From Figure 9 we see that the level of numeracy demand is highest for design and technology, science, and arts; moderate for society and environment, and health and physical education; and lowest for English, and languages.

Despite these differences, however, it is important to recognise that all Learning Areas have distinctive numeracy demands in relation to the type of mathematical knowledge required by students in order to demonstrate successful learning. Teachers are ultimately responsible for enacting the curriculum in their classrooms and they can, therefore, exploit numeracy learning opportunities in the Learning Areas beyond those implied by the published curriculum.

The strands of mathematical knowledge are also represented to different extents in the Learning Areas. Exploring, analysing and modelling data is most strongly represented, followed by measurement, number, and spatial sense and geometric reasoning, with the strand of pattern and algebraic reasoning the least strongly represented. It is perhaps not surprising that algebra, as an element of numeracy knowledge, appears to be under-represented in the curriculum, since some people may believe that algebraic ideas are quite abstract and have little connection with real world contexts or Learning Areas other than mathematics. However, it is worth emphasising the potential connection between algebraic reasoning and modelling with data, since exploration of patterns and generality in the middle years of schooling can begin with an empirical focus on data collection and analysis.
Summary

**Tools**

Representational, physical and digital tools are used across all Learning Areas. Some of these are specific to the discipline while others are more generically useful. Graphs, diagrams, tables, maps and plans are commonly used in many Learning Areas, as are measuring instruments, both physical and digital. There is also a strong emphasis on digital tools, software, and web resources. Thus, all Learning Areas have specific numeracy demands in relation to accurate and intelligent use of tools to represent and analyse ideas. Students need to become proficient with the tools of each Learning Area, but they also need to be aware that some tools are used in more than one Learning Area and to be flexible in applying tools in different curricular contexts. For example, students may come to believe that there are different ways to read and create maps in mathematics as compared with society and environment, or different ways to create graphs that show relationships between variables in science as compared with health and physical education. Teachers in these Learning Areas need to be aware of any differences in techniques and terms associated with the use of these representational tools and to draw students’ attention to important similarities between underlying concepts.

**Critical Orientation**

The SACSA Framework emphasises developing a critical orientation in students across all Learning Areas. Such an orientation cannot be fully enabled without numeracy knowledge, dispositions and tools, nor can it be convincingly enacted unless learning takes place in a range of real life contexts. Conversely, being numerate requires adopting a critical stance in order to question, compare, analyse, and consider alternatives. The numeracy demands inherent in the Learning Areas should facilitate development of this critical orientation.

**Dispositions**

Throughout the SACSA Framework, there is evidence of a desire to develop in learners positive dispositions such as perseverance, confidence, resilience, willingness to take risks and for them to show initiative, respect for cultural diversity, and commitment to ecological sustainability. These are admirable goals, but dispositions towards learning in one discipline do not automatically transfer to another discipline; it is possible, for example, for students to feel confident about their learning in arts but not in mathematics and not in relation to numeracy more generally. Teachers need to be aware of the damaging effects of negative mathematical dispositions, to look for opportunities to successfully engage their students with the numeracy demands of their Learning Area, and to make explicit to students the positive dispositions that are helping them to achieve this success. Linking positive dispositions with numeracy learning is therefore vital.

**Contexts**

The range of numeracy learning contexts highlighted in the tetrahedral model in Figure 1 is well represented across the Learning Areas of the SACSA Framework. Each Learning Area, including mathematics, emphasises the value of connecting students’ learning to real life contexts that are meaningful for them, whether this involves personal interests, family and community life, leisure pursuits, the physical environment, vocations and careers, diverse cultures, or social, economic and political systems. The numeracy statement for mathematics says that students should develop and use mathematics in different contexts and also supports the notion of curricular numeracies by noting that students should ‘apply mathematical understandings to their learning in all curriculum areas’ (DETE, 2001, Middle Years Band, p 219). The numeracy statements for the other Learning Areas also make it clear that numeracy is both developed and demonstrated by working in a variety of contexts.
### Planning resource: Identifying numeracy demands in curriculum

Use this table to record further numeracy examples that you may identify as you read this audit and reflect on the numeracy embedded in your area of specialisation or planned unit of work.

<table>
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Bibliography


