Numeracy Across the Australian Curriculum: Opportunities from F to 6

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This study examined how opportunities to incorporate numeracy across different primary curriculum areas and grade levels are highlighted in the Australian Curriculum v9.0. A document analysis approach was used to track the numeracy opportunities in the document across different curriculum areas and grade levels. The results showed that Science has the most identified numeracy opportunities across all grade levels, with 43 occurrences. Findings also showed Statistics as the most prominent mathematics content strand suggested as numeracy opportunities, followed by Space. The study provides examples of missed numeracy opportunities in underrepresented curriculum areas.

The need for numeracy in students as an important skill for effective participation in society is widely recognised. As a result, fostering numeracy has become a priority in school systems internationally, including Australia (Australian Curriculum and Assessment Reporting Authority [ACARA], 2022). The definition of numeracy as the ability to apply mathematics in diverse life situations has gained widespread acceptance and influenced research and curriculum development (Department of Employment, Education, Training and Youth Affairs [DEETYA], 1997). As it is situated within the Australian Curriculum: Mathematics, numeracy encompasses the knowledge, skills, behaviours, and dispositions that students need to use mathematics in a wide range of situations. It involves students recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully (Geiger et al., 2015).

Numeracy develops as students learn to confidently apply mathematics across different curriculum areas and in diverse life contexts (ACARA, 2022; Bennison, 2015; Ford, 2018). Recognising its cross-curricular importance, countries including the UK, the USA, New Zealand, and Australia have integrated numeracy into various curriculum areas. In Australia, it is a key component of the general curriculum capabilities, in addition to, for example, literacy and social skills. However, integrating numeracy across curriculum areas and various mathematical concepts can be challenging for teachers (Geiger et al., 2015; Gough, 2007; Getenet, 2023). For example, Geiger et al. (2015) noted limited numeracy integration in English, while Gough (2007) highlighted its prevalence in Science. Additionally, Getenet (2023) found that pre-service teachers are more interested in incorporating statistical concepts than other mathematical concepts into other curriculum areas. To support teachers, the Australian Curriculum v9.0 (and previous iterations) includes a numeracy icon that highlights numeracy opportunities across the curriculum content (ACARA, 2022). There is, however, a lack of comprehensive research on how these opportunities are distributed across different curriculum areas, year levels, and the type of mathematical concepts included.

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This study aims to address this gap through a document analysis of v9.0 of the Australian Curriculum, addressing the following research questions:

- How does the representation of numeracy in the Australian Curriculum v9.0 vary across different year levels and curriculum areas?
- Which mathematical concepts or strands are most prominently represented in the numeracy aspects of the Australian Curriculum v9.0?

This research will also identify potential gaps, illustrate examples of missed opportunities in numeracy through lack of identification in curriculum documents across key learning areas, and provide insights into implications for teachers' practices. Furthermore, the results will assist teachers by highlighting the presence of extra numeracy opportunities throughout all curriculum areas, beyond those specified in the curriculum. This will encourage teachers to incorporate these missed opportunities into their lesson planning and teaching strategies, thereby addressing the issues associated with teachers identifying numeracy opportunities. Missed numeracy opportunities in this study refer to those mathematical knowledge, skills and dispositions that exist within curriculum areas but are not explicitly denoted with the numeracy icon.

Background

Numeracy Across Curriculum Areas

To develop students' skills in numeracy, teachers are required to provide opportunities for students to use their mathematical knowledge and understanding in multiple contexts. Various strategies and approaches to support this development include cross-curriculum area approaches and teaching numeracy as a separate discipline. When teachers are encouraged to identify and use the numeracy learning opportunities in various curriculum areas, students' numeracy capabilities and learning in each area are likely to be enhanced and help students learn to think critically (Bennison, 2015; Brown et al., 2002). This support allows students to transfer their mathematical knowledge and skills to contexts outside the mathematics classroom and across the curriculum areas (Bennison, 2015; Mathieson & Homer, 2021). In Australia, teachers are encouraged to develop students' numeracy skills by using mathematics confidently across all curriculum areas (ACARA, 2022). These curriculum areas are English, Humanities and Social Science (HASS), Health and Physical Education (HPE), Languages, Science, Technologies (digital and design), and the Arts. By including numeracy as a general capability in the Australian Curriculum v9.0, teachers are directed to opportunities to support students in developing their numeracy capabilities across curriculum areas (ACARA, 2022; Forgasz et al., 2017).

General capabilities, including numeracy and cross-curriculum priorities tagging, have been included in the Australian curriculum documents with revisions made in 2011 (ACARA, 2011). In 2020, the numeracy icons were linked with the Numeracy Progression version 3.0. The numeracy progressions supplement and underpin the Australian Curriculum v9.0 and describe the observable indicators of increasing complexity in the understanding of and skills in key numeracy concepts (ACARA, 2020). In version 9 of the Australian Curriculum, the numeracy icons are again linked with the numeracy progressions as they were previously, in relation to the elements of Number and Algebra, Measurement and Geometry, and Statistics and probability, rather than the updated six content areas in v. 9 of the national curriculum. While the inclusion of the numeracy icons highlights numeracy opportunities across different content areas and is designed for teachers to integrate numeracy into various curriculum areas, the links are not comprehensive and could inadvertently lead to teachers overlooking valuable numeracy opportunities. Studies looking into these opportunities, including those not explicitly indicated in the curriculum, could provide teachers with a broader range of options for incorporating numeracy, rather than being restricted to the opportunities specifically shown in the national curriculum.

Method

This study used a document analysis method to examine the numeracy presentations in the Australian Curriculum v9.0 from Foundation to Year 6. The focus was on how numeracy is represented across various curriculum areas and year levels and identifying missed opportunities. Document analysis, as defined by various researchers such as Bowen (2009) and Morgan (2022), involves categorising information from diverse sources like books, national guides, articles, and reports to address the research questions. This approach also considers the document's purpose, target audience, authorship, and original sources.

The Australian Curriculum v9.0: Mathematics is divided into six strands: Number, Algebra, Measurement, Space, Statistics, and Probability. Each strand has content descriptors and elaborations detailing student learning objectives and teaching examples. In addition, numeracy opportunities are made explicit throughout the other curriculum areas through the use of an icon linked to numeracy learning progressions. The curriculum incorporates references to *Relevant Content Descriptors* (outlined in Table 2), highlighting areas in mathematics where opportunities to develop numeracy skills can be identified.

Given that our team's expertise predominantly lies in primary education, our study's scope was strategically limited to Foundation to Year 6 levels. In addition, the Language curriculum, was not included in the analysis to further limit the scope of this study. This decision ensured a focused and in-depth analysis within our areas of expertise. To conduct the document analysis, we followed a structured three-step process as suggested by Bowen (2009). We began by skimming the curriculum documents for a preliminary understanding, followed by a thorough reading to quantify and characterise the numeracy representations, and concluding with an interpretation phase where the data was categorised based on curriculum areas, year levels, and mathematical strands. Our analysis was informed by the *Numeracy for the 21st Century Model* (Goos et al., 2012). The model was developed to support teachers in improving their students' numeracy capabilities in the range of curriculum areas, evaluating activities related to numeracy, as well as identifying opportunities for numeracy engagement. The model consists of four core dimensions: attention to contexts, application of mathematical knowledge, use of physical and digital tools, and promotion of positive dispositions. Of particular relevance to our analysis was the consideration of context which the curriculum areas logically provided.

In addition, to enhance the rigour and reliability of our findings, each curriculum area was independently analysed by two authors. This dual-analysis approach ensured a comprehensive review and fostered consistency across our analysis. Any inconsistencies uncovered during this stage were addressed through further collaborative discussions. The specific activities and steps involved in our analytical process are shown in Table 1.

Table 1

Steps of the Document Analysis in the Study

Step	Description
Skimming	A preliminary review of the curriculum documents by each author to identify initial numeracy opportunities for further analysis
Reading	Detailed examination of the curriculum to quantify how often numeracy opportunities occur within each curriculum area
Interpretations	Categorisation of the numeracy opportunities identified, based on the specific curriculum areas, year levels, and the mathematical concepts or strands emphasised

As shown in Table 1, the authors initially reviewed the document, followed by quantifying identified numeracy opportunities across curricular areas. Finally, in the interpretations step, the findings of the numeracy opportunities were categorised based on curriculum areas, year levels, and mathematical concepts or strands. In addition to these steps, the authors also

identified and illustrated examples of missed numeracy opportunities in each curriculum area through a thorough analysis of the content descriptors of each curriculum area.

Results

The results of this study are presented to correspond with the research questions. These questions examine how numeracy is represented in the Australian curriculum across various year levels and curriculum areas and identify which mathematical concepts or strands are most prominently featured in the numeracy opportunities of the Australian curriculum.

Numeracy Representations in the National Curriculum Across Various Year Levels and Curriculum Areas

We have identified the articulated numeracy opportunities across various curriculum areas through document analysis of the Australian curriculum. With the exception of the Foundation year level, the numeracy opportunities in the curriculum for HPE, Technologies, and the Arts are presented for combined year levels. Specifically, these opportunities are grouped as Years 1 and 2, Years 3 and 4, and Years 5 and 6, as shown in Table 2 and further in Table 3.

Table 2 outlines numeracy opportunities across various curriculum areas and year levels. As shown in Table 2, in the English curriculum, there is a complete absence of numeracy opportunities from Foundation to Year 6, both directly and through related content descriptors. On the other hand, Science consistently provides numeracy opportunities across all year levels, peaking at 10 in Year 1 and varying between 3 to 9 in subsequent years. The HASS curriculum shows an increase in related content descriptors numeracy opportunities, ranging from three in Foundation to eight in Years 4 and 5, and finally leading to one direct opportunity in Year 6. In Table 2, the first number refers to the frequency of numeracy opportunities denoted with icons in the curriculum, whereas the number in brackets refers to the frequency of the related mathematics content links in each key learning area.

Table 2

Frequencies of Identified Numeracy Opportunities (Related Content Descriptors) in Various Curriculum Areas by Year Level

Curriculum area		Year level						
		F	1	2	3	4	5	6
English		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
HASS		0 (3)	0 (6)	0 (6)	0 (8)	0 (8)	0 (7)	1 (7)
Science		9 (11)	10 (9)	5 (5)	6 (7)	3 (3)	4 (4)	6 (6)
HPE		1 (3)	1 (3)		0 (5)		0 (2)	
Technologies	Digital	1 (1)	2 (5)		3 (9)		3 (6)	
	Design	0 (2)	1 (2)		1 (5)		0 (4)	
The arts	Dance	0 (0)	1 (0)		0 (0)		0 (0)	
	Drama	0 (0)	0 (0)		0 (0)		0 (0)	
	Media	0 (0)	0 (0)		0 (0)		0 (0)	
	Music	0 (0)	0 (0)		0 (0)		0 (0)	
	Visual	0 (0)	1 (0)		0 (0)		0 (0)	

The HPE curriculum presents numeracy opportunities in Foundation (n = 1), Year 1 (n = 1), Year 2 (n = 1), and in Years 3, 4, Year 5 and Year 6 with none in the related content descriptors opportunities. The Technologies curriculum, particularly in Digital Technologies, shows limited numeracy opportunities ranging from one in Foundation to three in Years 3 and 4, while design technologies present fewer opportunities than digital technologies. However, more

numeracy opportunities were found in the related content descriptors in both design and digital technology curricula. In the Arts curricula, numeracy opportunities are extremely limited, with only a few instances including in related content descriptors, such as one opportunity in Dance in Year 1 and one in Visual Arts in Year 1, with no opportunities in Drama, Media, and Music across all years. These results illustrate the varying degree of emphasis on numeracy in different curriculum areas and year levels, indicating areas where the inclusion of numeracy could be enhanced.

We further aligned the identified numeracy opportunities with the corresponding strands of the mathematics curricula. This alignment includes both opportunities directly suggested in the general numeracy capability and those related to mathematics content descriptors. This helps to determine which specific strands of Mathematics are given emphasis in various curriculum areas. These findings are presented in Table 3. In Table 3, the lead number is the number of strands linked to the numeracy button in general numeracy capability, and the number in brackets is those mathematics content descriptors linked.

Table 3

Frequencies of the Focus on Mathematical Concepts/Strands Across the Curriculum Areas

Strand	Curriculum area										
	English	HASS	Science	HPE	Technologies		Arts				
					Design	Digital	Dance	Drama	Media	Music	Visual
Number	0 (0)	1 (1)	6 (3)	0 (2)	0 (1)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Algebra	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Space	0 (0)	0 (7)	5 (4)	2 (6)	0 (0)	1 (4)	0 (1)	0 (0)	0 (0)	0 (0)	1 (1)
Measurement	0 (0)	0 (5)	13 (14)	0 (1)	2 (1)	2 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Probability	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Statistics	0 (0)	0 (32)	17 (23)	0 (4)	0 (0)	5 (7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	0 (0)	1 (51)	43 (45)	2 (13)	2 (2)	12 (18)	1 (1)	0 (0)	0 (0)	1 (0)	2 (1)

As shown in Table 3, HASS has a strong focus on Statistics, with 32 related opportunities. Science predominantly highlights Statistics and Measurement, with 17 and 13 direct suggested opportunities, respectively. The HPE curriculum focuses on Space (n = 2 direct suggested opportunities) and Statistics (n = 4 in related content descriptor opportunities). In Technologies, particularly in Digital technologies, there is a notable emphasis on the Statistics strands (n = 7) in the related content descriptor numeracy opportunities. These results showed that Statistics and Measurement are the most prominently featured strands in curriculum areas such as HASS, Science, and Technologies.

Numeracy Missed Opportunities Across Various Curriculum Areas and Year Levels

Although there are multiple potentially missed opportunities across all the curriculum areas, in this section, we provide examples of missed numeracy opportunities where the opportunities were found to be particularly scarce (see Table 2), such as English, Arts, HPE, and HASS. Table 4 provides an overview of some examples of missed opportunities, categorised by curriculum area and year level.

Table 4

Examples of Missed Opportunities for Numeracy Across Different Curriculum Areas

Curriculum area (year level)	Content Description	Description of demonstrated example	Maths content descriptor
English (1)	AC9E1LE0: Discuss how language and images are used to create characters, settings and events in literature by First Nations Australian, and wide-ranging Australian and world authors and illustrators	Map events in the literature on timelines; make timelines for own/families' lives	AC9M1M03: Describe the duration and sequence of events using years, months, weeks, days and hours Measuring Time: P1 Sequencing Time P2 Units of Time
HASS (2)	AC9HS3K02: Significant events, symbols and emblems that are important to Australia's identity and diversity	Discuss the importance of symbolism—religious/cultural/historical etc. Discuss the ... positioning, dominance, colouring etc, in the Australian and First Nations' flags. Design a new flag of relevance to the students with reference to unit fractions	AC9M3N02: Recognise and represent unit fractions including 1/2, 1/3, 1/4, 1/5, and 1/10 and their multiples in different ways; combine fractions with the same denominator to complete the whole Interpreting Fractions: P2: Repeated halving P3 Repeating Fractional Parts
Dance (1 & 2)	AC9ADA2E01: Recognising and describing patterns of movement in dances, using their own words and learnt dance terminology	Combine the dance concept of recognising and describing patterns of movement with mathematics as a "Dance Pattern Sequence Game"	AC9M1A01: Recognise, continue and create pattern sequences, with numbers, symbols, shapes and objects, formed by skip counting, initially by twos, fives and tens Number Patterns and Algebraic Thinking P2: Identifying and creating patterns P3: Identifying and generalising patterns
Media (1 & 2)	AC9AMA2E02: Exploring when, where, how and why First Nations Australians use media arts works to share knowledge about their cultures	Explore the concept of symmetry in Indigenous art, the use of geometric shapes, or the proportions in digital layouts	AC9M1SP01: Make, compare and classify familiar shapes; recognise familiar shapes and objects in the environment, identifying the similarities and differences between them Understanding geometric properties

As shown in Table 2, although some curriculum areas show fewer or no numeracy opportunities suggested directly or in the related content descriptors, it is important for teachers to recognise the potential and the availability for numeracy opportunities within various content descriptors across all curriculum areas (see Table 4). These opportunities are in addition to officially indicated opportunities in the curriculum document. For example, while English does not have explicit links to numeracy opportunities, we have identified several content descriptors within the English curriculum that offer opportunities for numeracy engagement. An example

is the descriptor, "Discuss how language and images are used to create characters, settings, and events in literature by First Nations Australians, and wide-ranging Australian and world authors and illustrators". Under this content descriptor, children can engage in activities such as mapping events in literature on timelines, recording event durations, creating timelines of their own or their families' lives, and making journals or timetables for the week that involve noting times and calculating durations. Such activities draw upon and develop numeracy skills, specifically the ability to describe the duration and sequence of events using years, months, weeks, days, and hours, as outlined in the mathematics curriculum.

Discussion and Conclusion

The Australian Curriculum v9.0 has mandatory general Capabilities that are essential components of curriculum delivery. However, this content analysis has identified that there remain many numeracy opportunities that have not been identified to support primary teachers in developing mathematical concepts and mathematical literacy within the context of all key learning areas. Missed numeracy opportunities predominantly exist in key learning areas that are often categorised as 'Arts curriculum' and those in the domain of health and development. These curriculum areas did not capitalise on the relevant contexts highlighting numeracy opportunities which is a key dimension of the Numeracy for the 21st Century Model (Goos et al., 2012). Further support is required to support teachers in creating and delivering contextualised numeracy tasks to support conceptual development during mathematics lessons and identifying where mathematical literacy can be enhanced by primary teacher consideration and targeting of mathematical demands to enhance conceptual development in a range of key learning areas, and to assist growth in numeracy understandings.

There are too many numeracy opportunities that are possible to articulate in a curriculum document of this nature. Our findings highlight that teacher requires the identification of more numeracy links to support their planning, particularly in English and Arts, followed by HASS, HPE and Technologies that are currently available. Results from studies such as this one could assist teachers in identifying additional opportunities for numeracy across different curriculum areas beyond those specifically marked with a special symbol in the curriculum. These curriculum key learning areas were also highlighted as challenging for teachers to identify numeracy opportunities by previous studies (e.g., Geiger et al., 2015). Whilst the curriculum design lends itself to highlighting numeracy opportunities, these links have been identified in the curriculum at varied levels across the different key learning areas. The results of this study showed that the Science key learning area, which is often described as being hand-in-hand with Mathematics and an integral component of STEM studies, has the most identified links to the numeracy framework and links related to other key learning area content. This further hinders the numeracy connections that can be forged between subjects that are not considered in the STEM field. Gough's earlier study (2007) also underscored the prominent role of Science in this context.

Interestingly, whilst links are often made between numeracy and the number strand, the most emphasised strands in the Australian curriculum linked to the numeracy framework are Statistics, Measurement and Space. This result aligns with the findings of a recent study by Getenet (2023), which indicates that teachers tend to favour the integration of statistical concepts into various curriculum areas over other mathematical concepts. The potential exists to build on the numeracy connections included in the Australian curriculum to Probability, Algebra and Number, where there are many examples of numeracy demands that are relevant to societal interactions and functioning. The number of suggestions and content links is similar across the year levels, with the exception of the Foundation year in Science, which has high numeracy indicators for that year level. The numeracy opportunities refer teachers to concepts in the numeracy framework. However, examples of suggested numeracy tasks to support

primary teachers' enhancement of numeracy development are not provided. To emphasise samples of missed numeracy opportunities in the national curriculum in English, HASS and Arts, the affordances of providing sample numeracy task suggestions have been highlighted.

This study has certain limitations that need to be recognised. First, to reduce bias and enhance credibility, documentary evidence can be supplemented with data from interviews and observations. However, in this case, the findings are solely derived from document analysis. Incorporating insights from school teachers regarding their application of the curriculum's numeracy indicators in designing classroom activities could have provided more robust results. Future research that addresses these limitations would offer a more substantial generalisation.

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