

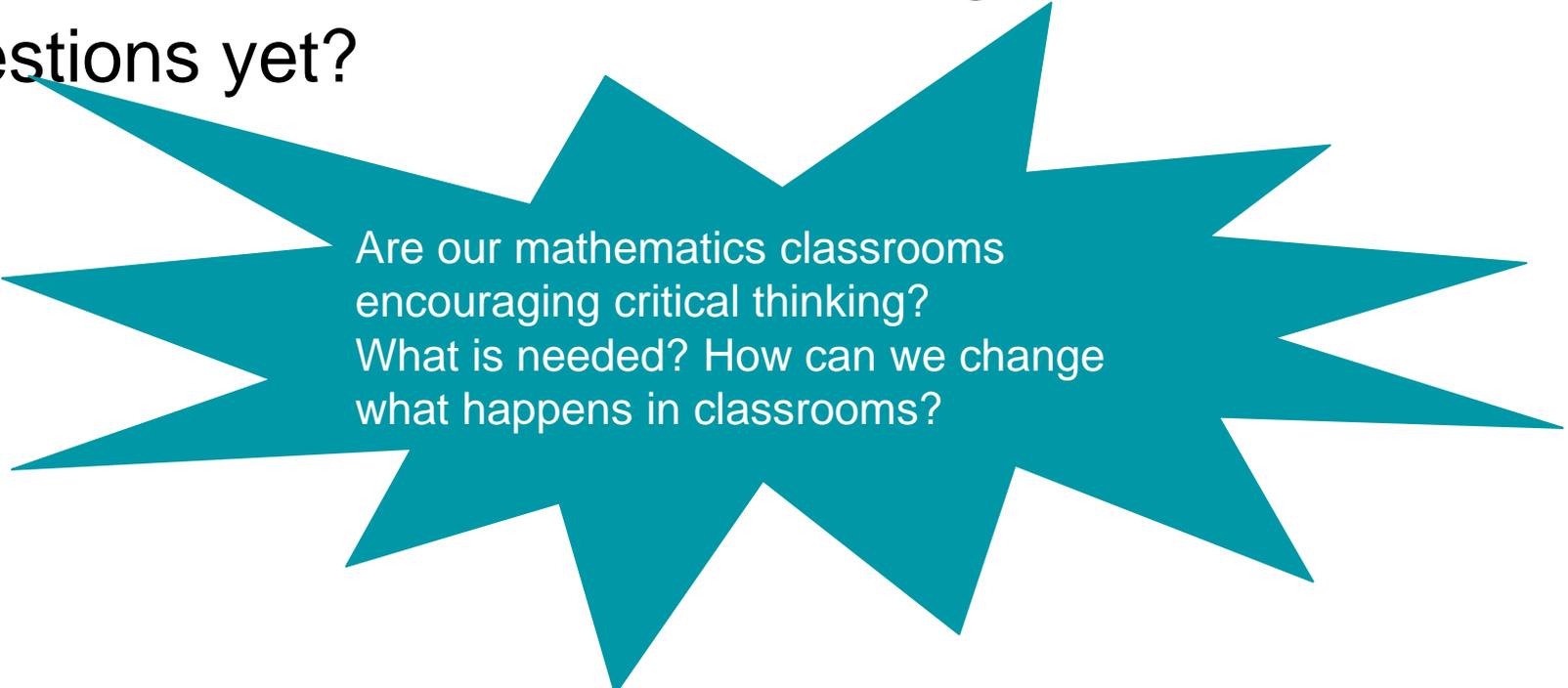
# Bringing Life to Maths!

*Mary MacKillop Secondary College Wakeley (Anthony Moore & Scott O'Brien) and Marist Sisters' College Woolwich (Brian Walker)*

*with Angela D'Angelo, Master Teacher Mathematics Sydney Catholic Schools*

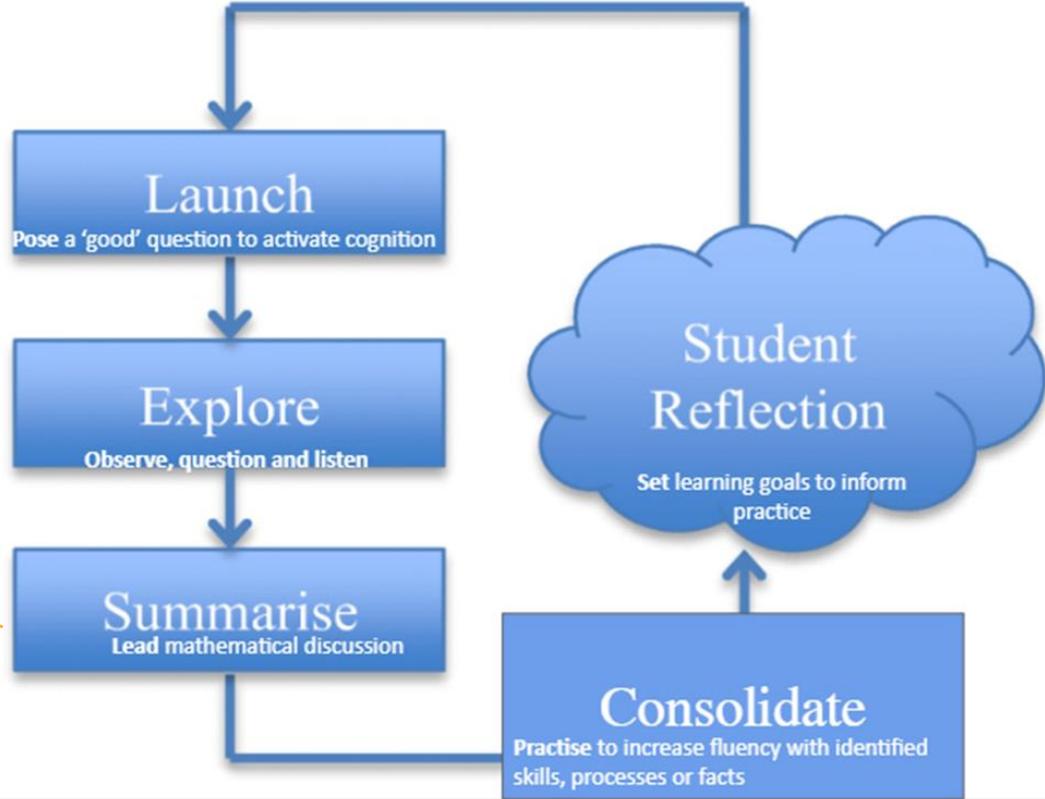
The latest evidence of need

[SMH Article](#) this one of the toughest HSC maths questions yet?



Are our mathematics classrooms encouraging critical thinking?  
What is needed? How can we change what happens in classrooms?

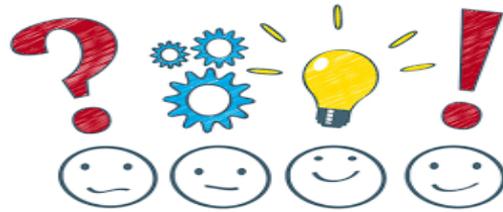
# Background



[Link to support article](#)

## *Inquiry tasks stem from the idea of Inquiry based learning*

*Inquiry-based learning is an education approach that focuses on investigation and problem-solving. Inquiry-based learning is different from traditional approaches because it reverses the order of learning. Instead of presenting information, or ‘the answer’, up-front, teachers start with a range of scenarios, questions and problems for students to navigate.*



ACARA 2016

*Inquiry-based learning 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, and **communicate findings**.*

# Use of evidence based practice

Connection to new syllabus:  
(WM -Communicating, Understanding and fluency, Reasoning, Problem solving)

High Impact Teaching strategies (VIC)



# Based on research: SCIENTIFIC PRINCIPLES OF LEARNING

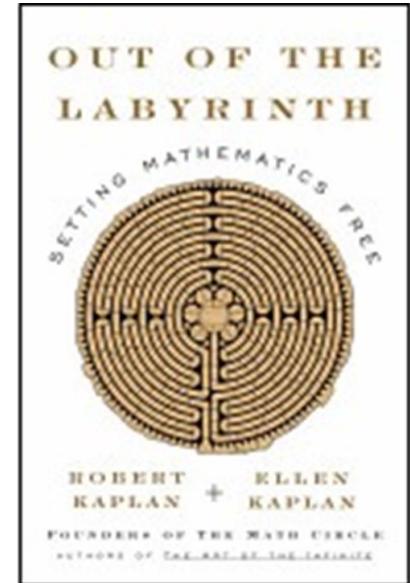
Scientific principles regarding how people learn:

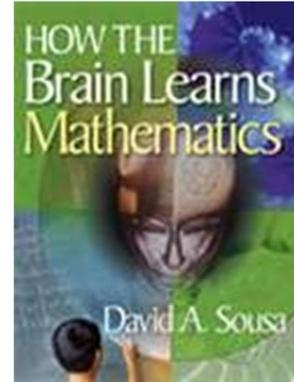
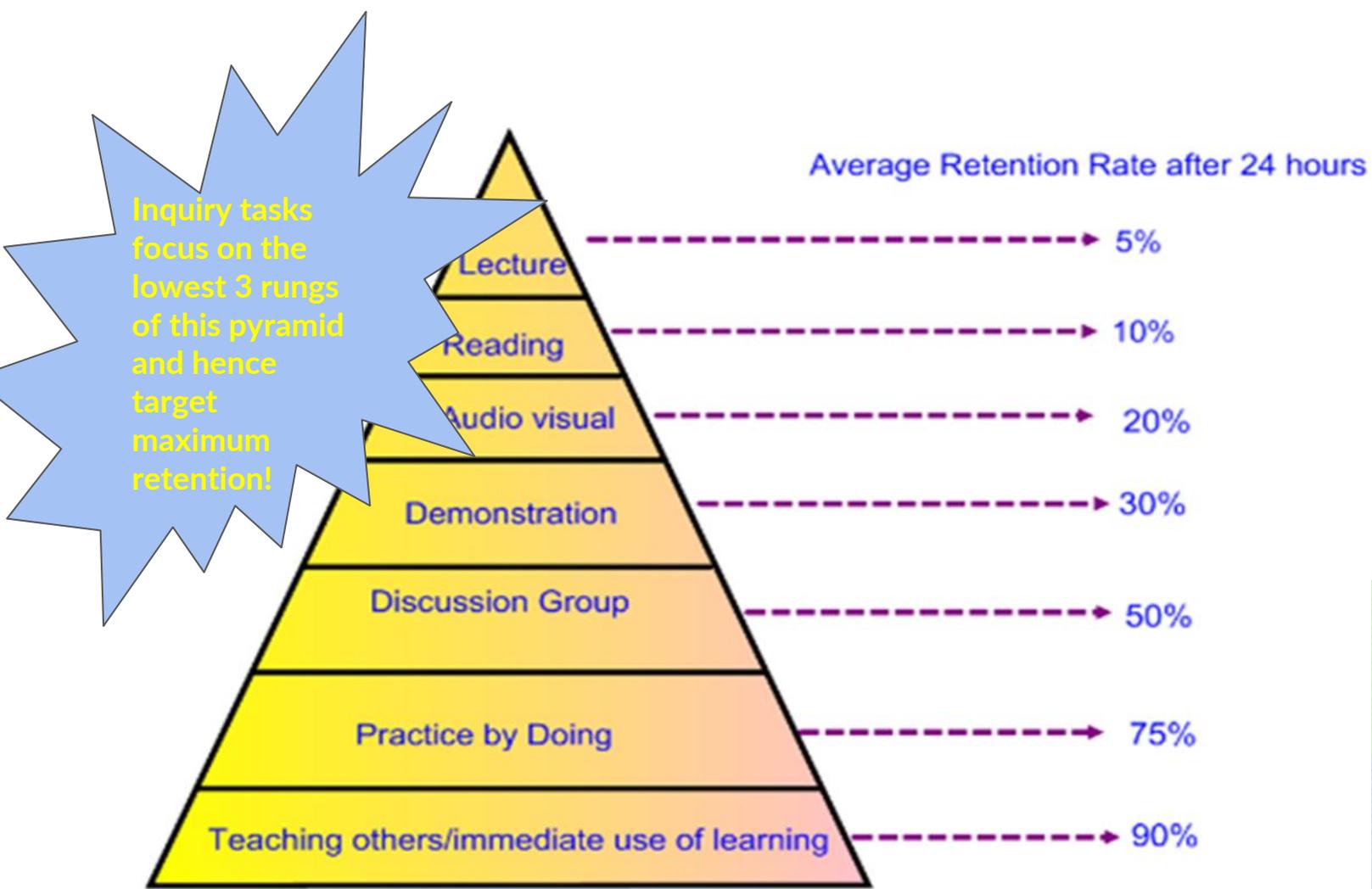
1. Engage students' initial understandings to address preconceptions about how the world works.
2. Develop competence by:
  - a. Ensuring a deep foundation of *conceptual understanding* in readiness for developing factual knowledge
  - b. *Connecting* concepts to the facts and skills that relate to them
  - c. Organising knowledge in ways that facilitate *retrieval and application*
3. Provide a *metacognitive approach* to instruction to help students learn how to control their own learning, including setting goals and monitoring their progress.

(Bransford, Brown & Cocking, 2000; Dinham, 2016; Sullivan, 2011)

# WHAT WORKS AGAINST THE BRAIN LEARNING

“Teaching mathematics as meaningless, boring and uncreative garbage holds many students back by making them think they are stupid in mathematics. So they become self fulfilling prophecies. They think that there is no hope for them so their brain shuts down.”





# THE ROLE OF STRUGGLE

苦劳 – Kurou

“hardship” and “labor.”

Japanese word for struggle

John Pegg

Teach through problem solving; often this is the weak area for most students. Hardship is an important part of learning.

Students must struggle with an idea in order to create and strengthen circuits in the brain.  
No pain – No neuroplastic gain.

## Getting the right balance



easy  
enough to  
expect  
success

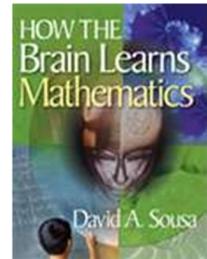
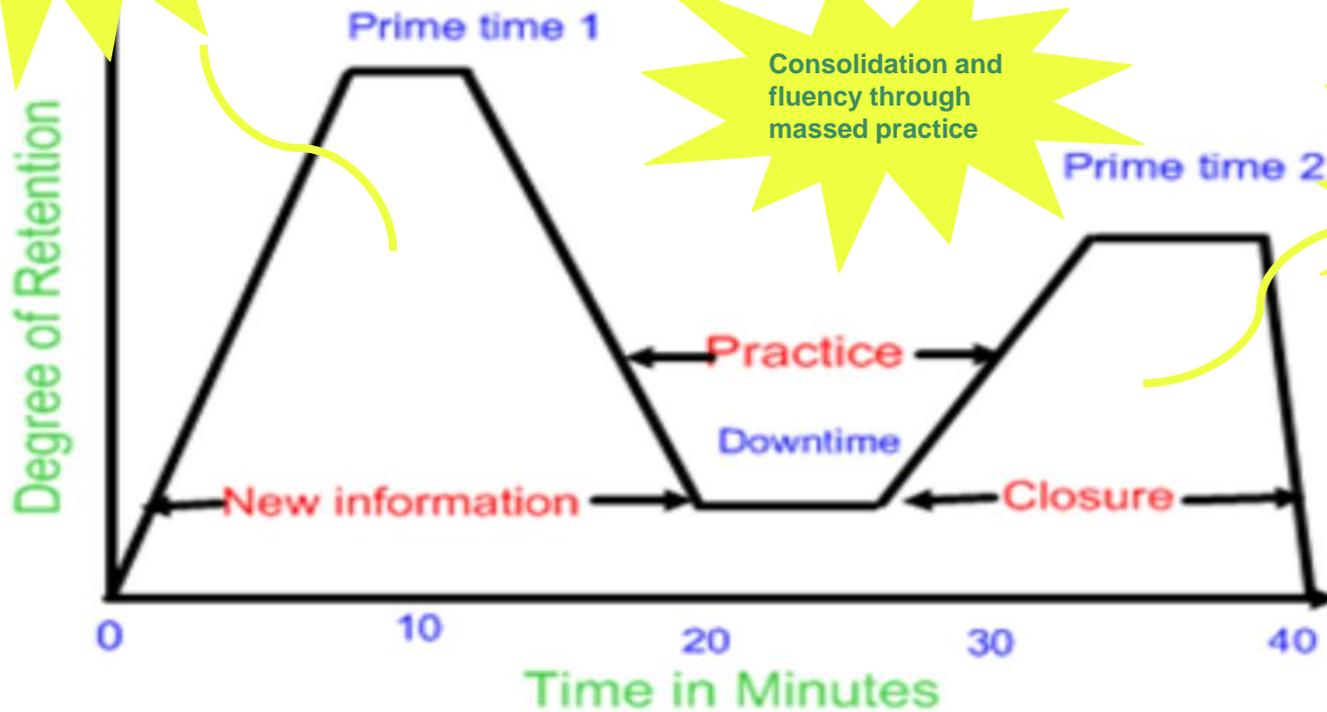
Challenging  
enough to  
demand effort

Consider student's individual needs

# The Primary-Recency Effect



## Retention During a Lesson



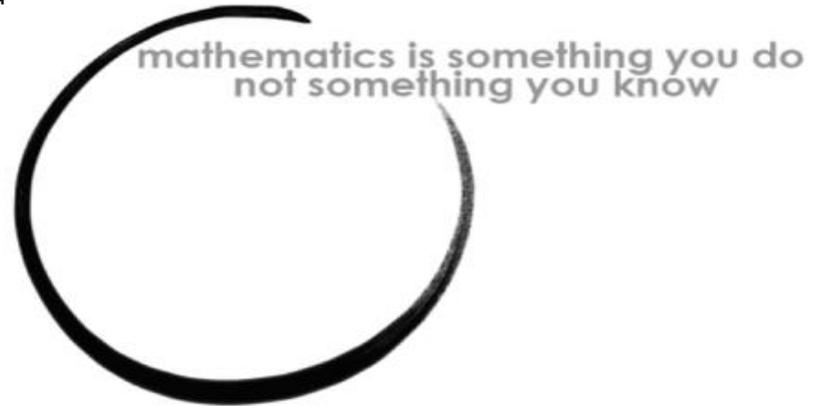
## BRAIN BASICS

Information is most likely to be stored if it makes sense and has meaning.

If meaning isn't assigned then the brain treats it as **brand new** next time it is encountered. Struggle helps to create meaning.

The more mathematics we can teach involving understanding and meaning the more students are likely to succeed and ~~actually enjoy mathematics~~

A reminder that....



# DISCUSSION: PROBLEM CHARACTERISTICS

A Problems	B Problems
Open: low entry - high ceiling	Closed
Unfamiliar, more complex, non-routine	Familiar, routine
Sustained cognitive effort, student decision-making	Short response, applying known procedures
Focus on deeper conceptual understandings	Focus on algorithmic thinking
Designed to stimulate reasoning and discussion	Designed to elicit correct answer or use a known rule or procedure

***Australian students need more opportunities to solve more complex problems, higher expectations for sharing their reasoning, and exposure to a greater range of solution approaches and representations (OECD, 2012; Mevarech & Kramarski, 2014; OECD, 2016).***

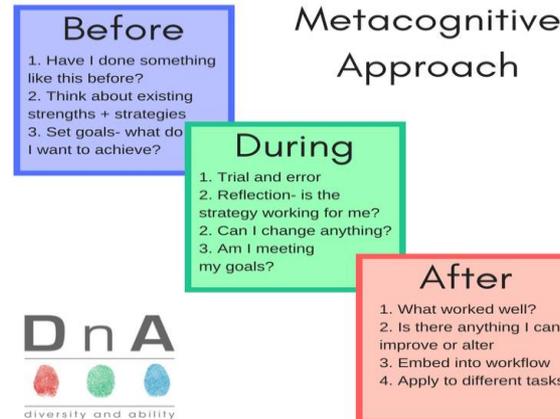
# THE ROLE OF METACOGNITION

The term, 'metacognition' was first introduced to indicate the process of 'thinking about thinking'. (John Flavell)

Today, metacognition is recognised as having two main components:

- 'knowledge of cognition' (declarative, procedural and conditional knowledge);
- 'regulation of cognition' (**plan, monitor, control and reflect**).

**This second component is seen as the most powerful for improving performance.**



# A tale of two schools



MARY MACKILLOP  
CATHOLIC COLLEGE WAKELEY



Marist Sisters' College  
— Woolwich —

## *Points of Similarity:*

Both girls schools

Enthusiastic leaders and teachers willing to action changes in their practice and receive feedback

## *Points of Difference:*

Very different socio economic and language backgrounds

Entry levels to Year 7

High literacy/low literacy

# Bringing Life to Maths at Wakeley

*Implementing the approach and exploring the benefits*  
*Anthony Moore & Scott O'Brien*



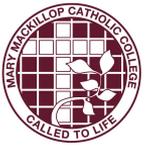
**MARY MACKILLOP**  
CATHOLIC COLLEGE WAKELEY

# Mary Mackillop Catholic College - Wakeley, NSW



A college leading/creating change through:

- Positive partnerships (trust, respect, accountability)
- Reflective teacher practice
- High impact teaching strategies
- Inquiry tasks



## Mary Mackillop Catholic College, Wakeley NSW



**Enrollments : 829**

**A significant range of physical, cognitive, social and emotional and sensory needs**

**A large percentage of students with a language background other than English.**

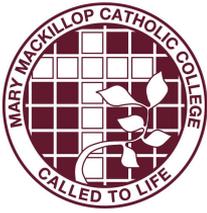
An all girls Catholic College characterised by **diversity**, with a differentiated, personalised and dynamic approach to learning in which we know and cater for each young woman's needs, passions and aspirations.



<b>EALD</b>	<b>Disabilities</b>	<b>Selective stream</b>
<p>LBOTE 93%</p> <p>Student born outside Australia 47%</p>	<p>Large degree of students with a cognitive disability (language deficit: receptive, expressive)</p> <p>NCCD, level of adjustments (10 students with extensive)</p>	<p>The College has a selective stream (Newman - Gifted Education) in the core classes and Mathematics</p>

Our diversity requires teachers to provide a range of **adjustments** and action **differentiation** for all students.

Staff must focus on activating students' prior knowledge to build new knowledge and understanding



Mary Mackillop Catholic College, Wakeley NSW

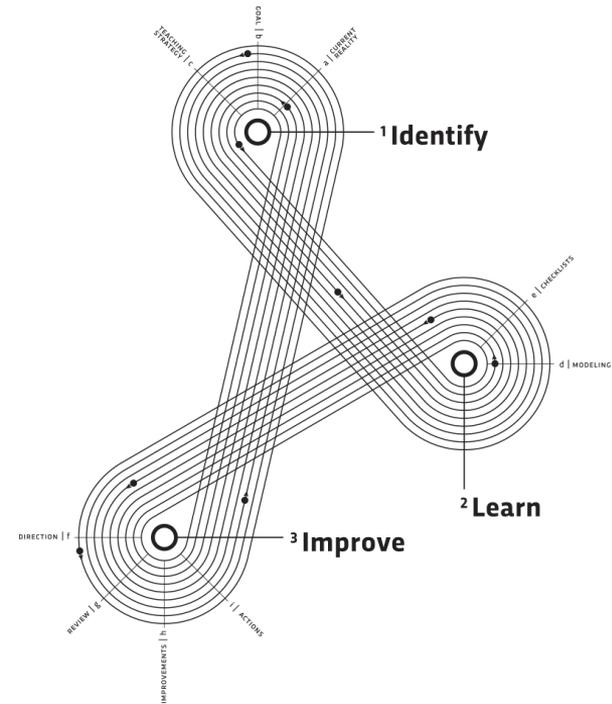
## Responding to data and actioning change through an inquiry cycle.

Drawing upon the model created by Jim Knight:

**Identify:** Analyse the **data**. What does the data tell us about mathematics at MMCC? (Student performance, staff and student efficacy, participation rates in mathematics courses). **Establish goals.**

**Learn:** Determine the learning and processes which must occur to respond to the data. Focus on building knowledge (5 practices -Peter Sullivan) and in situ strategies including modelling and observation.

**Improve:** Review the impact of improved pedagogical content knowledge (qualitative and quantitative data, surveys and self reflections).



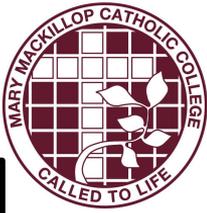
Source: Jim Knight, 2018



## Mary Mackillop Catholic College, Wakeley NSW



Pre lesson discussions (anticipation), lesson observation, modelling and post lesson analysis are all critical components of teachers refining their practice



# Mary Mackillop Catholic College, Wakeley NSW

Focus on engaging students through

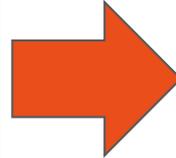
## High Impact Teaching:

**Structured lessons:** Clear and explicit learning intentions and success criteria

**Collaborative learning:** Exchanging knowledge and understanding between students

**Questioning:** extending and enabling prompts

**Differentiated teaching:** Low entry points and high ceiling



## What does this look like in the classroom and beyond?

Staff: 5 practices supporting structured inquiry, specific pedagogical moves, teacher reflective practice

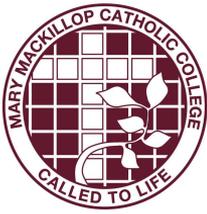
Students: Let's watch the evidence

# Mary Mackillop Catholic College, Wakeley NSW



A quick snapshot  
(literally) of HITS,  
inquiry and  
collaboration in  
action.

Year 7, November  
2022.



## Mary Mackillop Catholic College, Wakeley NSW



*Challenge faced by our students:*

- Literacy levels

*How this is addressed in the Launch Lesson:*

- Discussion
- Collaboration
- Transfer to written responses



## Mary Mackillop Catholic College, Wakeley NSW



*Challenge faced by our students:*

- Low ability and high variance in ability on arrival to College

*How this is addressed in the Launch Lesson:*

- Low entry
- Enabling prompts
- Collaboration

# Mary Mackillop Catholic College, Wakeley NSW



*Challenge faced by our students:*

- Confidence
- Engagement
- Limited experience of success in Mathematics

*How this is addressed in the Launch Lesson:*

- Pedagogical moves



## Mary Mackillop Catholic College, Wakeley NSW

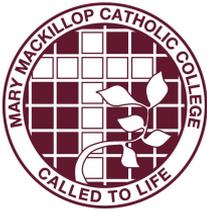


*Challenge faced by our students:*

- Connection with Mathematics, learning and teachers

*How this is addressed in the Launch Lesson:*

- Student centred learning

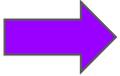


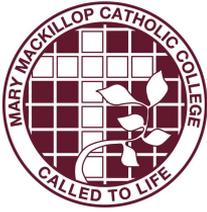
Where we have seen success:

**For teachers:**

- Enhanced pedagogical content knowledge
- Willingness to try new pedagogies in the classroom
- Engagement in an inquiry cycle:  
Use of data in action research  
Lesson observation (feedback), analysis of practice conversation, reflection and refinement

**Evidence  
of impact  
@  
Wakeley**



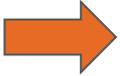


Where we have seen success:

### **For Students**

- sense of achievement in Maths heightened through low entry and use of enabling prompts
- engagement through challenge and interest in inquiry task and pedagogical moves
- development of growth mindset classroom culture: getting it wrong and getting it right, greater efficacy and confidence.
- Student data, expected growth (PAT maths)

**Evidence  
of impact  
@  
Wakeley**



# Bringing life to Maths at Woolwich

*What Inquiry tasks look like in Action*  
*Brian Walker*



Marist Sisters' College  
— Woolwich —

# Sample Task 1: Fractions

## MA4-5NA Operate with Fractions Decimals and Percentages

- Open ended
- Low entry level/ high ceiling
- Concrete materials to assist understanding (the task is designed to be used with playdough and cookie cutters)



Marist Sisters' College  
— Woolwich —

# Today, we are learning to add fractions

## GROUP TASK

*It is your good friend Jean-Luc Kleaver's birthday.*

*When you give him the cake that you made especially for him, Jean-Luc says: "So very thoughtful of you! Tell you what, I am having  $\frac{3}{8}$  of it and you can share the rest with your sister."*

*Can you list three different ways the rest of the cake can be subdivided?*



## SUCCESS CRITERIA

**Make** three different cakes to illustrate each of your three answers.

**Cut** all the pieces correctly.

**Record** your piece and your sister's piece as fractions.

**Simplify** all fractions where possible.

**Use** mathematical language to represent the sum of the pieces for the siblings.

**Create** a rule that explains how you add two fractions

**Solve** the challenge problem

# The challenge problem from the fractions task.

## ChALLENGE

A recipe requires  $\frac{1}{6}$  of a cup of rice. Use the measuring cups in front of you to measure the **exact** quantity required.

- You are allowed to use any or all of the cups (1 cup,  $\frac{1}{2}$  cup,  $\frac{1}{3}$  cup)
- You must show the appropriate calculation that gave you  $\frac{1}{6}$  of a cup otherwise it may be an estimate



# Sharing our pedagogy with the staff.

It was the first time some understood fraction addition through the use of equivalent fractions.



Many staff commented on the transferability of this pedagogy into their KLA areas.



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— Woolwich —

## Sample Task 2: Pythagoras Theorem

MA4-16MG Applies Pythagoras' Theorem to calculate side lengths in right angled triangles, and solves related problems

- **BACKGROUND:** This task they would have already seen pythagoras theorem and completed some bulk questions on using it to find unknown sides of right angled triangles and determining if a triangle is right angled.
- Low entry level/high ceiling
- The task is designed to be more abstract and higher level.



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— Woolwich —

# We are learning to apply Pythagoras' Theorem, folks!

## GROUP TASK:

### No Side in Sight...

*"You can calculate the area of a square by using the length of its diagonal only.*

*If you know the length of the diagonal, you do not need to measure the side length."*

*Big statement to be sure. Do you agree with it?*



## SUCCESS CRITERIA

**Draw** a square and its diagonal

**Measure** the sides and the diagonal

**Calculate** the area of a square

**Write** a pythagorean identity

**Evaluate** the length of the hypotenuse

**Establish** a relationship between the area and the length of the hypotenuse

**Verify** this relationship with an example

**Formulate** the relationship between the length of the diagonal and the area

## Sample Task 3: Data Analysis

MA4-20SP Analyse single sets of data using measures of location, and range

- BACKGROUND, students had covered the fundamentals of data analysis including calculating the mode, median, range and mean.



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— Woolwich —

# We are learning to interpret statistics in data.

From our class survey we collected what form of transport you take to school and your travel time. You are tasked with calculating statistical measures of the class data and comparing it to similar data from NZ.

## **SUCCESS CRITERIA:**

- Constructs a frequency distribution table for the class data.
- Calculates the Mode, Range, Median and Mean for our class data
- Calculates the same statistical measures for one of the NZ data sets provided.
- Compare each statistical measure (mode, range, median and mean) across the sets of data by describing what is higher/lower or different/same.
- Challenge: Can you explain using statistical measures the differences or similarities between the sets of data

# What it is like in Woolwich?



Marist Sisters' College  
— Woolwich —



**Thank You!**