

# ACADEMIC NUMERACIES FRAMEWORK

A tool to embed numeracy in tertiary courses, programs and study-support initiatives

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These slides are adapted from the presentation *The Academic Numeracy Framework: A tool to embed numeracy in tertiary courses, programs and study-support initiatives*, delivered at the Students Transitions Achievement Retention & Success (STARS) Conference (2023):  
<https://unistars.org/papers/STARS2023.pdf>

# Academic Numeracies Framework

## Key Features

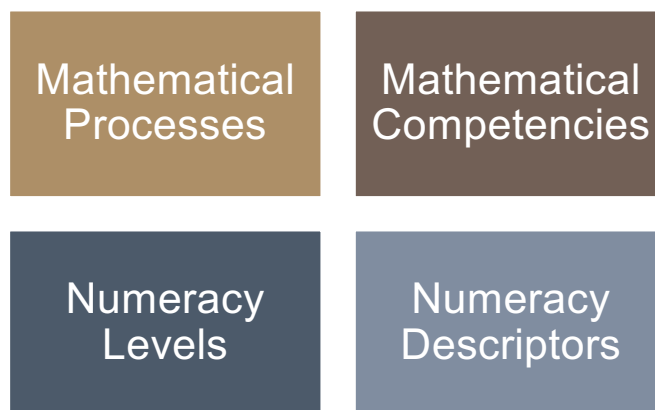
The **Academic Numeracies Framework** is designed to facilitate the systematic embedding of numeracy into courses, programs, and learning support initiatives (Galligan 2013b)

- Uses content from the Programme for International Student Assessment (PISA) framework (OECD, 2017)
- Focussed on tertiary education
- Applicable to different disciplines

**Key use case:** Map the **Target, Assumed** and **Actual** numeracy skills of students to inform lecturing and learning support strategies and activities

# Academic Numeracies Framework

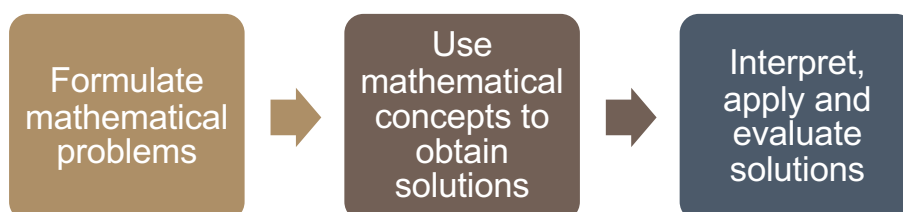
## Key Elements



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# Academic Numeracies Framework

## Mathematical processes



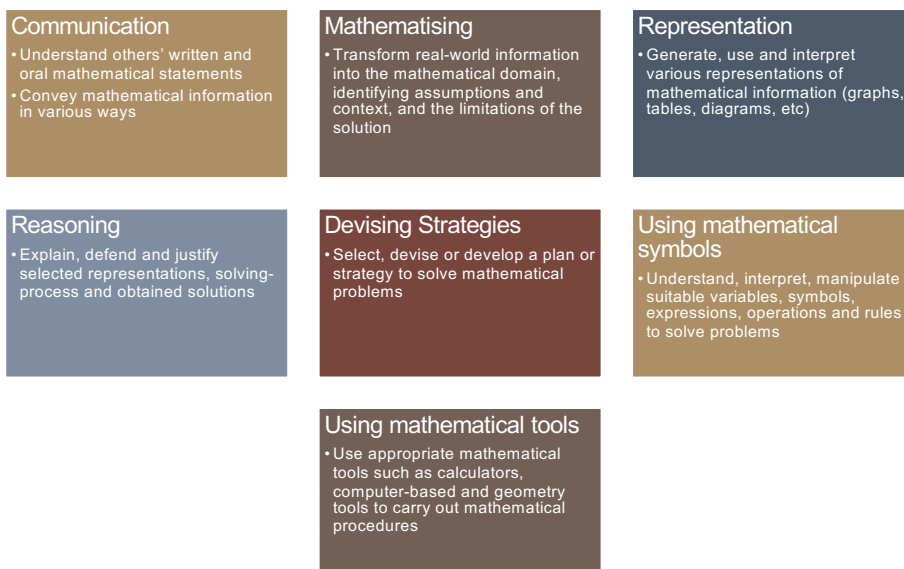
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### Key elements of the Framework – Mathematical Processes

These are the processes that we go through when engaging with a mathematical problem, namely

- Formulating the problem, using mathematical concepts to translate a contextualised problem into the domain of mathematics, thus arriving at a mathematical problem
- Conducting mathematical computations, derivations or manipulations as appropriate, to arrive at the solution of the problem.
- Interpreting the solution and judging whether it is reasonable, in the context of mathematics topic or a real-world application.

## Mathematical Competencies



### Key elements of the Framework – Mathematical Competencies

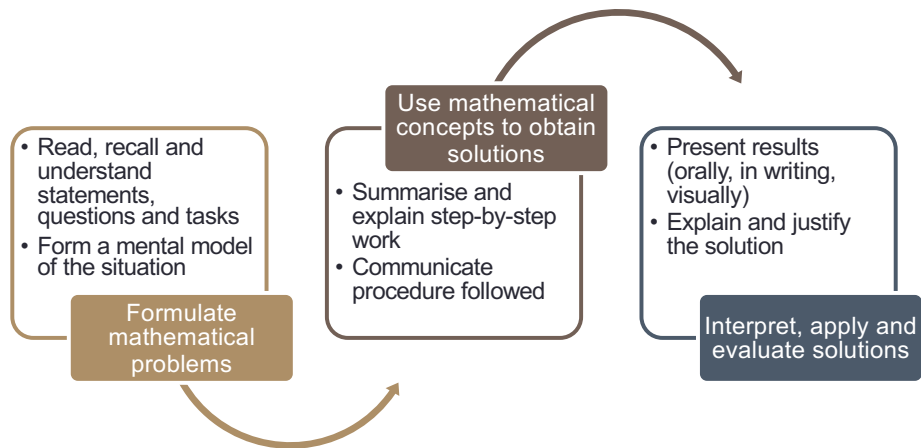
In order to complete these processes effectively, we use fundamental mathematical *competencies*, or capabilities. These constitute the second element of the framework.

When solving a problem, we

- Use communication skills, to understand and convey mathematical information, tasks and questions
- Mathematise, or transform real-world or contextualised information into mathematics,
- Create, use and interpret mathematical information represented in various ways, for example as graphs, tables, diagrams, and formulas
- Come up with strategies to tackle problems
- Reason, to explain and justify how we solved the problem, and the solution itself
- Use mathematical symbols, expressions, operations, and rules to arrive at the solution, with the help of appropriate mathematical tools (such as calculators, computer tools, and geometry tools) as needed

# Academic Numeracies Framework

## Mathematical processes - Communication



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### Key elements of the Framework – Mathematical Processes

These competencies are used in each of the mathematical processes.

# Academic Numeracies Framework

## Numeracy Levels

Topic Area		Discipline	
<b>Level 1 Scaffolded</b> <ul style="list-style-type: none"> <li>Students require significant scaffolding to develop numeracy skills and knowledge <b>within a topic area</b></li> </ul>	<b>Level 2 Supported</b> <ul style="list-style-type: none"> <li>Students require some scaffolding to develop numeracy skills and knowledge <b>within a topic area</b></li> </ul>	<b>Level 3 Supervised</b> <ul style="list-style-type: none"> <li>Students require some scaffolding to develop numeracy skills and knowledge <b>within a discipline</b></li> </ul>	<b>Level 4 Independent</b> <ul style="list-style-type: none"> <li>Students independently seek out and develop numeracy skills and knowledge <b>within a discipline</b></li> </ul>

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### Key elements of the Framework – Numeracy Levels

As students become more “numerate”, their level of proficiency in the mathematical competencies increases, and they are able to solve more complex and applied problems with more independence. These numeracy levels are the third element of the framework.

- Numeracy Levels 1 and 2 refer to the ability to solve a problem within a given mathematical topic, with less scaffolding required at level 2 with respect to level 1.
- Numeracy Levels 3 and 4 refer to students’ ability to solve applied problems in their fields of study, with some scaffolding at level 3, and essentially independently at level 4.

# Academic Numeracies Framework

## Numeracy Descriptors - Communication

	Topic Area		Discipline	
Descriptors	Level 1 Scaffolded	Level 2 Supported	Level 3 Supervised	Level 4 Independent
	<ul style="list-style-type: none"> <li>Students read, recall and extract basic information from limited sources, following explicit instructions</li> </ul>	<ul style="list-style-type: none"> <li>Students identify, extract, understand and interpret required information from various sources, to build a simple model</li> </ul>	<ul style="list-style-type: none"> <li>Students identify, extract, understand and interpret required information from relevant sources to build an applied model</li> </ul>	<ul style="list-style-type: none"> <li>Students identify, extract, understand, interpret and generalise information, linking sources to build complex, applied models</li> </ul>

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### Key elements of the Framework – Numeracy Descriptors

For each competency and numeracy level, the Framework provides a descriptor, which summarises the mathematical proficiency shown by students at that level.



# Academic Numeracies Framework

## Key Elements

Academic Numeracies Framework	Numeracy Levels			
	Level 1	Level 2	Level 3	Level 4
	<i>Scaffolded</i> Students require significant scaffolding to develop numeracy skills and knowledge within a <u>topic</u> area.	<i>Supported</i> Students require some scaffolding to develop numeracy skills and knowledge within a <u>topic</u> area.	<i>Supervised</i> Students require some scaffolding to develop numeracy skills and knowledge within a <u>discipline</u> .	<i>Independent</i> Students independently seek out and develop numeracy skills and knowledge within a <u>discipline</u> .
<b>Academic Competencies</b> <b>Communication</b> Communicating Representing Reasoning and argument Devising strategies Using symbolic formal and technical language & operations Using mathematical tools	<b>Communication</b>			
	<ul style="list-style-type: none"> <li><b>Formulating mathematical problems</b> <ul style="list-style-type: none"> <li>Read, recall, and understand statements, questions and tasks</li> <li>Extract and interpret information to form a mental model of the task</li> </ul> </li> <li><b>Using mathematical concepts, procedures and reasoning</b> <ul style="list-style-type: none"> <li>Explain a procedure</li> <li>Show step-by-step work conducted to arrive at a solution</li> </ul> </li> <li><b>Interpreting, applying and evaluating solutions</b> <ul style="list-style-type: none"> <li>Formulate and convey explanations based on interpretations and reasoning</li> <li>Present results (orally/in writing/visually)</li> </ul> </li> </ul>			
1. Understand others' written or oral statements about mathematical and numerical content and concepts.	Students read, recall and extract basic information from limited sources, following explicit instructions.	Students identify, extract, understand and interpret required information from various sources to build a simple model.	Students identify, extract, understand and interpret required information from relevant sources to build an applied model.	Students identify, extract, understand, interpret and generalise information, linking sources 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.

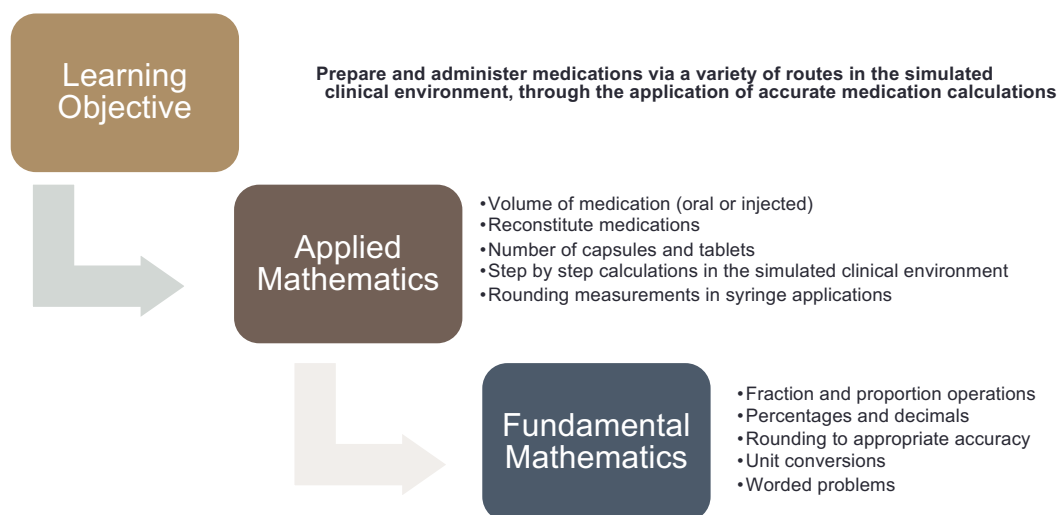
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## Academic Numeracies Framework

The Framework organises all these elements in a convenient format, one page for each competency. As an example, the Communication page is shown above.

# Academic Numeracies Framework

## Illustrative Example – Nursing Discipline



### Academic Numeracies Framework – Illustrative Example

This example illustrates the application of the Academic Numeracies Framework to map the numeracies of students in a course in the Nursing discipline. We commence with the course learning objectives, and determine the target or applied mathematics skills required to meet these objectives. These inform the applied maths content to be taught in the classroom.

For example, if a course learning objective is to “prepare and administer medications via a variety of routes in the simulated clinical environment, through the application of accurate medication calculations”, the applied maths skills would include the calculation of the volume of liquid medication, or number of tablets to be administered, reconstitution of medicines, syringe rounding and the use of the simulated clinical environment, including understanding mathematical instructions, and information (the domain of the teaching academic).

Next we determine the mathematics skills needed to perform in the course, that is, the ‘assumed’ or ‘pre-requisite’ skills that students are presumed to have on entering the course. These are typically the subject of study-support initiatives. In this example, these would include working with fractions, proportions, and percentages, rounding to appropriate accuracy, unit conversions and solving worded maths problems (the domain of the learning development professionals).

Typically one would need to consider more than one course learning objective, and we can also easily deal with program learning objectives, or objectives of learning development initiatives.

# Academic Numeracies Framework

## Communication – Intermediate course

Academic Numeracies Framework	Numeracy Levels			
	Level 1	Level 2	Level 3	Level 4
	<b>Scaffolded</b> Students require significant scaffolding to develop numeracy skills and knowledge within a <b>topic</b> area.	<b>Supported</b> Students require some scaffolding to develop numeracy skills and knowledge within a <b>topic</b> area.	<b>Supervised</b> Students require some scaffolding to develop numeracy skills and knowledge within a <b>discipline</b> .	<b>Independent</b> Students independently seek out and develop numeracy skills and knowledge within a <b>discipline</b> .
<b>Academic Competencies</b> Communication Mathematizing Representation Reasoning and argument Devising strategies Using symbolic formal and technical language & operations Using mathematical tools	<b>Communication</b>			
	<ul style="list-style-type: none"> <li>• <b>Formulating mathematical problems</b> <ul style="list-style-type: none"> <li>○ Read, recall, and understand statements, questions and tasks</li> <li>○ Extract and Interpret information to form a mental model of the task</li> </ul> </li> <li>• <b>Using mathematical concepts, procedures and reasoning</b> <ul style="list-style-type: none"> <li>○ Explain a procedure</li> <li>○ Show step-by-step work conducted to arrive at a solution</li> </ul> </li> <li>• <b>Interpreting, applying and evaluating solutions</b> <ul style="list-style-type: none"> <li>○ Formulate and convey explanations based on interpretations and reasoning</li> <li>○ Present results (orally/in writing/visually)</li> </ul> </li> </ul>			Applied Numeracies
				Fundamental Numeracies
				Actual Numeracies
1. Understand others' written or oral statements about mathematical and numerical content and concepts.	Students read, recall and extract basic information from limited sources, following explicit instructions.	Students identify, extract, understand and interpret required information from various sources to build a simple model.	Students identify, extract, understand and interpret required information from relevant sources to build an applied model.	Students identify, extract, understand, interpret and generalise information, linking sources 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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### Academic Numeracies Framework – Illustrative Example

We then map these applied and fundamental maths skills to the Framework, identifying the performance level associated with each one. For the current example, the mapping may look like this, showing a level 3 target for the applied maths skills, as appropriate for an entry-level applied course, and a level 2 for the Fundamental skills on entering the course.

It is essential to also identify the actual maths skills of students via, for example, discussion with lecturers and students, and / or analysis of data on current or previous offerings. These are shown here as a shaded area spanning levels 1 - 2 of the Framework. This information, allows us to identify any areas that may need focussed attention in lecturing and inform the development of resources and study support initiatives.

This comprehensive process is expedited and indeed enabled by a close collaboration between course lecturers and learning development staff. This approach is essential for a successful practical implementation of the numeracies framework.

## References

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