Library Services
Academic Literacies & Numeracies Framework
Academic Numeracies

Introduction

The *Academic Literacies and Numeracies Framework* provides a way of supporting Library Services academics and professional staff, teaching academics and students to cover academic and digital literacies, and numeracies, at intersections with content, support, and resources. In its full implementation, the *Framework* will reflect the anticipated numeracies, and the academic and digital literacies required of undergraduate students. Standard graduate attributes, and the Five Senses of Success (Lizzio, 2006; 2011) underpin the *Framework* and are interwoven into it at relevant points.

The *Framework* will represent an overarching, and integrated curriculum, designed to guide academic and mathematics learning advisors, and if required, academic staff, in the management of student development more broadly. The literacies and numeracies are intended to be used in advisor conversations with academic staff around the embedding of necessary academic literacies, numeracies, and skills into program and coursework.

Graduate Attributes and the Five Senses of Success

The success of students at tertiary level depends to a significant degree on their sense of *capability, connectedness, purpose*, *resourcefulness, and identity* (Lizzio, 2011). All universities appreciate that student success requires a range of supports and, therefore, provide a range of services for students in developing their academic and numeracy skills, at undergraduate levels, which also align with generic graduate attributes such as *effective communication, enterprise and resourcefulness, critical and creative thinking, professionally engaged, ethically driven, discipline expertise, and appropriate levels of research capability.* Moreover, there is an increased recognition that numeracy skills are an imperative precursor to successful completion of university level studies (Jain & Rogers, 2019) and to employability. A student's *capability* in numeracy is often hindered by a lack of confidence so it is intended that conscious embedding of numeracies (and literacies) within course or program content will create higher levels of confidence and capability.

Academic Numeracies

According to Galligan (2013a; 2013b), academic numeracy is defined as the capacity to use mathematics, both confidently and competently at university level. Galligan (2011) suggests that "academic numeracy" consists of three components: "mathematical competence" in the learner's chosen profession; a "critical awareness" both of the mathematics itself and of their own mathematical knowledge and "confidence, highlighting its deeply affective nature" (p. 289). It also involves applying, interpreting, critiquing, and communicating mathematical concepts, especially in particular disciplinary and applied contexts (Brady, 2014).

Taylor and Galligan (2005) investigated academic numeracy in non-mathematical university courses and found a significant mismatch in skills prevalent in commencing students and the expectations or demands of numeracy embedded in these courses. Moreover, most adult learners demonstrate a varying degree of mathematical

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experiences, confidence, ability, motivation, and their needs, when dealing with mathematical tasks (Jain & Rogers, 2019). With this in mind, the following *Academic Numeracies* have been developed.

The numeracies represent seven fundamental ***mathematical competencies*** adapted from the Programme for International Student Assessment (PISA) 2015 (Organisation for Economic Co-operation and Development [OECD], 2017). The competencies include, *"communication, mathematising, representation, reasoning and argument, devising strategies using symbolic formal and technical language and operations, and using mathematical tools*" (p. 68). These competencies support the processes required of students to engage with mathematical problems and the capabilities needed to demonstrate expected outcomes The mathematical processes for each competency are:

- "Formulating situations mathematically
- Employing mathematical concepts, facts, procedures and reasoning
- Interpreting, applying and evaluating mathematical outcomes." (OECD, 2017, p. 68).

As these skills and capabilities increase, students demonstrate greater competence and confidence in their mathematical behaviours, so they should graduate with a greater critical awareness of the mathematics in their disciplines, professions, and personal lives.

The following level indicators are applied to the academic numeracies to enable alignment with course (unit, subject, and module) or program (degree) learning outcomes:

- scaffolded — Students require high levels of scaffolding to develop numeracy within a topic area
- supported — Students require some level of scaffolding to develop numeracy within a topic area
- supervised — Students require some level of scaffolding to develop numeracy within a discipline
- independent — Students independently develop numeracy within a discipline.

This Academic Numeracies Framework provides a structure for Learning Advisors (Maths Skills) to assign the respective levels of numeracy when developing workshops, conducting consultations, academic liaison, course conversations, program/course development, and online resource design and development. It also facilitates discussions between Learning Advisors (Maths Skills) and academic staff in aligning numeracy levels with research, learning and teaching goals, program goals, and good practice.

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The Academic Numeracies • Communication • Mathematising • Representation • Reasoning & argument • Devising strategies • Using symbolic formal and technical language & operations • Using mathematical tools	***Numeracy Levels***			
	Level 1	***Level 2***	***Level 3***	***Level 4***
	Scaffolded *Students require high levels of scaffolding to develop numeracy skills and knowledge within a topic area.*	***Supported*** *Students require some levels of scaffolding to develop numeracy skills and knowledge within a topic area.*	***Supervised*** *Students require some levels of scaffolding to develop numeracy skills and knowledge within a discipline.*	***Independent*** *Students independently seek out and develop numeracy skills and knowledge within a discipline.*
Skill Development Areas Examples of skill development that may be covered in workshops, resource development and consultations.	**Communication** • **Formulating situations mathematically** ○ Read, recall, and understand statements, questions and tasks ○ Extract and Interpret information to form a model of the task • **Using mathematical concepts** ○ Communicate a solution ○ Show step-by-step work conducted to arrive at a solution • **Interpreting, applying and evaluating solutions** ○ Formulate and convey explanations based on interpretations and reasoning ○ Present results (orally/in writing/visually)			
1. Understand others' written or oral statements about mathematical and numerical content and concepts.	Students read, recall and extract basic information from a limited number of sources, following explicit instructions.	Students identify, extract, understand and interpret information from various sources, as needed to build a simple model.	Students identify, extract, understand and interpret information from relevant sources, as needed to build an applied model.	Students identify, extract, understand, interpret and generalise information, linking sources and unpacking problems as needed to build complex applied models.
2. Convey mathematical and numerical information in various ways.	Students organise and convey information requiring at most direct inference; and perform literal interpretation of the results.	Students organise and convey information from simple reasoning and interpretation of the results.	Students organise and convey relevant information using appropriate mathematical concepts and sound interpretations.	Students confidently organise, convey information using a range of complex strategies and well-developed interpretations.

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<tr><td>The Academic Numeracies
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• Representation
• Reasoning & argument
• Devising strategies
• Using symbolic formal and technical language & operations
• Using mathematical tools</td><td colspan="4">Numeracy Levels</td></tr>
<tr><td></td><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td></tr>
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Students independently seek out and develop numeracy skills and knowledge within a discipline.</td></tr>
<tr><td>Skill Development Areas: Examples of skill development that may be covered in workshops, indiscipline sessions and consultations.</td><td colspan="4">Mathematising
• Formulate mathematical problems
○ Identify variables and assumptions
○ Develop a mathematical model to solve a task
• Using mathematical concepts
○ Use context to guide and streamline solving process
○ Use key constraints and assumptions to arrive at the solution
• Interpreting, applying and evaluating solutions
○ Interpret and evaluate the solution
○ Understand the validity and limitations of the solution, based on the adopted mathematical model</td></tr>
<tr><td>Students ethically transform a real-world problem into a mathematical problem, identifying assumptions and problem context, and the limitations of the solution.</td><td>Students develop and evaluate simple models of basic problems, using limited knowledge.</td><td>Students develop and evaluate models to analyse and solve a range of problems, using sound knowledge.</td><td>Students develop, analyse, synthesise and evaluate models for applied situations.</td><td>Students confidently develop, analyse, synthetise and evaluate models for complex, concrete situations, and non-standard (new) contexts.</td></tr>
<tr><td>Skill Development Areas: Examples of skill development that may be covered in workshops, indiscipline sessions and consultations.</td><td colspan="4">Representation
• Formulate mathematical problems
○ Develop a mathematical representation of a task
○ Use different representations to formulate problems
• Using mathematical concepts
○ Select, develop and use a range of representations when solving a problem
○ Integrate and link different representations of a problem, and translate among them
• Interpreting, applying and evaluating solutions
○ Interpret solutions presented in different formats
○ Compare and evaluate different representations of solution</td></tr>
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Students ethically generate, use and interpret various representations of mathematical information relevant to a problem or situation (i.e., graphs, tables, diagrams, pictures, equations, formulae, text, etc.).	Students create, understand, and use information from basic / limited mathematical representations.	Students create, understand, use and interpret simple representations of mathematical information from various sources.	Students create, understand, use, integrate, compare and interpret different representations of mathematical information from a range of sources.	Students accurately develop, understand, use, integrate, compare, interpret various mathematical representations that capture complex mathematical problems.

Skill Development Areas: Examples of skill development that may be covered in workshops, indiscipline sessions and consultations.	**Reasoning & argument**
	• **Formulate mathematical problems**
	  ○ Explain and justify selected mathematical models and representations of mathematical problems
	  ○ Provide interpretations and insights regarding the formulation of mathematical problems
	• **Using mathematical concepts**
	  ○ Explain and justify the adopted methodology and process to solve a mathematical problem
	  ○ Link, integrate and /or generalise information to solve problems
	• **Interpreting, applying and evaluating solutions**
	  ○ Evaluate mathematical solutions
	  ○ Develop explanations and arguments to justify the solution of a task.			

Students convincingly and ethically explain, defend, and justify selected representations, solving-process and obtained solutions.	Students provide limited explanations and justifications of the strategies used to determine a solutions and its validity.	Students provide appropriate explanations and justifications of the strategies used to determine a solution and its validity.	Students, provide well-developed explanations, justifications and insights of the strategies used to determine solutions to applied problems and their validity.	Students provide well-developed explanations, justifications and insights of the strategies used to determine solutions to a variety of complex, applied mathematical problems and their validity.

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<tr><td>Skill Development Areas: Examples of skill development that may be covered in workshops, indiscipline sessions and consultations.</td><td colspan="4">Devising strategies
• Formulate mathematical problems
○ Select and / or develop a strategy or approach to formulate a mathematical problem
• Using mathematical concepts
○ Develop, select, compare and evaluate strategies to solve problems
○ Follow a strategy to obtain a solution
• Interpreting, applying and evaluating solutions
○ Select and / or devise a strategy to interpret, evaluate and validate a solution</td></tr>
<tr><td>Students ethically select, devise or develop a plan or strategy to solve mathematical problems.</td><td>Students select and apply simple strategies to solve basic problems.</td><td>Students select and apply sound strategies to solve a range of problems.</td><td>Students select, compare, evaluate and apply appropriate problem-solving strategies for applied problems.</td><td>Students select, compare, evaluate and adapt a variety of appropriate strategies to solve applied problems, including tackling new and / or complex situations with novel approaches.</td></tr>
<tr><td>Skill Development Areas: Examples of skill development that may be covered in workshops, indiscipline sessions and consultations.</td><td colspan="4">Using symbolic formal and technical language & operations
• Formulate mathematical problems
○ Use appropriate mathematical notations, symbols and expressions to formulate a mathematical problem
• Using mathematical concepts
○ Employ algorithms, formulas and procedures to solve problems
○ Use appropriate symbols and mathematical constructs to solve the problem
• Interpreting, applying and evaluating solutions
○ Recognise the relationship between the mathematical solution and the context of the problem
○ Use meaningful symbolic and technical language to assist with interpretations and potential limitations of the solution</td></tr>
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Students understand, interpret, ethically manipulate, and make use of suitable variables, symbols, arithmetic expressions, and operations, or rules to solve mathematical problems.	Students recognise and understand symbolic expressions, technical language, operations and rules; and solve simple problems following clear instructions via basic algorithms, formulas or procedures.	Students recognise and understand symbolic expressions, technical language, operations and rules, and can complete specified procedures.	Students understand, interpret and apply symbolic expressions, technical language, operations and rules, and can carry out appropriate procedures to solve applied problems.	Students understand, interpret and confidently use advanced symbolic expressions, technical language, operations and rules, and can carry out complex procedures to solve applied problems.

Skill Development Areas: Examples of skill development that may be covered in workshops, indiscipline sessions and consultations.	**Using mathematical tools**
	• **Formulate mathematical problems**
	  ○ Use appropriate mathematical tools to understand a problem and recognise / portray mathematical relationships
	• **Using mathematical concepts**
	  ○ Use mathematical tools to implement procedures and methods to obtain mathematical solutions
	• **Interpreting, applying and evaluating solutions**
	  ○ Use mathematical tools to evaluate the validity of solutions and / or determine solution constraints			

Students use appropriate mathematical tools, such as calculators, computer-based tools, and geometry tools, to ethically carry out mathematical procedures.	Students make basic use of mathematical tools to carry out simple mathematical procedures.	Students make appropriate use of mathematical tools to carry out a range of mathematical procedures.	Students make appropriate use of mathematical tools to carry out a range of mathematical procedures to solve applied problems.	Students confidently use a variety of mathematical tools to carry out complex mathematical procedures to solve applied problems.

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