

Academic Numeracies Framework: A tool to embed numeracy in university curricula

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This paper introduces an Academic Numeracies Framework ('Framework'), designed to support the systematic embedding of academic numeracy across tertiary institutions. The Framework responds to challenges in aligning student numeracy with curricula and to the often-fragmented numeracy development practices in universities. Distinctive features include its focus on tertiary education, its purpose as a teaching and learning tool rather than an assessment instrument, and its multidisciplinary applicability. These features make it an ideal tool to facilitate numeracy embedding across universities. A key application is the mapping of target, assumed and actual student numeracy, informing curriculum design and development, and learning-support initiatives. The paper outlines the Framework's conceptual foundations, describes its structure and key features, and explains how feedback from first-year and pathway academics, learning development staff and academic managers (educators) informed its refinement. An illustrative application for the nursing discipline is presented. The insights gained position the Framework as a timely and practical tool to guide educators seeking a structured approach to integrate numeracy development into courses, programs and initiatives.

Key Words: academic numeracy, academic numeracy framework, teaching and learning, study support, mathematics, quantitative literacy.

1. Introduction

Academic numeracy is critical for success in many disciplines and the workplace. Yet, many students fall short of numeracy expectations throughout their tertiary studies (e.g. Woolcott et al. 2021). This situation may be exacerbated by the diverse and evolving approaches to entry requirements employed by Australian universities, shaped by market pressures, widening participation agendas, and institutional priorities. Many institutions have removed entry-level prerequisites and rely instead on ATAR thresholds or assumed-knowledge statements. This, together with cohort diversity and institutional approaches to learning support, results in highly-variable student preparedness (Finkel et al., 2020; Office of the Chief Scientist & AMSI, 2020; hereafter OCS-AMSI2020). Moreover, this variability occurs alongside recent policy requirements for higher education providers to identify and support at-risk students (Parliament of the Commonwealth of Australia, 2023; hereafter PCA23), placing renewed emphasis on understanding and addressing students' academic preparedness.

Against this backdrop, knowledge gaps are common, with many students requiring support with basic mathematics across disciplines where contextualised mathematics is essential (Bell et al.,

2020; Lefevre et al., 2017; OCS-AMSI2020). This includes paramedicine, nursing, and engineering where mathematical knowledge is applied in high-stakes situations (e.g. medication calculations). In these contexts, competency expectations can be 100% (Minty-Walker et al., 2024), often exceeding the standards students have previously encountered. Therefore, in academic settings, numeracy requires students to identify appropriate mathematics for a given context and apply it competently and confidently (Bell et al., 2020; Lefevre et al., 2017).

To address issues of student preparedness effectively, it is essential to adopt a consistent approach at the individual, course, program, and university levels to ensure students' academic numeracy aligns with curricular demands (Galligan, 2013a). This contrasts with common practices in tertiary institutions, which often result in multiple, disconnected and ultimately ineffective academic numeracy development initiatives. In our research, we have observed that support for students is frequently fragmented, with staff working in isolation within disciplines, learning support units, and institutions. This fragmentation can lead to duplication and pedagogical approaches shaped by individual experience rather than a comprehensive understanding of the complex issues around adult numeracy learning. Although the specific mathematics may differ, the underlying pedagogical challenges and approaches are often similar. A shared Framework can enable collaboration, reduce duplication and provide consistent tools to support students' numeracy development within their disciplinary context, ultimately improving student outcomes.

It is therefore important to define *academic numeracy* to distinguish it from related terms such as general numeracy or school mathematics. A clear definition is essential for conceptual clarity and for delineating the specific practices and competencies addressed in this research. While *numeracy* is often used in the sphere of general life skills, *academic numeracy* is more specifically defined as the "capacity to confidently and competently use mathematics at university level, and to be able to apply, interpret, critique and communicate mathematical concepts in particular disciplinary contexts" (Brady, 2017, p. 176). The term 'quantitative literacy' is often used interchangeably with numeracy and refers to "mathematics and statistics used in context" (Frith & Prince, 2016, p.4). Moreover, while foundational mathematics skills may appear similar across disciplines, each discipline has its own mathematics culture and unique characteristics, necessitating an understanding of how mathematics is applied, contextually.

This paper proposes and conceptualises an Academic Numeracies Framework ('Framework'), a tool designed to support the systematic embedding of academic numeracy across tertiary institutions, describing its key features and how they are useful to support numeracy development. This conceptual paper is part of a broader research project aimed at developing a mature, tested and trialled Framework. Framework development is, in turn, part of a comprehensive research program that also includes an ongoing national audit of the current state of numeracy support nationally (Rylands et al., 2025 and *in preparation*). The program, approved by the institution's Human Research Ethics Committee (Project ID: ETH2025-0438), adopts an action research (McAteer, 2013) and mixed methods (Creswell & Creswell, 2018) approach. As part of the Framework development process, feedback was gathered via focus groups from first-year and pathway academics, learning development staff and academic managers (educators) from several regional Australian tertiary institutions on the design and usefulness of the Framework, and insights were used to refine the tool and inform future trials.

The proposed Framework provides a multidisciplinary tool for mapping academic numeracy across diverse courses and programs. It is intended to support educators in making explicit the relationship between mathematical content and its contextual application, rather than focussing on the assessment or grading of students' numeracy attainment. Unlike most existing discipline-specific approaches, it enables the systematic embedding of numeracy at an institutional level (as recommended by Galligan (2013a), supporting alignment and continuity in teaching and learning. This makes the framework both distinctive and timely, particularly in light of recent policy requirements (PCA23).

We do not advocate for a national academic numeracy curriculum, but rather for a shared framework that can enable collaboration, reduce duplication, and provide a tool to support students' numeracy development within their disciplines, ultimately improving student outcomes. We also acknowledge that fragmentation and duplication may offer benefits, including local adaptability, and enhanced ownership and autonomy. The Framework is not intended to diminish these strengths, but to provide a common foundation, structure and language that consolidates shared principles and improves coherence, while still supporting discipline-specific contextualisation and innovation (e.g. Murray & Nallaya, 2016).

The paper is organised as follows: Section 2 further discusses academic numeracy. Section 3 provides a literature review, including an overview of existing general and numeracy-focussed frameworks relevant to this work. Section 4 presents the elements and structure of the Academic Numeracies Framework. Section 5 outlines focus-group feedback, highlighting the Framework's perceived benefits and suggested enhancements, and resulting refinements and clarifications. Section 6 offers an illustrative application of the Framework focussed on the nursing discipline, and Section 7 discusses the implications of this contribution, including for future research.

2. Academic numeracy

Academic numeracy comprises the elements of *competence*, *confidence* and *critical awareness* (Galligan, 2013b). It is essential that educators (as defined here) appreciate that early integration of these elements in the student numeracy journey can support success. In relation to students' application of mathematical skills, students in diverse disciplines (e.g. engineering and nursing) need to be competent, confident, and critically aware of the application and mathematics' context, and their own metacognition. These elements are described below.

- **Competence**, in the context of the discipline and/or intended profession. Widening access to tertiary study has resulted in diverse student demographics (Faulkner et al., 2014) where mathematical competency and experience can impact numeracy. Educators are aware that poor mathematical capability can lead to high failure rates in those programs where mathematical computation and problem-solving skills are fundamental, such as engineering, nursing, initial teacher education, paramedicine (Pettigrew et al., 2020) and many others. Therefore, identifying the skills and knowledge required of students to enable them to successfully apply mathematics in their disciplines is essential.
- **Confidence**, or numeric self-efficacy, "that provides engagement and persistence with numeric tasks" (Peters et al., 2019, p. 19386). Lefevre et al. (2017) emphasise that low confidence in numeracy creates a deleterious cycle of anxiety and reduced attention, which compromises problem-solving and learning. Incomplete mastery of even basic numerical skills can minimise acquisition of advanced conceptual knowledge and procedural skills, further exacerbating learning challenges. Attaining sufficient confidence to apply knowledge illustrates that numeracy is complex; it requires high levels of sophisticated thinking and encompasses sociocultural aspects such as attitude, language, and culture, making it multifaceted (Maguire & O'Donoghue, 2002).
- **Critical Awareness**, of the application and mathematics' context, and of students' own mathematical knowledge and confidence. Each discipline brings different ways of understanding and applying mathematics, shaped by specific practices and expectations (Galligan, 2013b). Steele and Kilic-Bahi (2008) examined the integration of numeracy into different academic disciplines, finding that embedding numeracy in coursework strengthened students' ability to apply mathematical concepts in diverse contexts. They also argued that numeracy skills improved alongside students' critical thinking and problem-solving abilities. Madison and Dingman's (2010) study explored students' quantitative reasoning in a tertiary course, showing that students' learning is enmeshed in, and bound by, context. Often what has been learnt cannot be adequately transferred or applied to other areas when

disciplinary relevance is unclear (Nakakoji & Wilson, 2018, 2020). For example, students may understand the foundational concepts of fractions and percentages, but applying them in nursing, business or engineering, requires recognising underlying mathematical structures across contexts and mapping familiar concepts onto unfamiliar problems (e.g. Geiger et al., 2014). Metacognition –encompassing metacognitive knowledge, regulation, and self-awareness/monitoring– is therefore an important tool for students to utilise, and has been shown to be a predictor of mathematical performance (e.g. Ma, 2024). Staff in academic pathways or development programs would be more effective if they understood students’ metacognition of their mathematics skills and their perceptions of the mathematical demands of their studies, as well as the discipline discourse that accompanies skill development for the learner (Galligan, 2013b; Shilo & Kramarski, 2019).

These three numeracy components are interrelated. Peters et al. (2019) concluded that high levels of mathematical ability do not necessarily guarantee success in applying that ability. Both objective numeracy (the ability to perform the mathematics correctly, i.e. *competence*) and numeric self-efficacy (i.e. *confidence*), which drives engagement and persistence, are crucial for realising the benefits of numeracy. Conversely, in this study, “mismatched” individuals” (both high confidence paired with low competence, and high competence paired with low confidence) “experienced the worst outcomes” (Peters et al., 2019, p. 1), even worse than having *both* low competence and low confidence (see also Figs. 1 and 2 of that paper). Additional studies would provide valuable insight into the generality of this finding, including any impact of contextual features. Optimal decision-making requires both adequate ability and balanced confidence to avoid negative consequences. In the tertiary context, these qualities are likely to be best developed in supportive, contextualised environments that provide learners with frequent opportunities to successfully apply their learning.

3. Review of existing general and numeracy-focussed frameworks relevant to this work

3.1. General frameworks

3.1.1. Gradual Release of Responsibility Instructional Framework (GRRIF)

A relevant general framework is Fisher and Frey’s (2021) Gradual Release of Responsibility Instructional Framework (GRRIF), first introduced by Pearson and Gallagher (1983). The GRRIF is based on the idea that educators can intentionally drive a progressive shift in responsibility for learning from educators to students. It considers four intentional phases to the mastery of content, its application, and demonstration:

1. Focused Instruction
2. Guided Instruction
3. Collaborative Learning
4. Independent Learning.

The first two phases correspond to the ‘Teacher Responsibility’ side of the framework, driven by the educator; whereas the latter two are the ‘Student Responsibility’ side, focussed on the student. As students move from instructor-led delivery to joint responsibility and, ultimately, independent learning (Pearson & Gallagher 1983), they demonstrate increasing capability and competence. These phases do not need to occur in strict sequence, but it is important that students experience all four stages to promote deep learning, especially when engaging with new knowledge and skill sets. Depending on the content, its application and degree of difficulty, the cycle may unfold within a single session or across a longer period, and it can be applied recursively. The GRRIF also reflects aspects of Maguire and O’Donoghue’s (2002) Adult Numeracy Concept Continuum of Development, where the learner demonstrates learning across levels of complexity from the formative to the integrative. The Framework presented here broadly aligns with the GRRIF in the proposed numeracy levels (Section 4.1.3).

3.1.2. Transition Pedagogy Framework

The Transition Pedagogy Framework (Kift et al., 2010; Nelson et al., 2014) acknowledges that university study can be transformative. However, the transition into university is often daunting for students starting the journey, and for their instructors. Transition pedagogy embraces the complex and multifaceted nature of university study through its structured curriculum-design approach that delivers contextualised and individualised learning and support (Kift et al., 2010). Within this approach, Transition Pedagogy supports the use of a framework for numeracy development as part of curriculum design and student engagement strategies (Nelson et al., 2014).

The Framework proposed in this work facilitates a guided approach to numeracy development that recognises the diversity of undergraduate learners, including their backgrounds and prior experiences that may impact success. Lisciandro et al. (2020) argue that students inhabit transition spaces premised on what precedes university entry, such as aspirations built through schooling, family expectations, and enabling programs, which in turn influence attitudes toward and confidence with numeracy. These aspirations can persist in the undergraduate space, as students build capability and understanding across contexts, including their perceived expectations and self-awareness of mathematical ability and application. While incorporating numeracy development early in coursework helps establish a strong foundation when transitioning students to discipline requirements (Brady, 2017; Galligan, 2013a), the Framework is designed to support numeracy development across the full program of study, extending beyond transition-focused contexts.

3.2. Numeracy frameworks

While general frameworks are useful, a more focussed framework would better support the systematic embedding of academic numeracy and help formalise and incorporate the concepts of competence, confidence and critical awareness into teaching and learning development initiatives. Galligan et al. (2020) recommended the “continued exploration of frameworks that can assist in deep understanding of mathematics”. Some numeracy frameworks exist in the literature (Table 1 shows a non-exhaustive summary). Some are intended to support learning and teaching, while others function as assessment tools. Frameworks may target students at different educational levels or the broader population, and may be discipline-specific (e.g. health, engineering), or tailored to particular groups, such as patients.

Across these frameworks, there is substantial variation in how mathematical content, problem-solving processes and progression are conceptualised. Most Frameworks are *context* sensitive, and explicitly include relevant mathematical *content* or *subject areas*. In contrast, the Association of American Colleges and Universities (AAC&U) framework – designed to evaluate authentic student work – and its adaptation by Boersma et al. (2011), focus on *competencies*, while Niss and Højgaard’s (2011) framework and OECD instruments include both competencies and content. The stages of mathematical problem solving (Polya, 1957) are not typically treated as a separate dimension, except for the OECD (2013, 2017) tools. Frameworks also differ in their treatment of progression: AAC&U, ACARA, OECD, Hoogland et al. (2020) and Boersma et al. (2020) specify proficiency or progression levels, whereas Niss and Højgaard (2011) characterise competency along three dimensions: *degree of coverage* (relevant aspects mastered), *radius of action* (breadth of applicable contexts), and *technical level* (sophistication of use). Their approach highlights the need for progression to be interpreted flexibly and contextually, and informs the design of the Academic Numeracies Framework.

Table 1. Numeracy Frameworks.

Target	Purpose	
	Assessment Tools	Learning & Teaching Tools
Students		
Primary	ACARA (2017), Clarke et al., (2009), Niss & Højgaard (2011).	ES (2016), Hogan (2000), Quinnell (2016), Stack et al., (2010)
Secondary	ACARA (2017), Callingham & Griffin (2009), Niss & Højgaard (2011), OECD (2013, 2017, 2023), Scott (2016, biology).	ES (2016), Goos et al., (2014), Hogan (2000).
Tertiary	AAC&U (2025); Boersma, Diefenderfer, Dingman, and Madison (2011); Dalim et al., (2023), , Niss & Højgaard (2011, introductory post secondary)	Hadley & Oyetunji (2022, <i>Engineering</i>), Lipkus & Peters (2009, <i>health</i>).
Enabling		Mann (2022)
Population		
General	Gal et al., (2005), Golbeck et al., (2005, health), Hoogland, Diez-Palomar and O'Meara (2020), OECD (2009, 2012), Tout et al., (2017).	
Specific Groups	Schapira et al., (2008, <i>patients</i>).	

4. Academic Numeracies Framework

This section introduces the Academic Numeracies Framework, a tool designed to facilitate the systematic embedding of numeracies in tertiary education. While transition pedagogy offers valuable, broad principles for supporting student transition and success, the Academic Numeracies Framework provides a more specific tool that aligns with these principles and is designed to inform curriculum design, support the mapping of students' assumed, target and actual numeracies, and guide the design of numeracy intervention initiatives. Its utilisation can raise awareness of the need to scaffold students through the application of mathematical content and, thereby, strengthen the numeracy development required in specific situations or disciplines.

An online copy of the [Framework](#) is available and is open licensed. It is also presented in Section 4.2. Its key components (Sections 4.1.1 to 4.1.4) are:

1. Mathematical Processes,
2. Mathematical Competencies,
3. Numeracy Levels and
4. (Proficiency) Descriptors.

It is structured around two tables (Section 4.2): Table 2 maps the relationship between mathematical processes and competencies to show how these capabilities contribute to problem solving, and Table 3 outlines what students should be able to demonstrate as their numeracy develops. Together, these tables are intended to support educators in identifying relevant numeracy capabilities and informing appropriate proficiency expectations.

The Framework draws on Niss and Højgaard (2011), the Programme for International Student Assessment (PISA) 2015 Assessment and Analytical Framework (OECD, 2017), and the GRRIF (Fisher & Frey, 2021) for the numeracy levels, mathematical processes, and competencies. PISA

has significantly influenced the mathematical literacy discourse via its focus on real-world situations as key indicators of readiness for real-life challenges, and promoting the integration of applications, contexts and processes in national curricula (Kadijevich et al. 2023, Kappassova et al., 2025). The most recent PISA Mathematics Framework (OECD, 2023) places a stronger emphasis on mathematical reasoning, which partially overlaps with problem solving. In our Framework, mathematical reasoning is integrated within the competencies as they are applied throughout the problem-solving process, an approach that reflects the more specific demands of tertiary education. While the PISA Framework situates problems across broad life domains and organises mathematical content into curriculum-based categories, the Framework presented here remains multidisciplinary and intentionally avoids prescribing mathematical content.

The Framework complements the literature because, unlike similar tools in Table 1, it is not discipline-specific but is conceived as a multidisciplinary tool that can be applied to map academic numeracy across diverse courses, programs, and initiatives. This makes it well suited to support the systematic embedding of academic numeracy across tertiary institutions, facilitating alignment and continuity of efforts across these different domains. Its multidisciplinary character is achieved by focussing on foundational numeracy competencies that are relevant across disciplinary boundaries, while recognising disciplinary context as an integral element of numeracy (Section 2). Rather than specifying content or applications as done by many of the tools in the table, the Framework is designed to incorporate the distinction between the learning of mathematics' topics and the ability to apply them in disciplinary contexts, while entrusting specific contextualisation to educators, who are best placed to embed discipline-specific details into their courses or initiatives, to best support student learning. The AAC&U framework is perhaps the closest to the Academic Numeracies Framework. However, by explicitly distinguishing between mathematical processes and competencies (see Sections 4.1.1 and 4.1.2 below), the proposed Framework provides a clearer structure that is especially useful as an instructional tool.

The Framework also addresses the challenge of deployment at scale. Programs designed for micro settings, such as a single class or course, often fail to consider the complexity of scaling to larger, diverse educational settings; a key reason for their failure (Robinson et al., 2020). The Framework, however, provides a simple, inexpensive, and comprehensive way in which to embed competencies at scale.

4.1. Elements of the Academic Numeracies Framework

The Academic Numeracies Framework incorporates the following elements.

4.1.1. Mathematical processes

These are the processes that learners typically follow when engaging with a contextualised mathematical problem to arrive at a meaningful solution (namely, problem formulation, problem solving and interpretation or evaluation of the solution), and are active areas of research in mathematics education (e.g. Santos-Trigo 2024; Toh et al, 2023). They are described below.

Problem formulation

This stage involves translating a contextualised problem into the mathematics domain, producing a problem with appropriate mathematical structure and detail to be solved using mathematical procedures and tools. Typical tasks include:

- Understanding, stating and discussing the problem; identifying the question/s being asked and forming a mental model of the problem.
- Adopting appropriate simplifications and assumptions to arrive at a mathematical model of the problem.
- Understanding different representations of the problem.
- Justifying the problem formulation, adopted assumptions and / or simplifications.

- Planning how to approach the problem; choosing an appropriate method.
- Expressing the problem using mathematical notation.
- Identifying relevant tools to engage with the problem; using tools to determine information to help formulate the problem.

Problem solving

This stage involves applying mathematical concepts, procedures and reasoning to conduct computations or manipulations to find the solution of a mathematically expressed problem. Typical activities include:

- Explaining the method being employed, problem-solving steps and intermediate results.
- Making context-informed decisions to guide the solution process (e.g. appropriate simplifications, level of accuracy, parameter values).
- Identifying and using appropriate representations to extract information and advance the solution; changing representations as needed.
- Following logical steps to connect stages of the solution; checking for consistency and validity; justifying the process.
- Devising strategies to perform each of the steps required to advance the solution.
- Understanding and using mathematical rules, methods and procedures to carry out the solution; correctly manipulating the mathematical constructs.
- Using relevant mathematical tools or technology to perform calculations, generate tables or graphs, or simulate outcomes.

Interpretation and evaluation of the solution

This stage focusses on understanding and reflecting on the solution, interpreting it and judging whether it is valid and reasonable in the context of the mathematics topic or the real-world application. Typical tasks include:

- Explaining the results in plain language, including their implications and limitations.
- Linking the mathematical solution back to the original contextualised problem; assessing the limitations and validity of the solution.
- Interpreting the results within the chosen representation; converting the solution to another representation to aid understanding and communication.
- Evaluating the reasonableness of the solution and the adopted solving strategy; comparing with alternative methods and arguing for validity.
- Devising strategies to interpret and evaluate the solution; considering alternative approaches.
- Translating the symbolic or numerical results back into words or practical meaning.
- Using tools to test plausibility, check accuracy and present results in accessible formats.

Importantly, these processes draw on distinct abilities: a learner may be able to formulate a problem but not solve it, or solve a posed problem while struggling to formulate it (Niss & Højgaard, 2011).

The above elaboration demonstrates that each problem-solving process –formulation, solving and interpretation– draws on multiple competencies. For example, communication is essential to understand and present the problem (formulation), explain the step-by-step process (solving), and articulate the solution (interpretation). Similarly, the typical tasks under each process refer to a range of competencies (e.g. communication, mathematical representation, reasoning, devising solving strategies, and using mathematical language and operations). These competencies are

relevant across problem solving, but may manifest differently on each stage. The Framework maps the competencies against each of the problem-solving processes.

4.1.2. Mathematical competencies

Mathematical competencies are cognitive capabilities that learners use when working through the mathematical processes of problem-solving and, more broadly, to reason mathematically and engage with mathematical information. Højgaard (2009, p. 226) defines the term as “someone’s insightful readiness to act in response to a certain kind of mathematical challenge of a given situation”, with the following characteristics:

- **Action-oriented.** Competencies must be able to be enacted, as insight or knowledge translates to competency when it can be activated in action. Actions may include taking specific steps, deciding not to act, or being indirectly guided by one’s insights when responding to a situation.
- **Domain-specific,** but not bound to specific methods or tasks. Competencies are developed within domains or spheres of use, framed by the wider context of the situation.
- **Subjective.** Competencies are not independent entities; they belong to individuals and reflect their personal abilities.
- **Socially and culturally situated,** as their relevance and legitimacy depend on what a community or context recognises as a competent action.

We adopt here the competencies considered by the PISA 2015 Assessment and Analytical Framework (OECD, 2017), in turn based on the work of Niss (2003) and Niss and Højgaard (2011). These are described below.

Communication

This competency refers to the ability to understand and interpret questions, tasks, data and information (e.g. oral, written or visual), as well as to convey arguments and ideas about mathematical situations appropriately, using different representations and addressing different audiences. In the context of problem solving, it is essential to form a mental model of the problem, explain the steps followed to obtain the solution, and present and justify the adopted mathematical procedure and the solution itself. The communication competency is closely linked to the competencies of representation and using mathematical symbols, which support the effective communication of both the problem and its solution.

Mathematising

This competency refers to transforming real-world or contextualised information into mathematics, including to formulate the problem, guide the solving process, and assess the limitations and validity of the solution. The scope also includes ‘de-mathematising’, or relating the result back to the original, contextualised problem.

It is important to distinguish between the *process* of formulating the problem and the *competency* of mathematising. Although related, as both involve translating contextualised information into mathematics, they are conceptually different. The formulation process encompasses the broader set of activities culminating in the definition of the problem within a mathematical framework, which draws on all the competencies. In contrast, the mathematising competency refers specifically to the capability of constructing and working on the mathematical model itself, which applies to all the mathematical processes, for example expressing the problem using mathematical constructs during formulation, making decisions to constrain and guide the solution process when solving, and assessing the domain of validity of the solution when interpreting.

Representation

This competency refers to the ability to engage with different representations of mathematical information, such as graphs, tables, diagrams, equations or formulas, and text. It involves

understanding, using and manipulating these representations to understand the problem, advance the solution, and present results. It also includes the ability to choose between representations, switching flexibly among them and understanding how they are related, including choosing appropriate representations to convey meaning to different audiences.

Reasoning and argument

This competency involves the ability to follow and critically assess mathematical reasoning (both one's own and that of others) to evaluate and justify the formulation of a problem, the adopted solving procedure, and the resulting solution, including its validity within the given context. The key goal is to develop confidence in the validity and soundness of the problem-solving process undertaken.

Devising strategies

This competency involves the ability to determine or select an appropriate plan or course of action to tackle problems, including using mathematics to formulate a problem in the appropriate context, guide its solution process, and interpreting and evaluate the obtained result.

Using mathematical symbols, expressions, operations and rules

This competency involves the ability to code and decode mathematical symbolic and formal language (i.e., converting natural language into mathematical language and vice versa). It also requires understanding and applying mathematical conventions, definitions and rules to manipulate mathematical expressions as needed to formulate, solve and interpret the solution of a problem. While closely related to the representation competency (e.g. via formulas or equations), this competency focusses on the formal mathematical meaning of symbols and expressions, as well as the rules for correctly manipulating them.

Using mathematical tools

This competency involves being aware of the different tools available to conduct mathematical work (e.g. measuring instruments, calculators, computer-based and representation tools such as logarithmic paper, and newer applications including AI), understanding their applications and limitations, and using them appropriately to assist with problem-solving and communication.

The next section considers the demonstrations of proficiency (numeracy levels), expected of a student across the Framework's mathematical competencies.

4.1.3. Numeracy levels

This element of the Framework considers the demonstrations of proficiency for each competency. Proficiency may refer to the target numeracy set by courses, programs or initiatives; the assumed numeracy of students entering them; or the actual numeracy demonstrated by students. While the Framework is not designed as an assessment tool, students' numeracy levels could be inferred through analysis of prior coursework, submitted assessments, or other evidence, to inform teaching and support strategies.

The Framework defines four numeracy levels. As students become more numerate, their proficiency increases enabling them to solve increasingly complex, and/or applied problems more independently. The numeracy levels draw inspiration from the GRRIF and the competency dimensions proposed by Niss and Højgaard (2011). They are characterised by these domains:

- **Contextual domain**, progressing from the capability to tackle problems within specific mathematical topics – where contextual information primarily support this goal – to solving discipline-applied problems.
- **Support domain**, indicating the level of scaffolding required to build numeracy, ranging from significant to minimal or no scaffolding, where students can independently develop and apply numeracy skills.

- **Technical domain**, the increasing level of sophistication in the application of mathematical competencies, from limited to expert application.

The numeracy levels proposed here incorporate these domains, and are specified as follows.

Numeracy Level 1 – Foundational: Students require significant scaffolding to develop basic numeracy skills and knowledge within a mathematics topic area.

Numeracy Level 2 – Developing: Students require limited scaffolding to develop sound numeracy skills and knowledge within a mathematics topic area.

Numeracy Level 3 – Applied: Students require some scaffolding to develop sound numeracy skills and knowledge within a discipline.

Numeracy Level 4 – Independent: Students independently develop and apply sophisticated numeracy skills and knowledge within a discipline.

4.1.4. Descriptor

The final element of the Framework is a brief descriptor, which summarises the mathematical proficiency shown by students for each competency and numeracy level. The descriptor text is broadly organised so that it specifies the *actions* students need to demonstrate, the *target* of these actions, the *purpose* or *outcome* that is sought, as well as any *qualifying* information. The descriptors offer a convenient way to map the target, assumed and actual numeracies of students and inform the design, development, and implementation of initiatives to embed numeracies in the curriculum.

At first glance, the Framework tables could be seen as rubrics. However, the GRRIF, upon which the Framework's numeracy levels are based, is an instructional model which progresses learning responsibility from the teacher to that of the student through 'stages' of instruction. It emphasises the importance of scaffolding in supporting the student to build mastery and to successfully apply knowledge, skills and conceptual understandings, independent of the educator (Eide et al, 2025). The GRRIF is non-linear and can be extended or revisited at any stage to ensure student understanding. The Framework, therefore, is a deliberate attempt at managing student learning across time (including the hand-over of responsibility for learning from the educator/institution to the learner), in a somewhat discursive and iterative way to the end point; mastery or independence. A rubric, on the other hand, can have a variety of functions – with the most obvious being to bring about consistency of grading – and generally describe the requirements and expectations of an assignment by providing “assessment criteria, a grading strategy, and standards/quality definitions” (Panadero et al., 2014, p. 135). The Framework provides a tool for educators to ‘map’ their mathematical content to the application of that content (numeracy) but does not assume to grade students in relation to the competencies and proficiency levels.

4.2. Structure of the Framework

The Academic Numeracies Framework organises the numeracy elements discussed in the previous section as presented below. The Framework comprises two pages:

- **Page 1 (Table 2):** A table that summarises the relationship between mathematical processes and competencies, highlighting the typical capabilities associated with each competency as they contribute to advancing the problem-solving process. This table provides educators with a structured way to consider the range of capabilities involved in developing numeracy.
- **Page 2 (Table 3):** A table that outlines the descriptors for each competency and numeracy level, summarising what students must be able to demonstrate at each level. This table supports educators in planning for appropriate levels of complexity and scaffolding in their teaching.

The Academic Numeracies Framework, presented as Tables 2 and 3, provides educators with a practical and structured tool to facilitate the systematic embedding of numeracy within curricula and learning developing initiatives.

Table 2. Academic Numeracies Framework – Mathematical competencies by mathematical processes.¹

Academic Numeracies Framework	Formulating (translating to a mathematical problem)	Solving (applying mathematical procedures)	Interpreting (judging validity and meaning of the solution)
Communication <i>Understand and convey information about mathematical and numerical content and concepts in various ways</i>	<ul style="list-style-type: none"> - Clearly understand and state the problem in words - Identify the question/s being asked - Form a mental model of the problem - Discuss the problem with others 	<ul style="list-style-type: none"> - Explain the chosen method - Explain the steps taken while solving - Explain intermediate results 	<ul style="list-style-type: none"> - Explain the meaning of the obtained result - Present results in plain language - Communicate limitations and implications of the solution.
Mathematising <i>Students ethically transform a real-world problem into a mathematical problem, identifying assumptions, context, and the limitations of the solution.</i>	<ul style="list-style-type: none"> - Translate a real-world situation into mathematics, arriving at a mathematical model of the problem - Express problem using mathematical constructs and concepts - Identify constraints and assumptions derived from the adopted mathematical model - Adopt appropriate simplifications, so the problem can be solved 	<ul style="list-style-type: none"> - Make context-informed decisions to guide the solution process (e.g. simplifications, level of accuracy, values of modelling parameters). 	<ul style="list-style-type: none"> - Link the obtained mathematical solution back to the original context - Assess the limitations and domain of validity of the solution
Representation <i>Students ethically generate, use and interpret mathematical representations relevant to a problem or situation</i>	<ul style="list-style-type: none"> - Choose how best to represent the problem (e.g. diagram, graph, table, algebraic forms) - Understand different representations of the problem 	<ul style="list-style-type: none"> - Use appropriate representations to extract information and advance the solution - Make use of different representations as appropriate to advance the solution 	<ul style="list-style-type: none"> - Translate results to alternative representation to aid understanding and communication. - Use different representations to assist with interpretation
Reasoning and Argument <i>Students convincingly and ethically explain, defend, and justify selected representations, solving process and obtained solutions.</i>	<ul style="list-style-type: none"> - Justify the problem formulation, adopted assumptions and simplifications 	<ul style="list-style-type: none"> - Follow logical steps that connect one stage of the solution to the next - Check for consistency and validity of the intermediate results - Justify the employed solution process 	<ul style="list-style-type: none"> - Evaluate the plausibility of the solution - Reflect on the effectiveness of the chosen strategy - Compare with alternative methods and argue for validity.
Devising Strategies <i>Students ethically select, devise or develop a plan or strategy to solve mathematical problems.</i>	<ul style="list-style-type: none"> - Plan how to approach the problem (e.g., break it into parts, choose appropriate methods for each one) 	<ul style="list-style-type: none"> - Plan, select and adapt appropriate pathways to advance the problem-solving process 	<ul style="list-style-type: none"> - Plan approaches to interpret and evaluate the solution - Identify possible refinements or alternative approaches.
Using symbolic language and operations <i>Students understand, interpret, ethically manipulate, and make use of suitable variables, symbols, expressions, and operations, or rules to solve mathematical problems.</i>	<ul style="list-style-type: none"> - Express the problem using mathematical notation (symbols, formulas, expressions) 	<ul style="list-style-type: none"> - Understand appropriate mathematical rules, methods, and definitions needed to carry out the solution - Correctly manipulate mathematical symbols, expressions, formulas, and data to progress towards the solution 	<ul style="list-style-type: none"> - Translate mathematical results back into words or practical meaning
Using mathematical tools <i>Students use appropriate mathematical tools, such as calculators, computer-based tools, and geometry tools, to ethically carry out mathematical procedures.</i>	<ul style="list-style-type: none"> - Identify useful tools (e.g., calculator, spreadsheet, software) to use - Use appropriate tools to determine or uncover information to formulate the problem 	<ul style="list-style-type: none"> - Utilise relevant mathematical tools accurately to perform calculations, generate graphs/tables, or simulate outcomes 	<ul style="list-style-type: none"> - Use tools to test plausibility, check accuracy, and present results in accessible formats.

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Table 3. Academic Numeracies Framework - Mathematical competencies by numeracy levels.

Academic Numeracies Framework	Foundational Students require significant scaffolding to develop numeracy skills and knowledge within a topic area.	Developing Students require limited scaffolding to develop numeracy skills and knowledge within a topic area.	Applied Students require some scaffolding to develop numeracy skills and knowledge within a discipline.	Independent Students independently seek out and develop numeracy skills and knowledge within a discipline.
Communication <i>Understand and convey information about mathematical and numerical content and concepts in various ways</i>	Students understand, organise, infer directly, interpret literally and convey information from limited sources, following explicit instructions.	Students use simple reasoning to identify, extract, organise, understand and interpret information from various sources, to build a simple model and convey results.	Students use sound reasoning to identify, extract, organise, understand and interpret information from relevant sources, to build an applied model and convey results.	Students confidently identify, extract, organise, understand and interpret information using complex strategies to build advanced, applied models and convey results.
Mathematising <i>Students ethically transform a real-world problem into a mathematical problem, identifying assumptions, context, and the limitations of the solution.</i>	Students develop and evaluate simple models of basic problems, using limited knowledge.	Students develop and evaluate models to analyse and solve a range of problems, using sound knowledge.	Students develop, analyse, synthesise and evaluate models for applied situations.	Students confidently develop, analyse, synthesise and evaluate models for complex, applied situations and new contexts.
Representation <i>Students ethically generate, use and interpret mathematical representations relevant to a problem or situation</i>	Students create, understand, use and interpret basic mathematical representations from limited sources.	Students create, understand, use and interpret simple mathematical representations from various sources.	Students create, understand, use, integrate, compare and interpret mathematical representations from diverse sources relevant to their disciplines.	Students independently create, understand, use, integrate, compare and interpret complex mathematical representations relevant to their disciplines.
Reasoning and Argument <i>Students convincingly and ethically explain, defend, and justify selected representations, solving process and obtained solutions.</i>	Students provide limited explanations and justifications to formulate a problem, solve and validate solution strategies.	Students provide comprehensive explanations and justifications to formulate a problem, solve and validate solution strategies.	Students provide well-developed explanations, justifications and insights to formulate an applied problem, solve and validate solution strategies.	Students provide well-developed explanations, justifications and insights to formulate complex applied problem, solve and validate solution strategies.
Devising Strategies <i>Students ethically select, devise or develop a plan or strategy to solve mathematical problems.</i>	Students select and apply simple strategies to solve basic problems.	Students select and apply sound strategies to solve diverse problems.	Students select, compare, evaluate and apply sound strategies to solve applied problems.	Students select, compare, evaluate and adapt sound and novel strategies to solve complex, applied problems.
Using symbolic language and operations <i>Students understand, interpret, ethically manipulate, and make use of suitable variables, symbols, expressions, and operations, or rules to solve mathematical problems.</i>	Students recognise and understand symbolic expressions, technical language, operations and rules; and follow instructions to solve simple problems via basic procedures.	Students recognise and understand symbolic expressions, technical language, operations and rules; and solve diverse problems via sound procedures.	Students understand and interpret symbolic expressions, technical language, operations and rules; and solve applied problems via sound procedures.	Students understand, interpret and confidently use advanced symbolic expressions, technical language, operations and rules; and solve applied problems via complex procedures.
Using mathematical tools <i>Students use appropriate mathematical tools, such as calculators, computer-based tools, and geometry tools, to ethically carry out mathematical procedures.</i>	Students use mathematical tools to carry out simple procedures to solve problems.	Students use mathematical tools to carry out a range of procedures to solve problems.	Students use mathematical tools to carry out a range of procedures to solve applied problems.	Students confidently use a range of mathematical tools to carry out complex procedures to solve applied problems

5. Focus-group feedback – Illustrative evidence

We conducted three focus-group sessions with educators from regional Australian universities to gather preliminary feedback on the proposed Framework (Howarth et al., 2025). The purpose was not empirical validation, but to inform its conceptual development by identifying potential enhancements and perceived value; formal validation will be undertaken in a future trial. The following sections summarise suggested enhancements and resulting changes or clarifications (Section 5.1), and present key perceived benefits (Section 5.2).

5.1. Framework enhancements

1. **Student version.** Participants suggested developing a student version of the Framework to give learners visibility of targeted competencies and allow them to monitor their progress. This would increase transparency, facilitate student-educator dialogue, and provide students with clearer insights into their learning journey and expectations as they progress. In turn, this may help alleviate maths anxiety in some learners. A student version is underway and will be presented separately.
2. **Wording of numeracy descriptors.** One participant suggested explicitly referencing ‘*assumptions*’, ‘*predictions*’ and ‘*intuition*’ in the descriptors, to reflect skills valued in tertiary studies and professional practice. While these terms do not always appear verbatim, their intent is incorporated into the Framework mathematical competencies-by-processes table (Table 2). For example:
 - a. Mathematising: ‘Identify constraints and assumptions derived from the adopted mathematical model’ (Formulation).
 - b. Reasoning and argument: ‘Justify the problem formulation, adopted assumptions and simplifications’ (Formulation); ‘Evaluate the plausibility of the solution’ (Interpretation).
3. **Competency levels and independent performance.** A participant queried why *independent* performance is only associated with disciplinary contexts (Numeracy Level 4 – Independent) and not with competency within mathematical topics (Numeracy Levels 1 and 2, Foundational and Developing, respectively). The Framework aligns its numeracy levels with the GRRIF (Fisher & Frey, 2021), which progresses from instructor guidance to independent mastery (Section 3.1.1). While Numeracy Level 2 focusses on developing procedural fluency, Numeracy Level 4 emphasises flexible application, synthesis, and contextual problem-solving, critical elements of independent performance that extend beyond rote learning.
4. **Contextual information.** Participants highlighted the usefulness of disciplinary context and how it is incorporated into the Framework. Contextual awareness is a key numeracy element (Galligan, 2003b), and disciplinary context is explicitly part of the expected performance at Numeracy Level 3 and 4 of the Framework. As the Framework is designed as a multidisciplinary tool, discipline-specific contextual information is intended to be incorporated by users.
5. **Illustrative examples, guidelines and workshops on using the Framework.** Feedback highlighted the value of these resources to promote Framework adoption. An illustrative application is presented here, with additional materials and workshops planned as part of the upcoming trial. The authors will also seek opportunities to conduct both internal and external workshops to facilitate implementation of the Framework and obtain feedback to further refine it.
6. **Intended cohorts.** Participants suggested to explicitly state that the Framework is intended for all student cohorts, and that it works equally for students regardless of their socioeconomic status and background. The Framework functions as an instructional and pedagogical model, providing educators with a structured approach to design learning experiences, reflect on and compare their approaches with prior practices, and identify

demonstrations of student numeracy. It is intended to facilitate targeted numeracy instruction for all students, regardless of study mode (online/on-campus), type of enrolment (full-time/part-time), academic level, socio-economic background, equity status, and other factors.

5.2. Potential Framework benefits

1. **Structure for teaching and learning**, by formalising the identification of students' numeracy needs, facilitating conversations among educators, guiding curriculum changes and the development of course materials, supporting individualised learning and promoting innovation.
2. **Multidisciplinary applicability**, enabling use across units and disciplines, including foundational courses that feed to different disciplines (e.g. nursing, engineering, education).
3. **Support for addressing maths anxiety**, by giving students a clearer sense of progression and helping educators who may become anxious when teaching.
4. **Transparency and clarity**, making explicit the skills students are expected to learn at each stage of their journey and how these connect to future learning.
5. **Comprehensive scope**, encompassing the wide range of elements relevant for academic numeracy.

This feedback reinforced the Framework's potential as a valuable tool for systematically embedding academic numeracy across tertiary education.

6. Illustrative application

This section presents a practical application of the Framework through an illustrative example drawn from a typical university-level nursing course. Consistent with the paper conceptual focus, the example reflects common curriculum requirements rather than a specific course.

The course learning objective considered is "*Accurately perform calculations of oral and injected medication dosages*". Three sets of numeracies are relevant for achieving this objective:

- **Target numeracy**, corresponding to the applied mathematical skills taught within the course. For this illustration, these would typically include reading medication charts, medicine labels and equipment instructions, calculating drip rates, and the volume of oral or injected medication, reconstituting medications, determining the required number of capsules or tablets, and applying clinically-appropriate rounding conventions (e.g. rounding syringe measurements to appropriate accuracy).
- **Assumed numeracy**, reflecting the foundational skills that students are expected to bring to the course, and that may be supported through avenues including mathematics learning advisors, online platforms or software. To acquire the target skills, students are expected to draw on prior skills, including manipulating fractions, proportions, percentages and decimals; rounding numbers appropriately, performing unit conversions, and working with worded problems and formulas.
- **Actual numeracy**, corresponding to the mathematical skills students possess on entering the course. This information could be identified via, for example, prior student coursework or educator input. However, we reiterate that the Framework is designed as an instructional and pedagogical tool rather than an assessment tool.

To develop these numeracies, students must employ a range of mathematical competencies (Section 4.1.2) across the problem-solving cycle (Section 4.1.1). A key application of the Framework is, therefore, the mapping of target, assumed and actual competencies, providing a structured mechanism to inform curriculum design and learning support. In this example we do not consider student data and instead employ the Framework to map only the target competencies (Table 2) and numeracy level (Table 3).

We first establish the target numeracy level on course completion, using Table 3. For this entry-level nursing course, an appropriate level might be Applied (Numeracy Level 3), reflecting that students require ‘some scaffolding to develop sound numeracy skills and knowledge’ within the discipline (Section 4.1.3). A consistent assumed numeracy level of students entering the course would be the previous one, namely Developing (Numeracy Level 2), so students ‘require limited scaffolding’ within a topic area. We then use Table 2 as a template to map specific competencies for this context and numeracy level. An illustrative mapping is shown in Table 4.

The mapping demonstrates how the Framework helps clarify the range of competencies needed to meet the course learning objective. While all elements of the competencies-by-processes table are relevant in principle, in practice some may be emphasised, and not all may be addressed at once. The mapping completed here considers the full set for illustrative purposes, but the Framework allows flexibility for educators to adapt it depending on context, scope and purpose.

7. Discussion

This paper introduced the Academic Numeracies Framework, a tool designed to facilitate the systematic embedding of numeracies within university curricula and study development initiatives. Distinctive features include its intent as an instructional and pedagogical tool for learning and teaching rather than an assessment instrument, its focus on tertiary education, its multidisciplinary applicability and the explicit integration of competencies and mathematical processes. The Framework's multilayered structure is granular and operational at classroom level, making it well-suited to guide the embedding of numeracies across tertiary institutions, notably the mapping of students' target, assumed and actual numeracy, thus informing curriculum design, and learning support.

The Framework integrates established perspectives on numeracy development, drawing on Niss and Højgaard (2011), PISA (OECD, 2017) and the GRRIF (Fisher & Frey, 2021), and supports intentional instructional design and scaffolding. By making explicit the numeracy competencies, problem-solving processes and numeracy levels, the Framework assists educators in designing teaching and learning activities aimed to progressively shift responsibility from the instructor to the student. The Framework complements GRRIF by providing a tool for educators to identify specifically where scaffolding and targeted support are needed to support students' transition to independent numeracy.

Our research project adopts an action research approach (McAteer, 2013) combined with mixed methods analysis (Creswell & Creswell, 2018), with the goal of developing a fully tested and trialled version of the Framework. This paper addresses the conceptual stage, proposing and conceptualising the Framework and describing its key features. The Framework comprises four elements: Mathematical processes, mathematical competencies, numeracy levels, and descriptors, presented in a concise two-page format (Section 4.2) for easy use. We also presented an illustrative application for the nursing discipline, to demonstrate its practical use.

Educator feedback through focus-group sessions informed the Framework's conceptual development and explored its perceived value. Participants suggested several enhancements, including a student version (in development), illustrative examples (Section 6), and clarifications around wording of descriptors, competency levels, contextual information and intended student cohorts (Section 5.1). They also highlighted key Framework benefits, notably that it brings structure to teaching and learning support by helping identify student support needs, facilitating conversations, informing curriculum changes and promoting innovation. Participants further highlighted its potential to help alleviate maths anxiety, its multidisciplinary applicability, its comprehensive

Table 4. Illustrative application of the Academic Numeracies Framework mapping target competencies for the entry-level nursing course learning objective “*Accurately perform calculation of oral and injected medication dosage*”.

Academic Numeracies Framework (Nursing Application)	Formulating (translating to a mathematical problem)	Solving (applying mathematical procedures)	Interpreting (judging validity and meaning of the solution)
Communication <i>Understand and convey information about mathematical and numerical content and concepts in various ways</i>	- Understand and restate dosage problem clearly, including what is being asked, and which information has been provided	- Show step-by-step working clearly using correct mathematical notation.	- Explain results clearly in words (e.g., “this calculation means that 2 mL is needed in the syringe”).
Mathematising <i>Students ethically transform a real-world problem into a mathematical problem, identifying assumptions, context, and the limitations of the solution.</i>	- Translate medication orders into a mathematical model (e.g. the number of tablets is the amount of drug prescribed divided by the amount per tablet).	- Maintain appropriate accuracy when calculating required dosage.	- Relate numerical result back to medication context (e.g., the result is the number of tablets for a given dose) - Assess the domain of validity of the solution (e.g., the applied rounding is valid for 10mL syringes).
Representation <i>Students ethically generate, use and interpret mathematical representations relevant to a problem or situation</i>	- Choose the right representation for the problem (fractions, ratios, decimals, conversion tables, algebraic expression).	- Use fractions, ratios, tables or formulas to perform calculations.	- Interpret graphs, charts, or numeric answers in the clinical setting (e.g., syringe markings).
Reasoning and Argument <i>Students convincingly and ethically explain, defend, and justify selected representations, solving process and obtained solutions.</i>	- Justify which method to use (e.g., ratio-proportion vs. formula approach).	- Apply logical checks through the calculation (e.g., units remain consistent, intermediate results are reasonable).	- Evaluate plausibility of results (e.g., rejecting an answer of 20 tablets for a 200 mg dose).
Devising Strategies <i>Students ethically select, devise or develop a plan or strategy to solve mathematical problems.</i>	- Plan the calculation steps (e.g., convert units → apply formula → round result).	- Adapt strategies if an error is identified (e.g., recalculate using a different approach).	- Reflect on whether the method used was efficient and accurate, and whether another approach is possible.
Using symbolic language and operations <i>Students understand, interpret, ethically manipulate, and make use of suitable variables, symbols, expressions, and operations, or rules to solve mathematical problems.</i>	- Define and write quantities using appropriate symbols and units (e.g. Dose ordered (mg), Stock strength (mg/tablet)).	- Carry out calculations using fractions, decimals, ratios, and percentages.	- Translate symbolic/numeric results back into practical language (e.g., “Dose is 2 tablets”).
Using mathematical tools <i>Students use appropriate mathematical tools, such as calculators, computer-based tools, and geometry tools, to ethically carry out mathematical procedures.</i>	- Identify appropriate tools (calculator, conversion chart, syringe scale).	- Use tools correctly to perform calculations or measure values.	- Confirm tool outputs are sensible (e.g., syringe reading aligns with required dose).

scope and capacity to promote transparency and clarity. This feedback reinforces the Framework's usefulness for systematically embedding numeracy in higher education.

Systematic implementation of numeracy development initiatives across universities is important to fully achieve intended benefits (Galligan, 2013a). It would also be beneficial to adopt the tool in small-scale educational settings, and then extend its use towards a whole-of-institution approach. Progress towards this goal requires active promotion of this tool and appropriate support to educators, particularly domain-expert educators seeking to connect the mathematical competencies and numeracy levels with course and program learning objectives. A concerted approach, bringing together experts across the institution and providing tailored resources and training (e.g. example applications and workshops) would be particularly useful.

The Framework's flexibility and cross-disciplinary nature provide a shared structure and language to support diverse applications, including facilitating discussions, supporting curriculum design and implementation, and improving educators' understanding of student capabilities. In turn, this aids in contextualising and targeting learning approaches. This is particularly important for adult learners, for whom relating new knowledge to previous experiences is critical (Knowles, 1980).

This tool is timely given the recent Australian Government policy requiring educator providers to identify and support at-risk students (PCA23), as it provides an avenue to support this requirement. Moreover, an online copy of the [Framework](#) is available and is open licensed.

This research is ongoing. The next steps on Framework development include a structured trial of the Framework at an Australian regional university, and the release of web-based and student-facing versions currently under development. An initial trial would evaluate the Framework as a curriculum and teaching support tool, rather than measuring student learning outcomes. Testable elements include the clarity and usability of its structure and descriptors, the interpretability and perceived value of the numeracy levels, and cross-disciplinary applicability. Contextual factors (e.g. effectiveness of learning interventions) would be beyond the scope of this tool-focused trial. Implementation would involve recruiting educators through professional networks and supporting them via workshops, examples and guided activities to map assumed, target and/or actual numeracies within their courses or programs. Follow-up questionnaires and interviews will inform Framework refinements, demonstrating that it supports systematic development.

Adult learners' engagement with numeracy extends beyond competency, encompassing important 'affective' dimensions (Hoogland & Diez-Palomar, 2022). Supporting positive attitudes and dispositions is therefore critical for success (Mazana et al., 2019). The Framework can support these efforts by clarifying expectations and promoting inclusive numeracy instruction. The *confidence* aspect of numeracy is not yet incorporated into the Framework and will be addressed in future iterations.

Finally, this work is part of a broader research program which is also examining mathematics preparation and support across Australian universities. A recent national audit of 40 institutions documents the diversity, decentralisation and fluidity of these provisions, alongside emerging challenges in sustaining effective academic numeracy pathways (Rylands et al., 2025 and *in preparation*). The preliminary results from the audit suggests that an institutional approach to numeracy support is largely lacking. Insights from this work will provide important contextual evidence of the current support landscape and further inform how the Framework can be used to bring greater coherence, alignment and strategic focus to numeracy support across courses, programs and institutions.

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Declarations

1. **Ethics approval:** The project was approved by the institution's Human Research Ethics Committee (Project ID: ETH2025-0438).
2. **Competing / conflict of interests:** No conflict of interest to declare.
3. **Use of Generative AI:** Generative AI (ChatGPT, Copilot) was used for minor editing of the manuscript. The authors reviewed all content created via generative AI, edited it as needed, and take full responsibility for the publication.

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