

Mathematical Modelling and Statistical Investigations

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Today

- What modelling tasks are, and what that means for us
- Where modelling tasks fit in AC version 9.0
- Stimulus for task brainstorming
- Outlining tasks and checking they work




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What is modelling?

Identifying a real-world problem, simplifying the problem to a mathematical one, formulating a plan, finding a mathematical solution/s to the problem that works in the real context, interpreting and communicating the solution/s to someone who cares about the problem.

As real-world situations are messy, we need to make assumptions in order to simplify the problem and translate it into a form that can be investigated mathematically. We also need to test any solution/s to see if they make sense in the original context and verify that our process is reliable prior to making recommendations.




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Modelling vs Problem solving

Ben Galluzzo and Katie Kavanagh

<https://m3challenge.siam.org/resources/sample-problems>



- ▶ Did they start with a big, messy, real world problem?
- ▶ Did they ask questions and then make assumptions to define the problem?
- ▶ Did they identify what changes and what stays the same?
- ▶ Are they using mathematical tools to solve the problem?
- ▶ Are they communicating with someone who cares about the solution?
- ▶ Have they explained if/when their answers make sense?
- ▶ Have they tested their model/solution and revised if necessary?

(Levy et al)

▶ *Principle: if it's not worth answering, don't ask it*

Galluzzo and Kavanagh, 2019

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What that means for students

Start with a real-world stimulus, not a fully-written problem.

Discuss possibilities.

It should feel a bit messy.

Identify questions to answer, information to find and assumptions made.

Formulate a problem to solve.

Look for similarities and differences to previous learning, considering what mathematical tools and process might be appropriate.

Develop a plan and outline some major steps along the way.

When carrying out the plan, record set-backs and changes in steps. Check in regularly to make sure the plan still makes sense.

Test the model and any solutions. Decide if and when the solutions make sense, interpreting results based on the context.

Communicate any solutions/s clearly to someone who cares about the problem. Make it simple.

Generalise any findings.

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Mathematical modelling AC v9

<https://v9.australiancurriculum.edu.au/teacher-resources/understand-this-learning-area/mathematics>

- Students develop an understanding of mathematical modelling when they use mathematics to gain insight into and make predictions about real-world phenomena.
- Mathematical models are used to inform judgements and make decisions in personal, civic and work life.
- When using mathematical modelling to solve problems, students make assumptions, recognise, connect and apply mathematical structures.

- The modelling process utilises mathematics to formulate, analyse, solve, interpret, generalise and communicate their results in response to a real-world situation.
- Mathematical modelling is an essential dimension of the contemporary discipline of mathematics and is key to informed and participating citizenship.

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My assessment criteria

- Problem type and complexity:** is the problem itself hard enough? Consider: complexity, familiarity and structure of the task.
- Planning and formulating:** this includes selecting information, making assumptions, observations and translating into maths.
- Solving:** this includes organised steps, accuracy, techniques and tools.
- Verifying:** checking part-way through the solving process, modifying approach and verifying solutions.
- Communicating and interpreting:** this includes effective communication for the audience as well as interpreting and justifying conclusions (details of strengths or limitations).

Stage	A	B	C
1	-Complex -Unfamiliar -Unstructured	-Complex -Mostly familiar -Most structured	-Simple -Familiar -Structured
2	-Relevant info. multiple sources -Highly relevant assum.s & ob.s -Approp. & complex tech.s	-Relevant info. a few sources -Approp. assum.s & ob.s -Approp. tech.s, some complex	-Relevant info 1 source -Some assum & ob.s -Simple tech.s mostly approp.
3	Systematic, high accuracy, range of tech.s & tools	Organised, accurate, some complex tech.s, approp. tools	Follows a plan, mostly accurate simple tech.s, structured tools
4	Systematic checks, modifies & documents reasons, verifies	Notifies obvious errors, modifies, lists reasons, Checks results	Checks working & identifies obvious errors
5	Highly effective comm. & strong justification in context (S&L)	Clear comm., gives reasons for conclusions with ref. to context	Approp. Comm, states approp. Conclusions, limited S/L

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Stimulus for task design: my school context

Directly relevant in my school

- What real events are happening in my school?**
Think: competitions, sports, carnivals, concerts, celebrations, ceremonies, excursion, camps, building projects, tuck shop, music lessons...
- What real problems exist in our community that we might be able to help with?**
Think: cleaning up the local area, creating community spirit through events, volunteering, feeding my family, clothes/books for the poor
- What interests do the kids have? What is the current hot topic?**
Think: games, toys, activities, collecting things, lunch time activities

Numeracy possibilities in other subjects

- Science**
Fair tests or experiments: conditions, accurate measurements, repetition, graphing results
- Arts**
Music: Patterns of notes in scales, beats and time signatures
Drama and visual art: arranging objects or shapes in a space for visual appeal and access (symmetry/asymmetry, pattern, lines of view)
- Health and PE**
Measurements of distance, time, angle, strength; rates and improvements
- HAS**
Information sources, surveys, stats and bias

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Steps for designing great tasks

- **Brainstorm the stimulus:** What jobs/problems are there for the topic? What steps are needed? What questions would you want to know the answers to?
- **Pare it back:** Target one task or problem and brainstorm the sub-tasks. Write an ordered list of steps.
- **Maths it:** What maths content naturally fits the context? If it adds to the task, include it, if not, leave it out.
- **Be clear.** Write a three-sentence brief:
 - The context or stimulus:
 - Your job is to: (consider including a few problems to select from)
 - You have to hand in:
- *Principle: be clear in your expectations of what the problem is and what you expect from the student, without telling them how to solve the problem*

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Stimulus for task design: recent news

- Rewilding efforts in Europe have led to a 470% increase in bird populations since 2012. <https://www.rewildingeurope.com/wp-content/uploads/publications/wildlife-comeback-in-europe-2022/>
- Solar panel production increased by 45% globally between 2021 and 2022, with annual sales expected to triple by 2025. <https://www.pv-tech.org/global-polysilicon-capacities-to-reach-536gw-by-year-end-2023-cea/>
- In 2021, the International Energy Agency predicted that it would take until 2030 for global EV sales to reach 7%, but instead it took just 1 year to reach 10%. <https://www.businessinsider.com/electric-vehicles-accounted-global-auto-sales-could-quadruple-2030-report-2023-1>
- In 2022 Australia created a 744,000 km² marine park, meaning that 45% of our territorial waters are now protected. <https://www.abc.net.au/news/2022-03-20/two-marine-parks-to-be-set-up-christmas-cocos-islands/100924776>
- In 2022, Australians lost \$3.1 billion in scams, an increase of 80% compared to 2021. What does this mean for my family and how can we help? <https://www.scamwatch.gov.au/scam-statistics>
- Youth crime rates have dropped by 75% since the 1990s in both the US and UK. UK crime rates are at the lowest levels since 1980. Is that the same for Australia? Why don't we hear about it? <https://www.abs.gov.au/statistics/people/crime-and-justice/recorded-crime-offenders/latest-release#data-downloads>
- Nearly 300kg of food *per person* is wasted in Australia each year, costing \$18-20b and creating a carbon footprint. What does this mean for my family? <https://www.abc.net.au/news/science/2019-08-14/food-waste-climate-change-emissions/11399448>
- Globally, 409,000 people die from malaria each year, but a new, cheap vaccine provides up to 80% protection <https://www.bbc.com/news/health-62797776>

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Stimulus for task design: interesting questions

- How big is a tiny home compared to my bedroom?
- How much Lego would it take to go all the way across my classroom?
- How much does it cost for dinner?
- How many push-ups can our whole class do in 5 minutes?
- Why is everyone the same number of handprints high?
- How much wrapping paper does my family use?
- How much food does my family waste each week?
- How many fish are in the tank?
- How far would our shoes stretch?
- How much time do we spend just waiting while at school?
- How far do we walk/run in a week?
- Does our class have more space than the class next door?
- What is the “average” child in our class like?
- What food should the school canteen offer?
- Does the lightest ball go the furthest?
- How high am I likely to be as an adult?
- How many types of bugs or birds do we have in our school?
- Would our class’s lunch wrappers cover the whole mat in a day?
- Why are honey combs hexagonal?

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Useful sites for modelling ideas

- IM²C challenge site: <https://www.immchallenge.org.au/>
- Future crunch: <https://futurecrunch.com/goodnews/>
- Ben and Katie’s M3 challenge: <https://m3challenge.siam.org/>
- Resolve: <https://www.resolve.edu.au/teaching-resources>

If it’s not worth answering, it’s not worth asking.

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