CURRICULUM, PEDAGOGY AND BEYOND

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Explicit Teaching & Rich Problems: How to marry the two!

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Synopsis

Explicit teaching is one of 4 elements in the updated Victorian Teaching and Learning Model 2.0 released this year. In this session we will discuss some approaches that ‘marry’ explicit teaching and rich problems.

This marriage provides students with the tools and strategies to engage with challenging problems, and the opportunity to explore, reason, justify, connect ideas and deepen understanding.

Engagement is a key element to success in mathematics and central to fostering a positive disposition, which is often regarded as the 5th proficiency in mathematical education.

Key takeaways:

1. Strategies to help students engage in problem solving.
2. The benefits of explicitly considering what’s required for students to lead into successful problem solving.
3. The importance of fostering a positive disposition towards mathematics learning.

Rich Tasks

For students to learn mathematics with understanding, they must have opportunities to engage on a regular basis with tasks that focus on reasoning and problem solving and make possible multiple entry points and varied solution strategies.

NCTM Principles to actions

Warm up – Cookie Monster \3 ACT Problems

What do you notice? What do you wonder?

https://gfletchy.com/3-act-lessons/

Warm up – Cookie Monster

What do you notice? What do you wonder?

How many were there? How many were eaten?

The total eaten was 22. How many ways can you partition 22 in 3 ways?

I noticed…

- in the first row slightly less than half were gone
- in the second row around ⅓ were missing
- in the third row had an even number less than 10 left

	Thinking	Expression	
Row 1	16/2 R	7 + a	16
Row 2	16/3 R	2b + c	16
Row 3	2,4,6,8	? + 14,12,10 or 8	16

Explicit Instruction

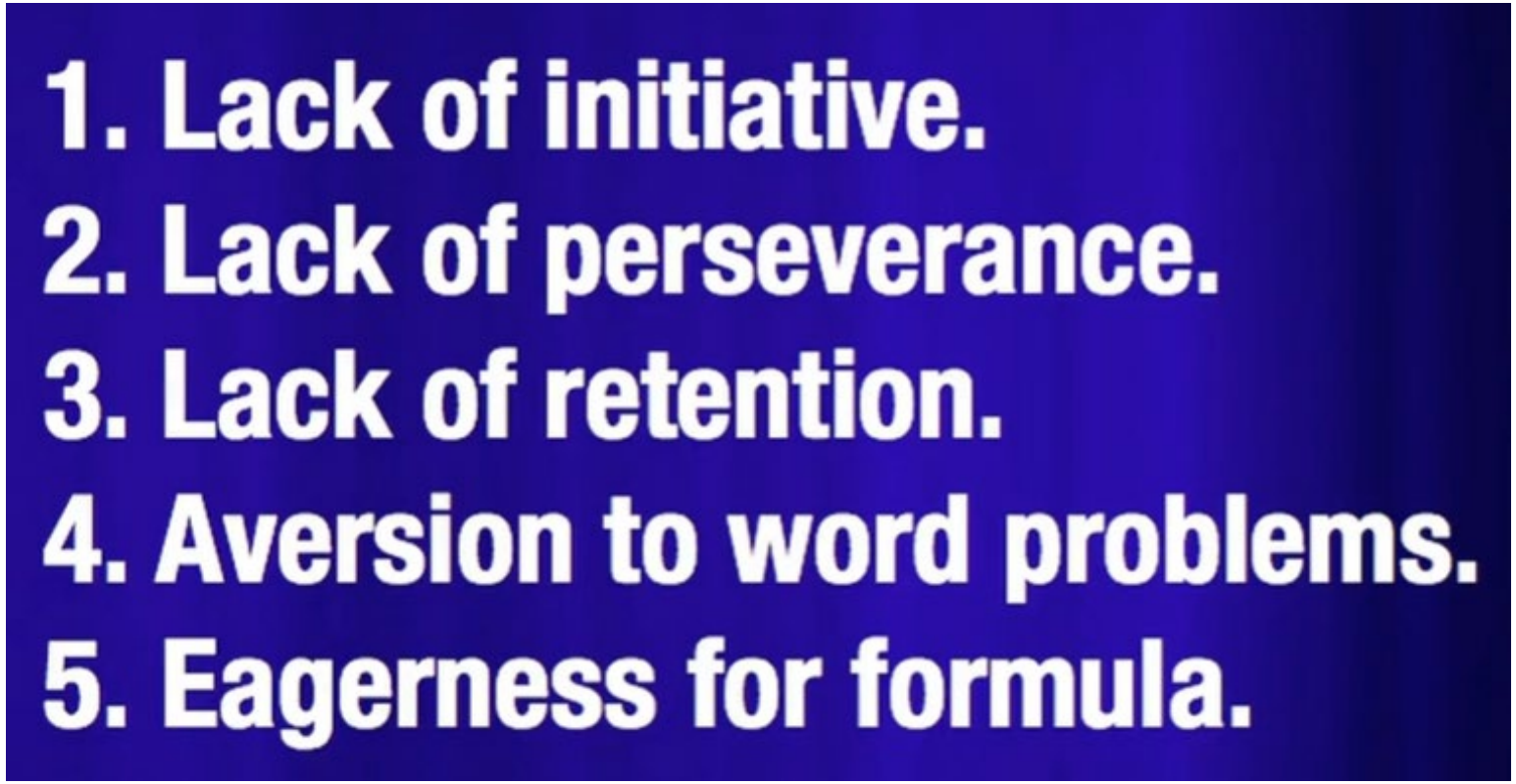
Our report on How Students Learn Best shows that learning is optimised through a structured and sequenced approach to explicitly teaching new content.

Introducing new information is most effective when teachers break it down and teach it explicitly using explanation, demonstration and modelling, especially when students are new to that learning area.

What prior knowledge is needed for success?

What needs to be explicitly taught?

Textbook Problems often lead to …



Are they encouraging our students to think and reason using mathematics? Dan Meyers

3 Acts

Encourages thinking and reasoning with Mathematics

Rich tasks have a range **of** characteristics that together offer opportunities to meet **the different** needs **of** learners. On its own a **task** is not **rich**, **it** is how **the task** is used **in the** classroom that may make **it rich**. ... **challenge** learners to think **for** themselves.

nrich.org

Learning in Mathematics

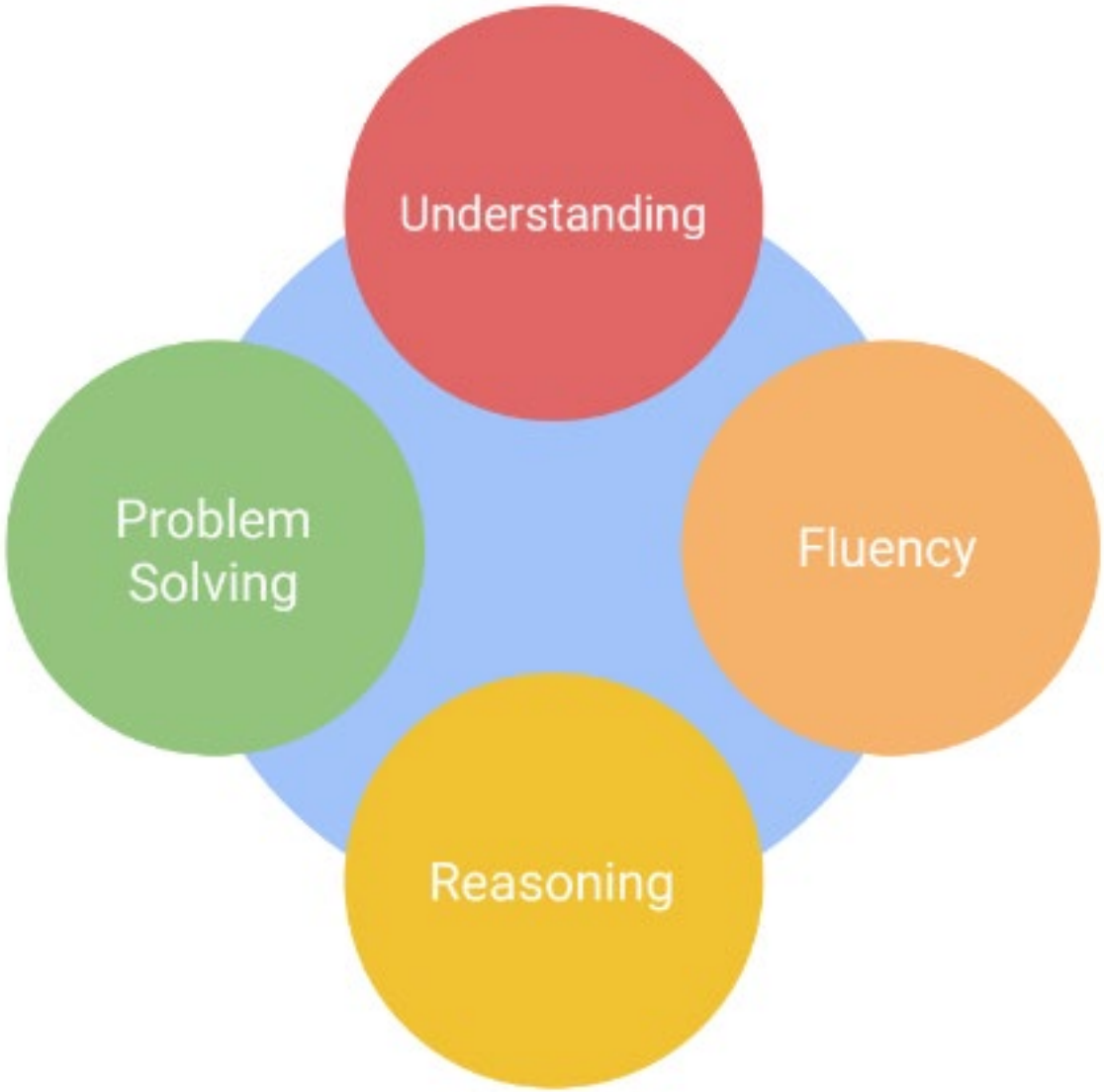
Content	Proficiencies	Processes
Number Algebra Measurement Space Statistics Probability	Fluency Understanding Reasoning Problem Solving	Mathematical Modelling Computational thinking and simulations Statistical Investigations Probability experiments and simulations Computation, algorithms and the use of digital tools in mathematics

What

How

Skills

Proficiencies



How do the fit in?

Peter Sullivan

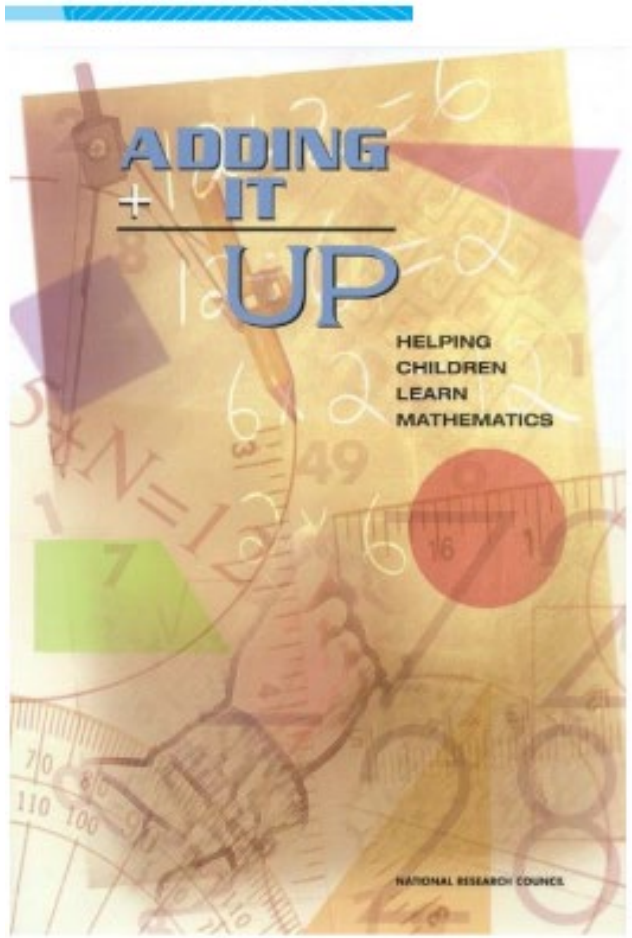
Proficiency Strands

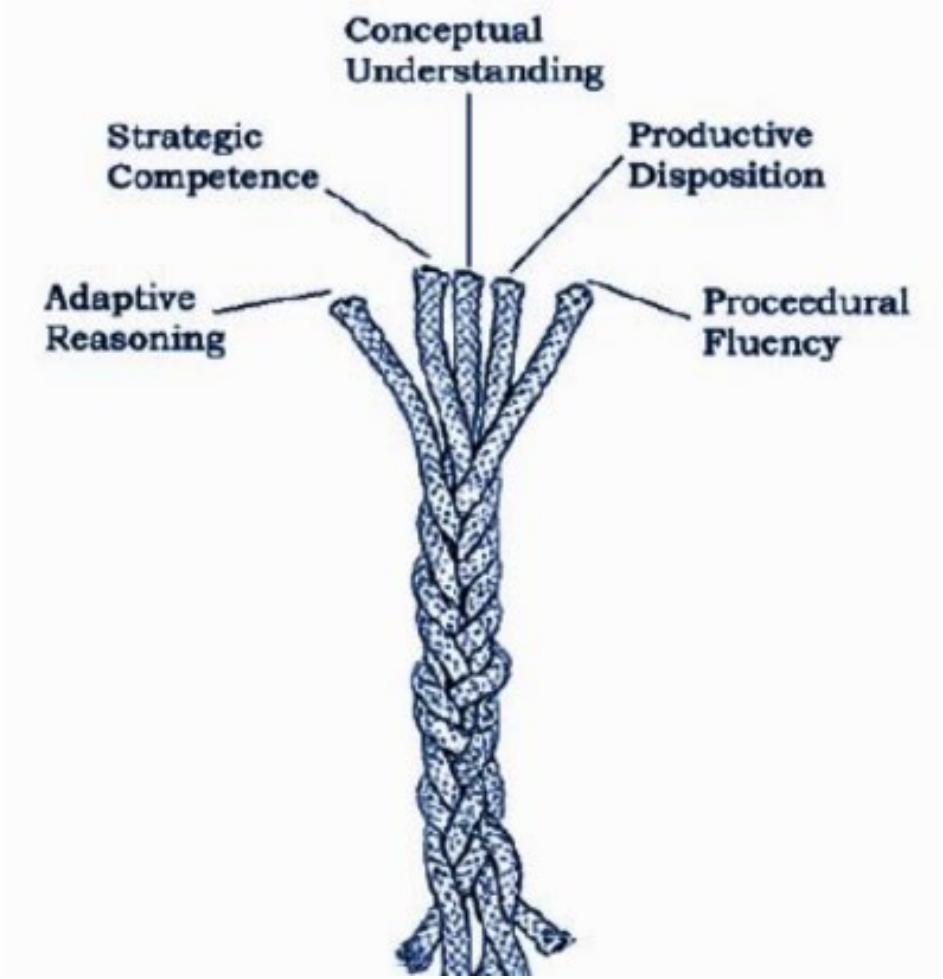
"describe the actions in which students can engage when learning the content" which "are represented across and within the level descriptions, content descriptions and achievement standards"

Proficiencies in the Victorian Curriculum Mathematics V 2.0

Proficiencies	Actions
Understanding	build, refine, make connections, transfer, adapt, draw on reasoning, cultivate new ideas, connect, represent, identify commonalities and differences, describe thinking, interpret
Fluency	practise, consolidate, choose procedures, carry out procedures, flexible, accurate, appropriate, efficient, recall, estimate, calculate, choose, use, connect conceptual understanding to strategies & procedures, apply, manipulate, find solutions
Reasoning	working mathematically, logical thought, conjecture, hypothesise analyse, prove, experiment, modell, evaluate, explain, infer, justify, refute, abstract, generalise, deduce, adapt, transfer, compare, contrast, reflect
Problem-solving	plan, choose, apply, review and analyse solutions, interpret, formulate, model, investigate, select and use technology, communicate solutions, represent, design, decide, verify, justify

Where did they come from?





Kilpatrick, Swafford & Findell (2001)

Mathematical Dispositions

How do students respond to mathematical challenges?

How do they see themselves as learners of mathematics?

Do they see Mathematics as useful and worthwhile?

Are they willing to persevere in attempting to make sense of a problem, a procedure, a concept, or some other important aspect of mathematics?

Are they accumulating a set of good mathematical examples that they can use to help remember or reconstruct important ideas?

Do they realise that making mistakes is part of the journey?

Mathematical Dispositions

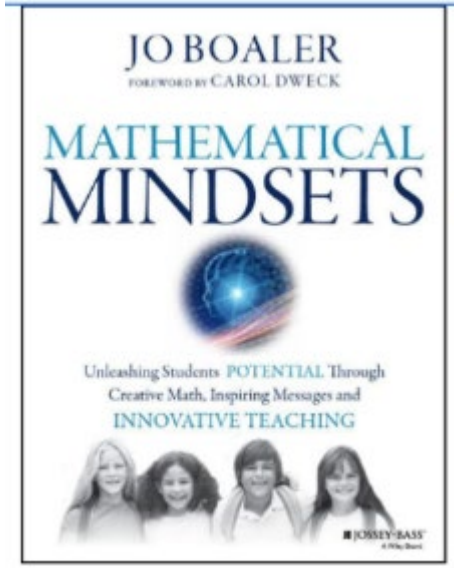
Mathematics classrooms are places where students believe:

Everyone can do well in maths.

Mathematics problems can be solved with many different insights and methods.

Mistakes are valuable, they encourage brain growth and learning.

Mathematics will help them in their lives, not because they will see the same types of problems in the real world but because they are learning to think quantitatively and abstractly and developing in inquiry relationship with math.



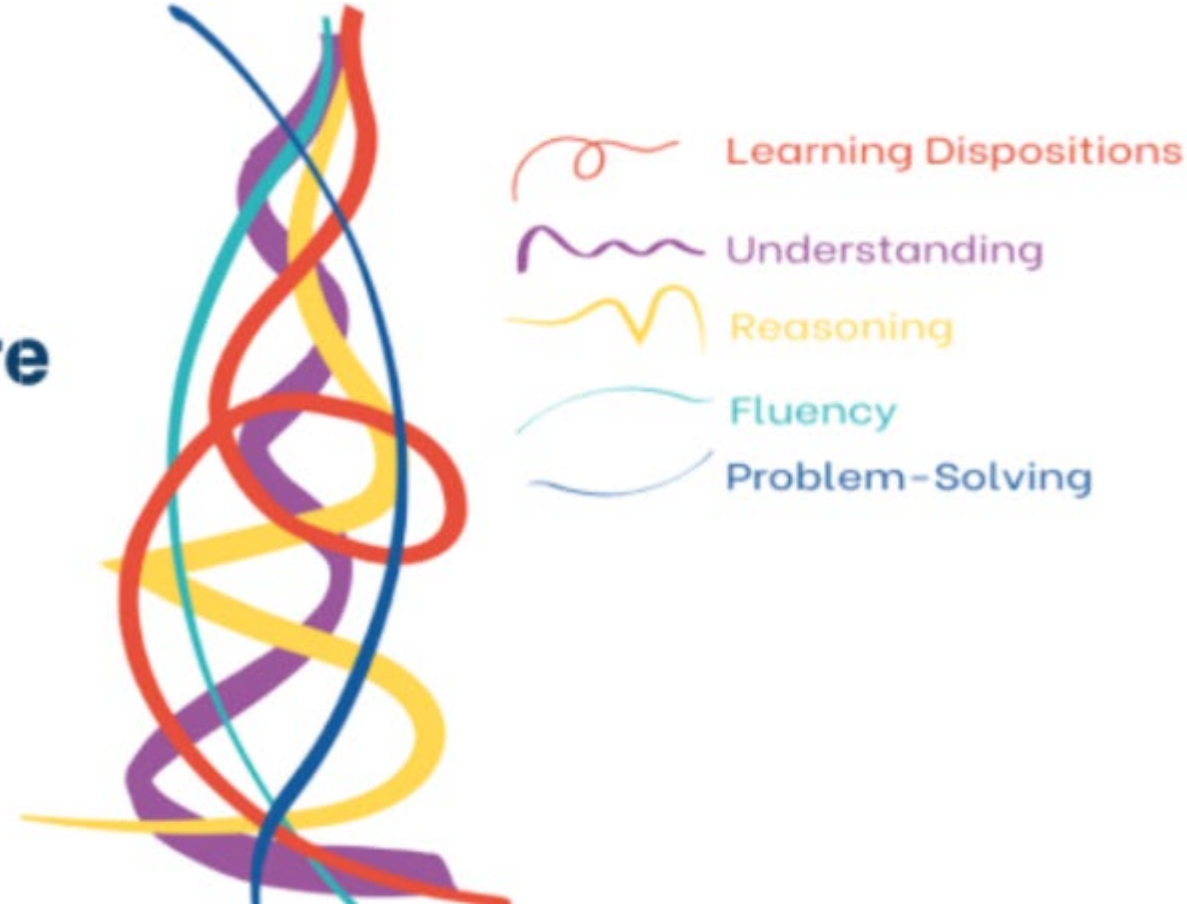
Youcubed.org

The 5 Proficiencies

Understanding	To connect and represent mathematical ideas
Fluency	To use methods flexibly, accurately and appropriately
Problem Solving	To observe, form conjectures and use evidence to (dis)prove mathematical ideas
Reasoning	To logically think through, reflect on and justify ideas
Productive Disposition	To believe in diligence and self-efficacy

Proficiencies

The proficiencies are intertwined and interdependent.



Learning in Mathematics

A stronger focus on the kinds of mathematics problems and activities that foster reasoning will develop more curious and investigative mathematical thinkers who wonder, ask questions, value mistakes, patiently explore problems, discuss, explain and justify their mathematical thinking and processes (as well as their solutions).

Proficiency in Mathematics

The proficiencies of **Understanding, Fluency, Reasoning and Problem-solving are embedded in all 6 strands** and further the development of increasingly sophisticated knowledge and understanding of mathematical concepts, fluency in representations and procedures, and sound mathematical reasoning and problem-solving skills.

Proficiency in mathematics enables students to respond to familiar and unfamiliar situations by employing mathematical processes to solve problems efficiently and to make informed decisions. Proficiency in mathematics also enables students to reflect on and evaluate approaches, and verify that answers and results are reasonable in the context. (Vic Curriculum 2.0)

Explicit Teaching & Rich Problems

How to marry the two?

Explicit and inquiry approaches

There's been a lot of debate, commentary and sensationalist headlines in the media recently, pitting different pedagogies against each other.

Summary of each approach

Explicit teaching

- Manages the cognitive load of students as they learn new content
- Activates prior knowledge and ensures that it is sound enough to build on
- Explains and effectively demonstrates what students need to learn
- Scaffolds learning by providing opportunities for students to apply and practice their new knowledge with timely corrective feedback to deepen their understanding
- Seeks to maximise student engagement through high participation

Victorian Department of Education – VTLM 2.0

Inquiry-based learning

- Focuses on investigation and problem-solving
- Reverses the order of learning, with teachers starting with a range of scenarios, questions and problems for students to navigate
- Prioritises problems that require critical and creative thinking, so students can develop their abilities to:
  - ask questions,
  - design investigations,
  - interpret evidence,
  - form explanations and arguments
  - communicate findings

Australian Government, Depart. of Education

Common misconceptions – explicit teaching

- That students passively sit in rows and engage in rote learning
- That explicit teaching is only for struggling students
- That explicit teaching limits higher-order thinking
- That explicit teaching is the same as direct instruction

Explicit teaching: *is a teaching strategy where the teacher clearly guides the students through the learning process. The focus is on clarity and transparency in teaching goals and procedures, and immediate feedback ensuring that all students understand the concepts being taught.*

Direct instruction: *a specific, highly structured teaching model developed by Siegfried Engelmann and Wesley Becker. It uses scripted, fast-paced lessons in which students are grouped by ability, with frequent questioning and corrective feedback.*

Explicit teaching as imaged by ChatGPT4

Common misconceptions – inquiry learning

- That teachers use only one approach to teaching – either explicit or inquiry-based
- That inquiry-based learning does not involve any explicit teaching
- That inquiry-based learning is a free-for-all, with no structure or rules
- That inquiry-based learning is the same as discovery learning

Inquiry learning: *involves teachers guiding the learning process by providing resources and scaffolding. Teachers pose key questions to stimulate students' thinking and help them reach a deeper understanding of the content or process. Students explore, ask questions, and engage actively with the material*

Discovery learning: *emphasises self-directed exploration where students discover concepts through independent investigation. Learning emerges from personal experience and experimentation, with minimal teacher intervention.*

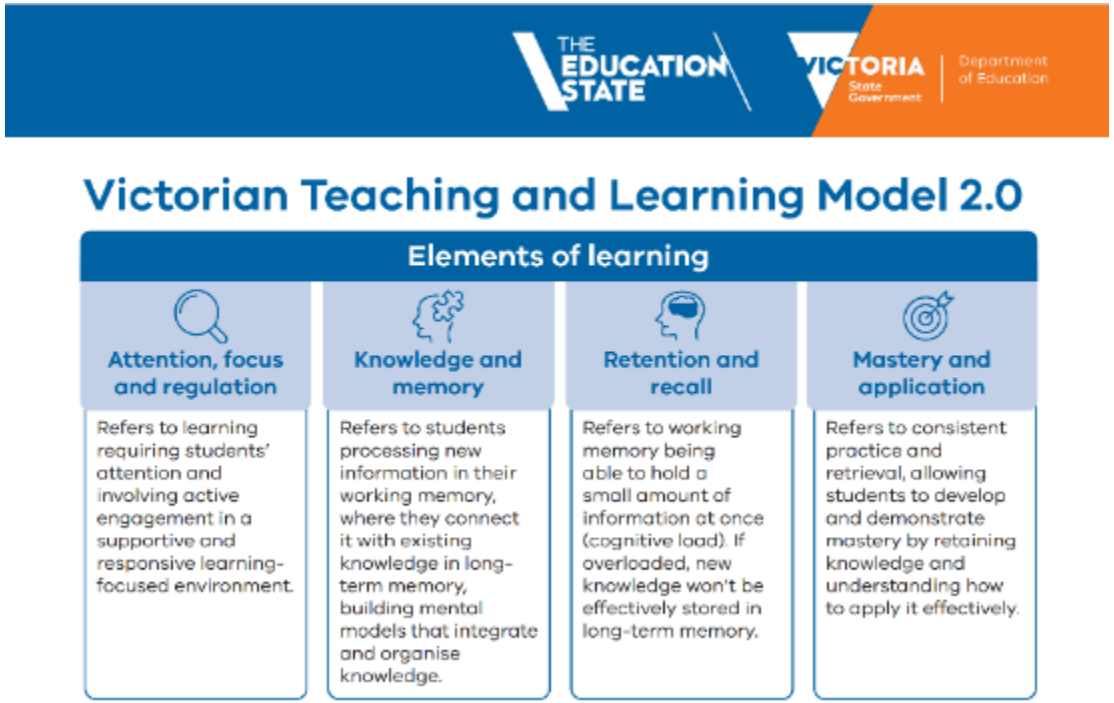
Inquiry learning as imaged by ChatGPT4

Victorian Teaching and Learning Model 2.0

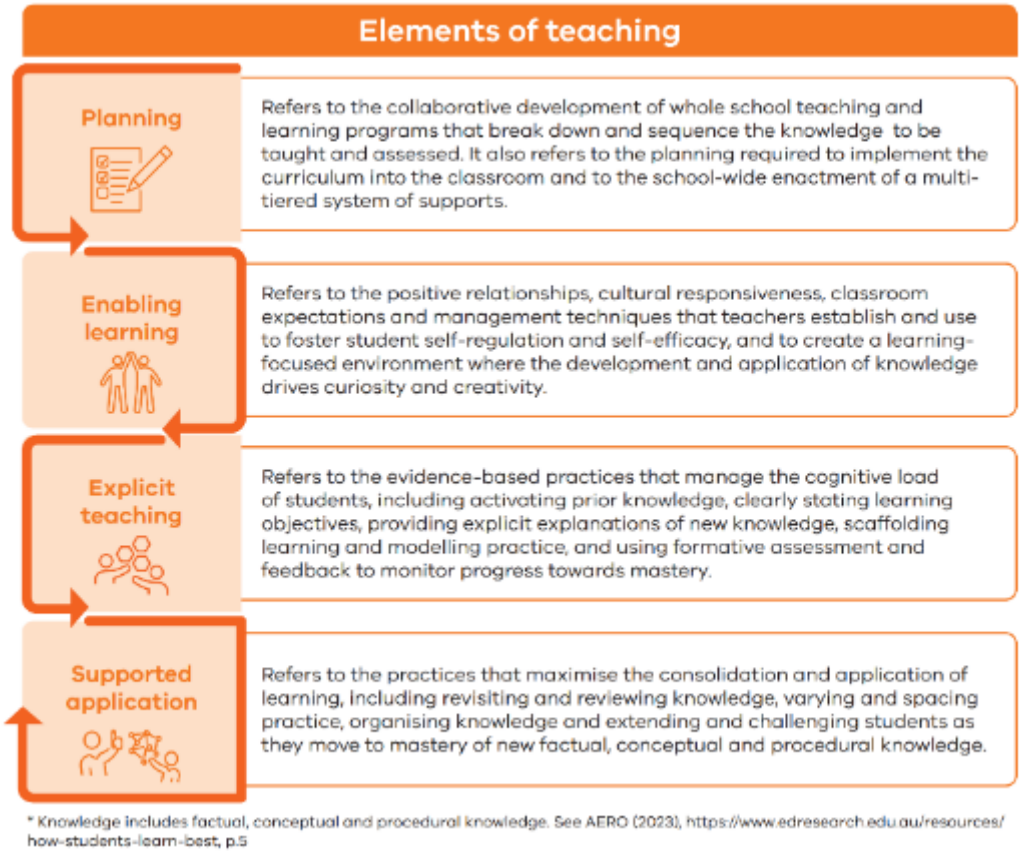
From the DE website: The revised VTLM 2.0 has explicit teaching practices at its core.

Designed to manage the cognitive load of students as they learn new content. It involves fully explaining and effectively demonstrating what students need to learn.

Explicit teaching is not all teacher talk. At its best, it is a high participation model.



[Victorian Teaching and Learning Model 2.0 (accessed 12 Nov 2024)]



Teaching Mathematics in Victoria

MAV The Common Denominator, Volume 4, 2024

David Howes, Department of Education (Victoria) Deputy Secretary, Schools and Regional Services., and Jen Bowden, MAV CEO

3. Explicit teaching is the key point of connection between learning and teaching.

...

Explicit teaching does not mean there is no place for inquiry-based learning and problem solving.

It certainly does not mean there is no place for supporting and enabling student curiosity and reasoning and questioning.

But it does mean that privileging the importance of planning to ensure students first develop an understanding of the concepts and procedures they will need to use to investigate and propose solutions to a range of problems before they are presented with the problem.

4. Supported application, that critical opportunity for students to apply their new knowledge to a wide range of increasingly complex problems.

The revised VTLM is not an end in itself. Effective teaching is not an end in itself. Both are means to an end that sees as many students as possible developing the proficiency in mathematics that will both provide them with the pragmatic capacity to manage the numeracy requirements for participation as a full citizen in our contemporary and future communities, and provide access to the joy and wonder of mathematics.

MACS Vision for Instruction

From the MACS website: *Vision for Instruction* is a key document underpinning the MACS 2030 strategic plan and has been crafted to communicate MACS' preferred system-wide approach to achieving teaching and learning excellence.

It is firmly grounded in the evidence of how students learn most effectively and efficiently, offering explicit guidance for MACS schools on instructional best practice.

Explicit instruction sequence:

Starting with the introduction of new content and skills, effective teaching will generally follow this sequence:

- **Explicit instruction:** Teachers fully explain the concepts and skills that students are required to learn. The most efficient way to teach knowledge is to teach it explicitly, and this is particularly true for the introduction of new concepts (Rosenshine 2012). However, this does not mean students are passively receiving information.
- **Modelling:** Effective teachers break down what students need to learn into smaller learning outcomes and model each step so that students can see what is expected of them (Rosenshine 2012).
- **Guided practice:** Teachers provide multiple opportunities for students to practise, and support is gradually removed as students develop understanding and can work more independently.
- **Independent practice:** Once students have developed understanding, teachers ask students to complete tasks themselves while the teacher monitors and provides feedback.

Formative assessment: Effective questioning is a core part of effective formative assessment. Instruction is most effective when it is highly interactive with frequent checks for understanding. Identifying where a student is in their learning by assessing what they know also helps teachers choose the right starting place before introducing a new unit of work (AERO 2021).

Regular review: Rehearsing and reviewing information creates stronger connections and makes prior knowledge more readily available for use. As a part of a routine, use low- or no-stakes quizzes for frequent review. Material that is practised and discussed in review will be easier to recall. If students are struggling with a concept during review, teachers can do a quick re-teach lesson.

Melbourne Archdiocese Catholic Schools (MACS) (accessed 12 Nov 2024)

MACS Vision for Instruction

Interestingly MACS expands on their vision, with a separate vision statement for:

- Reading instruction
- Writing instruction, and
- Mathematics instruction

The following recommendations are based on evidence-based practices for mathematics:

- **Develop number sense:** Teach students what quantities and numbers mean and how to represent them with objects and numerals. For example, use number lines, get students to count fluently, and compare amounts.
- **Build fluency:** Ensure that students have fluency with addition, subtraction, multiplication, and division.
- **Teach mathematics concepts:** Help students to understand mathematics concepts. Teach the 'why' and 'how' of mathematics in combination with procedures and rules.
- **Use concrete materials:** Get students to use hands-on materials and visual representations to show concepts and procedures.
- **Use problem-solving strategies:** Explicitly teach problem-solving and reasoning strategies. Teach students how to read problems and organise work according to the structure of the problem.
- **Use explicit instruction:** Use explicit instruction when introducing new mathematics content and then gradually release responsibility to students. Model mathematics problems step-by-step and use guided practice, then independent practice with teacher feedback. Provide opportunities for students to explain their work and thinking in oral and written forms.
- **Use precise mathematics language:** Encourage students to use correct mathematics language when verbalising explanations and steps for solving problems.

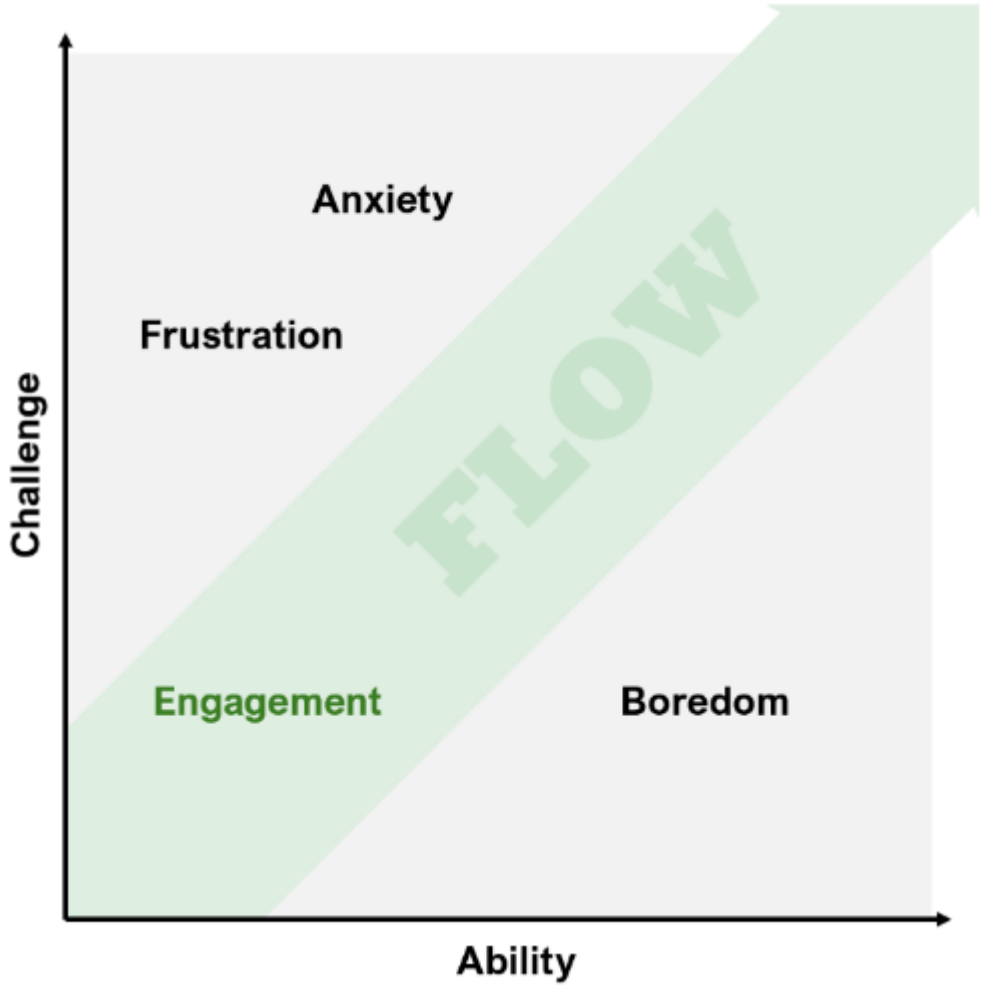
Melbourne Archdiocese Catholic Schools (MACS) (accessed 12 Nov 2024)

Optimal experience (flow state)

Flow happens when a person's skill level roughly matches the difficulty of the task.

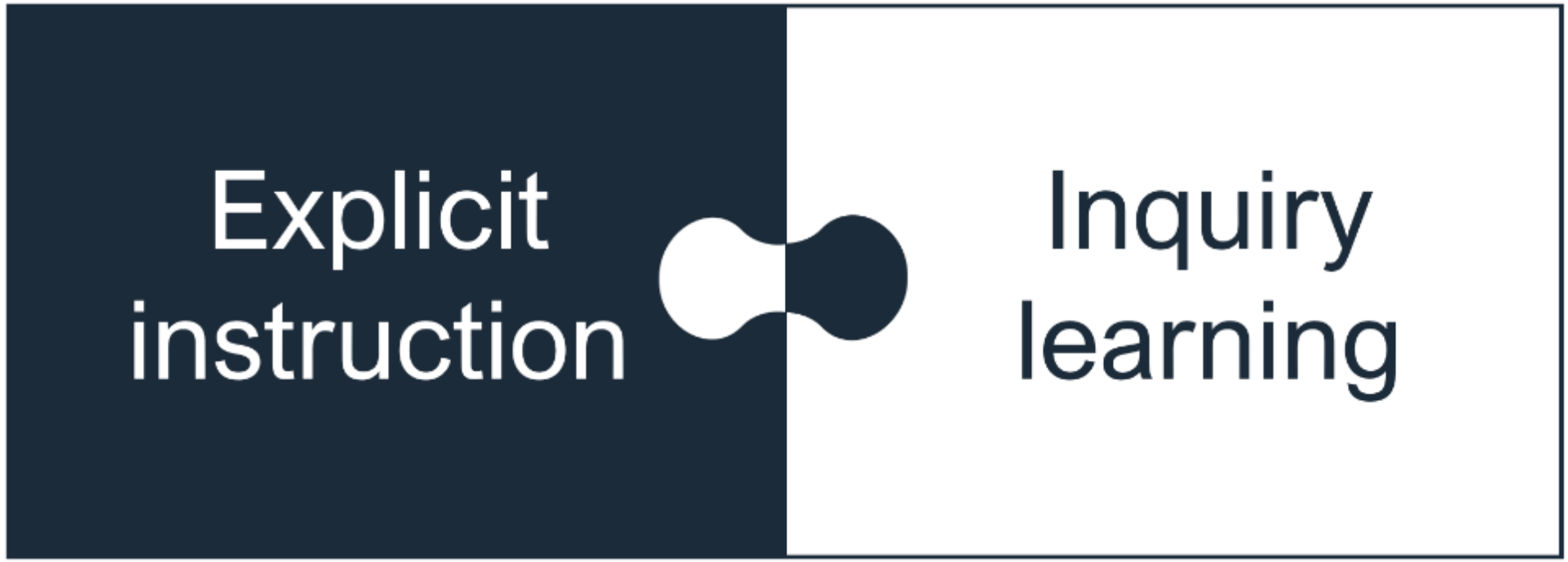
An optimal flow state occurs when people take on tasks that feel like the right amount of "stretch" for their abilities - challenging enough to be engaging but not so difficult that it causes frustration or anxiety

(Mihaly Csikszentmihalyi, 1975)



Towards inclusive pedagogies

Connecting the two recognises what many teachers already do, which is use a variety of pedagogies to meet the learning needs of their students.



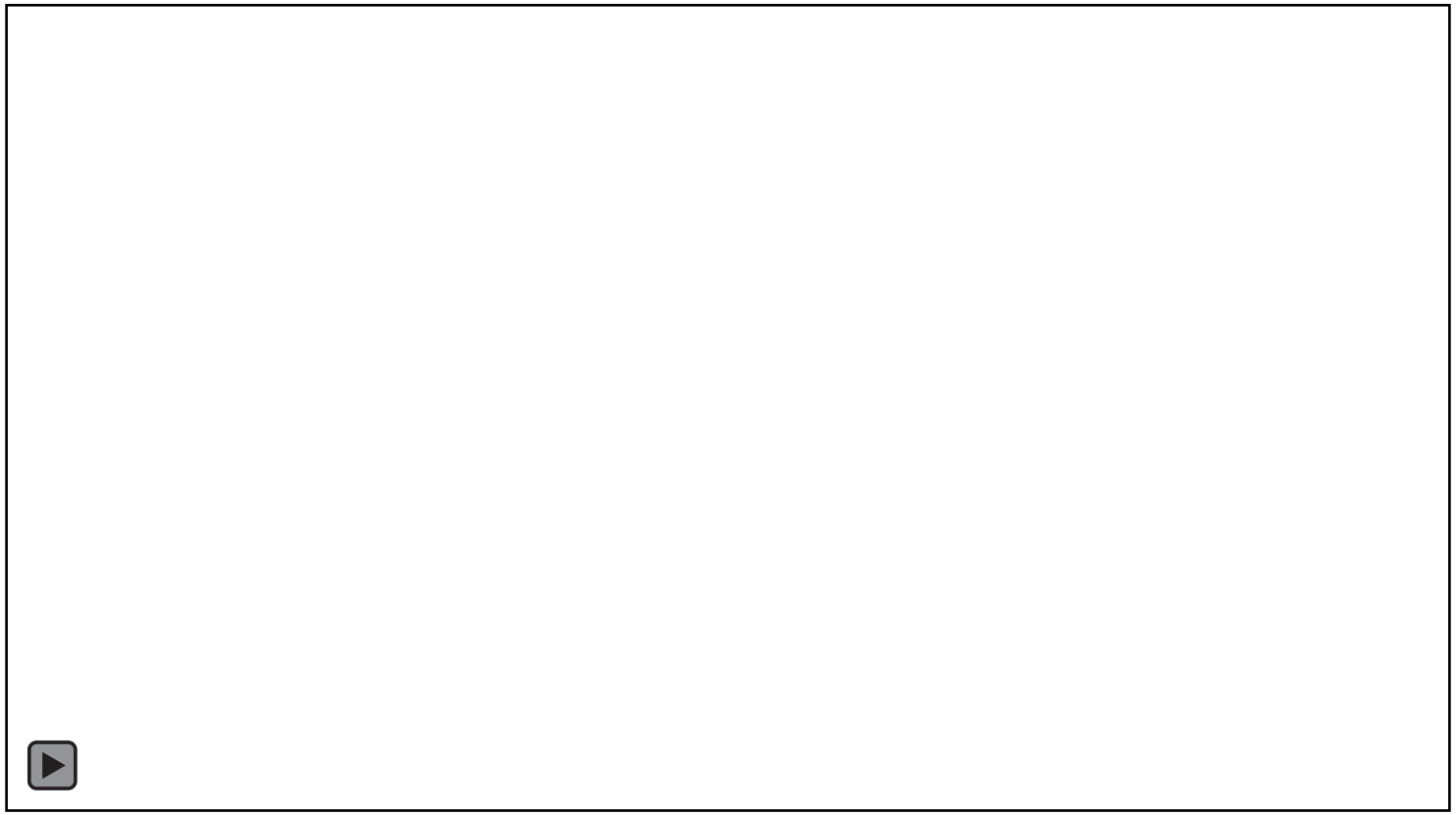
Explicit teaching and inquiry-based learning

Ways in which explicit teaching and inquiry-based learning are interconnected and mutually reinforcing:

- **Foundation building:** Explicit teaching establishes foundational knowledge, skills, and vocabulary that enable students to engage confidently in inquiry-based activities.
- **Conceptual connections:** Inquiry-based tasks strengthen connections between topics, reinforcing and expanding on explicitly taught material. They deepen understanding by allowing students to apply explicitly taught concepts in new and diverse contexts.
- **Critical Thinking Development:** Explicit instruction in critical thinking skills prepares students to tackle open-ended questions, fostering deeper inquiry.

World record – balloon popping dogs

Did you know that that there is a world record for the fastest time to pop 100 Balloons by a dog!



World record – balloon popping dogs

Some past world records:

- 2008, Anastasia 44.49 seconds Twinkie's mother
- 2015, Cally 41.67 seconds
- 2016, Twinkie makes an attempt to set a new world record

Question:

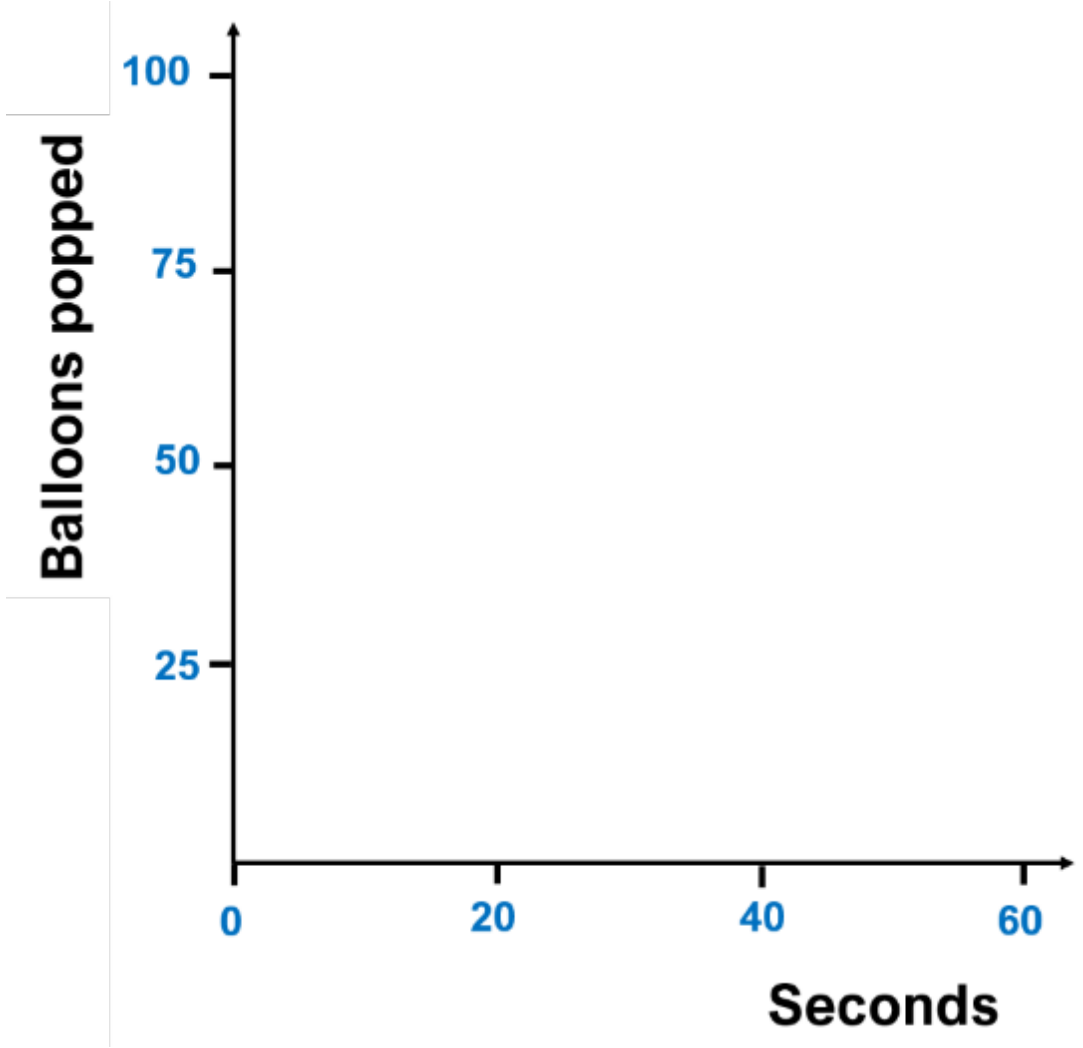
What prior knowledge would students need to have to be able to make a reasonable estimate of whether Twinkie is likely to beat the record or not?

World record – balloon popping dogs

- What prior knowledge would students need to have to be able to make a reasonable estimate of whether Twinkie is likely to bet the record?
- Understanding of the concept of rate (25 balloons over 5 seconds)
- Estimation skills, what number of seconds would be considered too low? Too high?
- Understanding of time, at minimum an ability to read seconds (depending on the year level also 100ths of a second and decimals)
- Realising that certain factors might slow down or speed up the process, such as the dog's speed varying due to excitement or getting tired, that the balloons might be harder to pop when only a few are left, …

World record – balloon popping dogs

Sketch a graph of what you think the relationship between **balloons popped** and **seconds elapsed** looks like.



World record – balloon popping dogs

Decide if Twinkie does or does not beat the record.

Yes  No 

Dan Meyer - World Record Balloon Dog

World record – balloon popping dogs

The current Guinness World Record for the fastest time a dog has popped 100 balloons is 28.22 seconds, achieved by Toby, a Whippet from Canada, on 9 April 2017.

Toby the Whippet bursts dog balloon record

Resources

- What does it mean to develop mathematical proficiency? – Wonder in Mathematics (amiealbrecht.com)
- Moving from “OR” to “AND” – Wonder in Mathematics (amiealbrecht.com)
- Mike Oppland 2016: 8 Traits of Flow According to Mihaly Csikszentmihalyi
- 2026 Twinkie breaks the word record
- Toby the Whippet bursts dog balloon record
- 3 Acts lessons

Feedback & PPT

We'd welcome your thoughts on today's session.

The QR code will take you to a very short feedback form.

If you'd like a copy of the PPT for this session, you can either:

- include your email address when completing the feedback form, or
- email Cath or Antje directly at:

  cathematics123@gmail.com

  antje@leighlancasterconsulting.com.au

Please also complete the MAV feedback survey in the conference app.

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