Further Mathematics 2016–2022

This document complements and should be read in conjunction with the [School-assessed Coursework report](http://www.vcaa.vic.edu.au/Documents/vce/mathematics/Further_mathematics_SAC_report.doc)*.*

Mathematical modelling

Mathematical modelling is the process of using mathematical constructs, structures and techniques to represent and describe a real-world context or system, in a simple and concise way that enables one to investigate features and characteristics of its behaviour, analyse particular aspects or solve problems of interest, and to make predictions related to the context or system.

For **Further** **Mathematics**, this includes the use of sets of empirical or observational data, lists, tables, diagrams and graphs, data representations, statistical measures and techniques, variables, constants, coefficients and parameters, financial constructs, first-order linear recurrence relations, relations and functions, variation, equations and inequalities, linear programming, matrices, networks, geometric shapes, objects, measures and trigonometry.

A simple and well known diagrammatic representation of the mathematical modelling process is shown below.



There is a considerable literature on mathematical modelling, both [in general](https://www.immchallenge.org.au/supporting-resources/mathematical-modelling-framework), and with respect to specific contexts, for example [social networks](https://theconversation.com/modelling-social-networks-reveals-how-information-spreads-18776). A brief elaboration on the process of mathematical modelling can be found [here](http://math4teaching.com/2011/04/16/what-is-mathematical-modeling/) .

The following tables map key knowledge and key skills for Outcome 2 and Outcome 3 to the stages of the mathematical modelling process.

Key knowlegde and key skills for Outcome 1 will be relevant to the stages of the modelling process depending on the context chosen, and the applicable content from the areas of study.

Each key knowedge and key skill statement is mapped to a particular stage of the process, or in some cases to two stages of the process as applicable. The numbers in the table correspond to the order of occurrence of that key knowledge or key skill statement in the list for each outcome.

This mapping should be used to inform the design and development of modelling tasks which incorporate the outcomes and assist teachers to ensure that related mark weightings are suitably addressed in the development of the corresponding approach to assessment.

Stage 1 – Formulate the model

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 1, 4 | 1, 4 | 1 | 1 |
| **3** | 2, 3 | 2, 3 | 5, 8 | 9 |

Stage 2 – Apply the model

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 2, 3 | 2, 3 | 1, 2 | 2, 3 |
| **3** | 6 | 1, 5 | 2, 3, 4, 6, 7, 9 | 2, 3, 4, 5, 6, 7, 8, 9 |

Stage 3 – Interpret and refine the model

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 4 | 4 | 3 | 4 |
| **3** | 1 | 1 | 1, 10, 11 | 1, 10, 11 |

Problem-solving

Problem solving is a process that occurs in a context where a question, task or issue needs to be solved or resolved, and there is a motivation, but not yet the means, to do so.

Questions or tasks for which there are already recognised methods or approaches for solution or resolution, do not require problem-solving in this sense.

In mathematics problems are generated from questions, conjectures and hypotheses within and across areas of study. New problems may arise in their own right, or as a variation, re-formulation, extension or generalisation of a known problem or class of problems.

A simple and well known diagrammatic representation of the problem-solving process, adapted from *How to Solve It* (Polya, 1945, Princeton University Press) follows.



The problem-solving process is elaborated briefly in [this short article](https://math.berkeley.edu/~gmelvin/polya.pdf) from the University of California Berkeley Mathematics Department, and discussed in more detail in
 Schoenfeld, A. (1985). *Mathematical Problem Solving*, Academic Press, New York.

The following tables map key knowledge and key skills for Outcome 2 and Outcome 3 to the stages of the problem-solving process.

Key knowlegde and key skills for Outcome 1 will be relevant to the stages of the problem-solving process depending on the context chosen, and the applicable content from the areas of study.

Each key knowedge and key skill statement is mapped to a particular stage of the process, or in some cases to two stages of the process as applicable. The numbers in the table correspond to the order of occurrence of that key knowledge or key skill statement in the list for each outcome.

This mapping should be used to inform the design and development of modelling tasks which incorporate the outcomes and assist teachers to ensure that related mark weightings are suitably addressed in the development of the corresponding approach to assessment.

Stage 1 – Pose/understand/define the problem

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 1, 4 | 1, 4 | 1 | 1 |
| **3** | 2, 3, 4 | 2, 3, 4 | 5, 6 | 5, 6 |

Stage 2 – Devise a plan

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 3 | 5 | 2 | 8, 9 |
| **3** | 6 |  | 8, 9 |  |

Stage 3 – Implement the plan

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 2 | 2 | 2 | 2, 3 |
| **3** | 1, 4, 5 | 1, 4 | 1, 2, 3, 4, 5, 7 | 1, 2, 3, 4, 6, 9 |

Stage 4 – Look back/review/extend

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot point** | **Key skill dot point** |
| **Unit 3** | **Unit 4** | **Unit 3** | **Unit 4** |
| **2** | 4 | 4 | 3 | 3, 4 |
| **3** | 1, 5 | 1 | 10, 11 | 10, 11 |

Mathematical modelling and problem-solving are [complementary processes](https://www.immchallenge.org.au/supporting-resources/what-is-mathematical-modelling). Developing a model may be a strategy that is employed to solve a problem, and problem-solving may be required in developing and applying aspects of a model. Some sample contexts for mathematical modelling and problem-solving can be found [here](https://plus.maths.org/content/teacher-package-mathematical-modelling).