

# MATHEMATICAL MODELLING IN THE VICTORIAN CURRICULUM 2.0

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Mathematical modelling is the solving of real-world problems. Sometimes the problem is already posed and other times the modeller needs to pose the problem.

Mathematical modelling is an essential part of mathematics. It allows students to understand why we value mathematics and make sense of its usefulness. In addition, students learn about the world in which they live.

Mathematical modelling has long been part of the Victorian Mathematics Curriculum from Foundation to Year 12. Elements of mathematical modelling are explicit in all four proficiencies. This includes:

- understanding (e.g., transfer understanding to unfamiliar contexts, describe their thinking mathematically and interpret mathematical information),
- fluency (e.g., make reasonable estimates, choose appropriate representations, recognise multiple ways of answering questions),
- reasoning (e.g., modelling, evaluating, explaining, justify strategies used and conclusions reached) and
- problem-solving (e.g., solve problems from real-world context, plan, make choices, interpret, formulate, model, communicate solutions effectively).

In July 2023, the Victorian Curriculum (VC 2.0) Mathematics was released. This curriculum is being implemented from 2024. The new curriculum has an increased emphasis on mathematical processes and mathematical modelling.

There are 19 new content descriptors (F-10) that focus explicitly on mathematical modelling\* or are associated with this (e.g., in VC2MFN05 students represent practical situations, including financial situations, and VC2M4N07 and VC2M5N08 focus on estimation, and the reasonableness of solutions).



Ideas associated with real-world problems that can be solved using mathematics should be a focus whenever possible. Year 6 students might discuss the difficulties associated with determining a rule-of-thumb (i.e., a mathematical model) to describe housing affordability in terms of proportion of income spent on housing (rent or mortgage) and time spent travelling to work. A report about this was in the news as I write. I am not suggesting Year 6 try to solve the task, rather they discuss the real-world context and recognise mathematics can be used to describe the real-world context.

Thinking about estimation, students in Years 3-6 could be asked to estimate how many people were impacted by the extensive Optus outage in Australia on 8 November 2023. One online source (not Optus) claims the number affected was 10.5 million Australians. We can and should ask, *how was this number determined? Is it reasonable?* Here we are examining and critiquing the results of someone else's modelling.

This is an important part of mathematical modelling.

As with all real-world tasks, we need to begin by thinking about the context. What do we know? What do we need to know? Previous experience and expertise with modelling would influence your decision as to how to introduce the task - would you begin with a whole class discussion or first have students discussing in pairs or small groups followed by class discussion.

Either way, the resulting class discussion would likely produce a list about the real-world context such as:

- Optus is a phone and internet provider.
- There are other providers (e.g., Telstra, Dodo, etc).
- Optus has a lot of customers (i.e., it is one of the main providers. If this is unknown, then you might set homework and collect some data as to what providers are used by your students' families. This would likely include Optus as a common provider.
- Many people have an internet provider.
  - Some people have 2 providers (with phone and internet separate)
  - Not all phones are connected to the internet.
- Optus is also used indirectly by other companies. Some companies simply use the Optus service, others companies will select the best service in your location at any given time. (This may not arise. It is an additional complexity and certainly can be set aside (i.e., knowingly ignored) in the first attempt(s) to solve the problem).
- My family uses Optus. This should lead to a discussion as to how this might, or might not, help solve the problem.

Optus Outage 8Nov2023 estimate : Sheet1				
	A	B	C	D
1	Questions	Estimates	Calculations	Explaining my reasoning
2	Number of people living in Australia	25000000		
3	How many (what fraction or proportion) of Australains have a phone?	70%	17500000	Initial very rough estimate to help me think about the problem. Later I will think about the ages of Australians and at what age I can assume everyone has a phone, or consider something even more realistic thinking about various age ranges (e.g. 0-7 (? what should this be) no phones, etc.
4	How many (what fraction or proportion) have two (or more) phones?	0%		AS my initial estimate is zero, I have skipped over cell C4 in my initial model. Mutliplying by zero will not give me the result I want. I will adjust my model if i decide to include a non-zero estimate here.
5	What fraction or proportion or percentage of phone users/owners with smart phones use Optus?	30%	5250000	My initial estimate of 5 250 000 or 5.25 million is substantially below the reported number of 10.2 million customers. Next step is to make some more careful estimates. It is too early to critique the results of the model reported in the media.

Figure 1. My initial thoughts and estimates.

At all levels of schooling it is expected the list will contain factors not relevant to solving the problem (e.g., I like the Optus logo) and deciding what is relevant and important is part of mathematical modelling.

During mathematical modelling it is important to discuss the real-world context, not just the problem. In some problems it can be a challenge to separate these, in others it is not.

A second discussion about the problem: *How was this estimate determined? Is it reasonable?* Should follow and focus on what is known, what it might be helpful to know, and how we might solve the problem. A discussion may include:

- We need to know how many people live in Australia.

Thinking about phones

- How many (what fraction or proportion) of Australians have a phone?
- How many (what fraction or proportion) have two (or more) phones?
- What fraction or proportion or percentage of phone users/owners with phones use Optus? (or have Optus as their provider - as noted above these are not the same thing).

## THINKING ABOUT PHONE USAGE

A simple and sensible approach to the task would be to begin solving the task just accounting for phone use. This can then be revisited and revised (time permitting) to additionally consider the additional impact of internet users. Similar questions can be posed as for phone use. For now, let us take the simple approach and just consider phone use.

For this problem these questions (i.e., the previous dot points) are building up a model to answer our question, that is a series of proportions. We could leave this as a series of questions, write in symbolic form, or use a digital tool such as a spreadsheet to undertake the calculations for us.

The advantage of a spreadsheet is we can easily make adjustments to our estimates and the digital tool will automatically recalculate our estimate. We can also see and consider the interim solutions as we progress. This allows us to decide if both the model and the final result is sensible.

In this particular case, we have the estimate reported by the media and we should be able to determine the model they most likely used. We can then decide if we think this is reasonable model and solution.

Figure 1 shows my first (dodgy, as I am leaving the estimates to you) thinking.

I begin by ignoring the fact I know some people have multiple phones. I assume all phones are smart phones, so my result will be an overestimate based on this. Perhaps I might consider this as accounting for those people with multiple phones. You can critique my interim estimates and calculations. More thinking is needed on this problem.

Anyone with a phone or the internet will be interested in this task, including in the future, as the incident affected many people and was widely reported.

News items are one good source of ideas for mathematical modelling tasks. Another source is to just live and take photos of things you notice.

The model(s) developed for this task can be modified for similar real-world situations such as when a large company is hacked and personal data stolen or imagine the government or your local Council or a charity offered 10 free swimming lessons to anyone unable to swim. You can pose the questions for the contexts.

Mathematical modelling is engaging and inherently interesting for teachers and students. Enjoy the opportunities that the new curriculum encourages with regard to mathematical modelling.

*\* Jill is leading a team (with Carly Sawatzki and Gloria Stillman) writing web-based content related to these new content descriptors, providing tasks and teaching advice related to implementing mathematical modelling.*