

# Building and Using Evidence in Education: Lessons from the Thinking Maths Trial

13 November 2018

Pauline Ho and Tanya Vaughan



**EVIDENCE  
FOR LEARNING**

# Acknowledgement of Country

I would like to **acknowledge** the Wurundjeri people of the Kulin nation who are the traditional custodians of the land on which we meet, and pay my respects to elders past, present and emerging.



# Expected outcomes

By the end of this session, you will:

- Learn about the results of the Thinking Maths trial and how to assess this kind of evidence
- Identify teaching strategies (e.g. metacognition ) that worked in the Thinking Maths program to help support the use of evidence in practice
- Integrate the Teaching & Learning Toolkit to explore how it can be used as a school improvement strategy to assess and implement evidence in your school context

QUIZ



## Learning Impact Fund

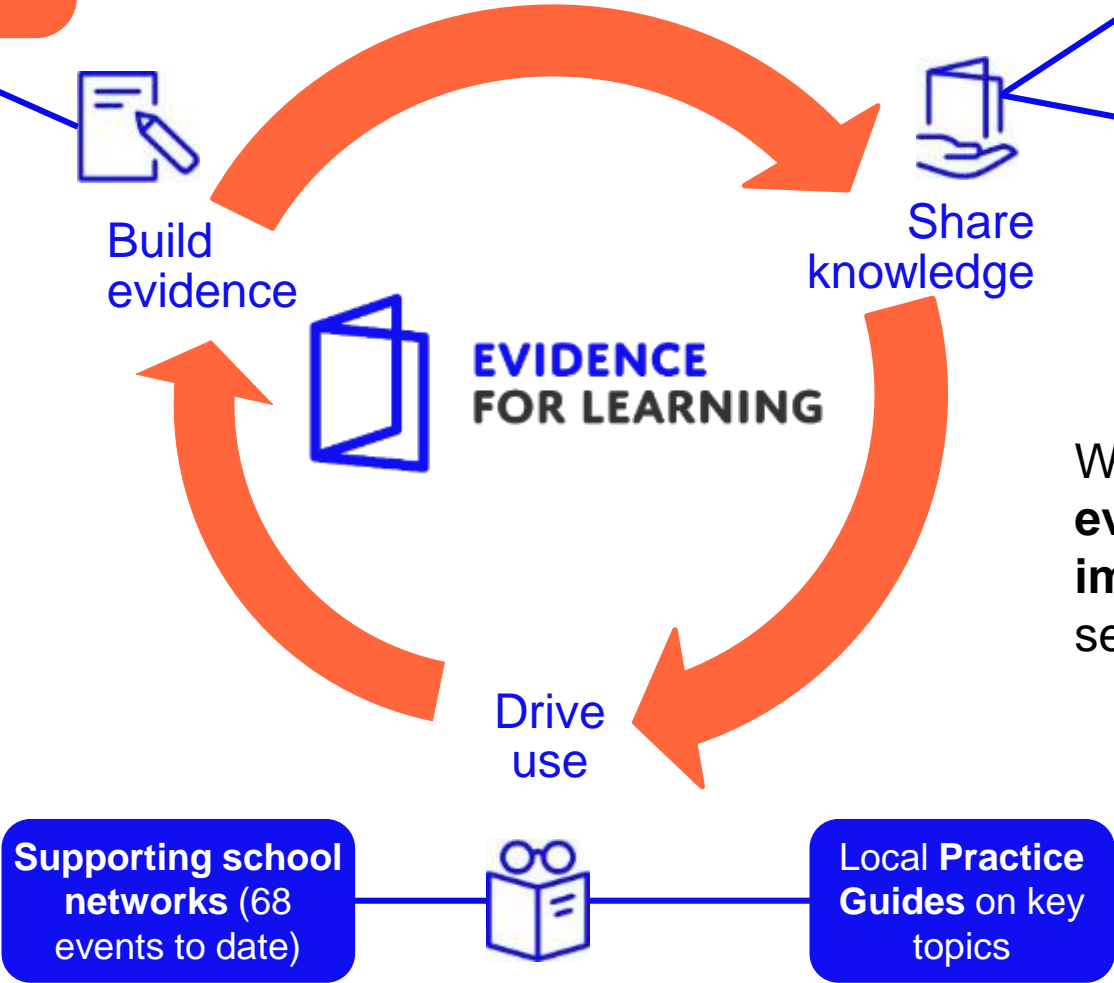
**Trials Unit (RCT)**  
Philanthropy + Govt \$ on  
school programs  
(4 underway)

**Teaching & Learning Toolkit**  
Global evidence summaries and  
practice guides from international  
partners

**Tailored evidence  
Toolkits (18)**

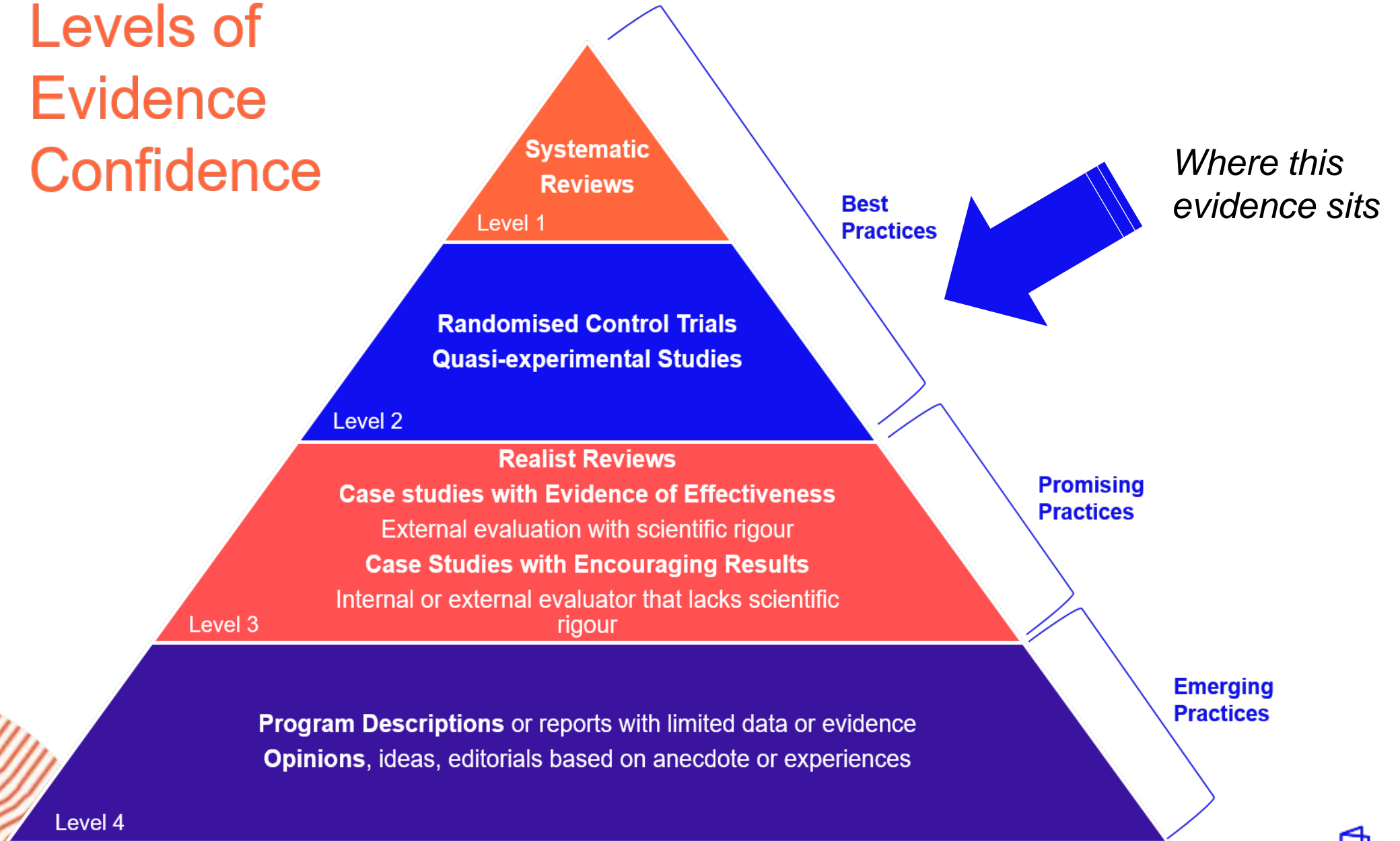
## Better school decisions informed by evidence

We are an **Evidence  
Intermediary**; we play  
a brokering role  
between research and  
practice.



We specialise in **translating  
evidence** and then **help  
implementing** it in real world  
settings.

# Levels of Evidence Confidence



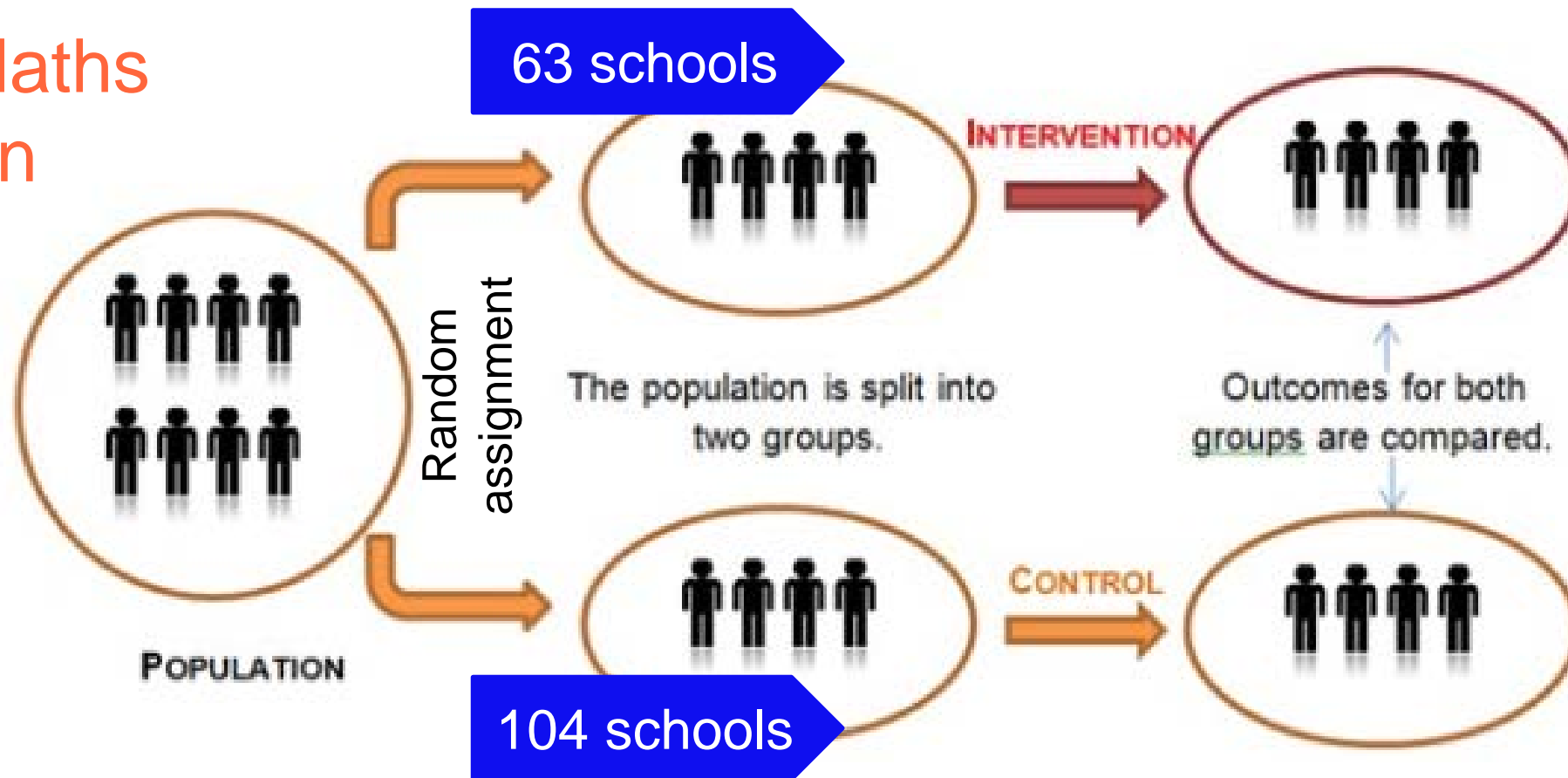


# What is evidence informed decision making?

Evidence informed decisions are about *'integrating professional expertise with the best external evidence from research to improve the quality of practice'* (Sharples, 2013, p. 7). This is not about *'prescribing what goes on from a position of unchallenged authority'* (Sharples, 2013, p. 7).



# Thinking Maths RCT design



Pre and post data collection:

- primary outcome – student **PATMaths** test (Sep 2016 & Sep 2017)
- secondary outcomes – teacher and student surveys



# What we want to find out...

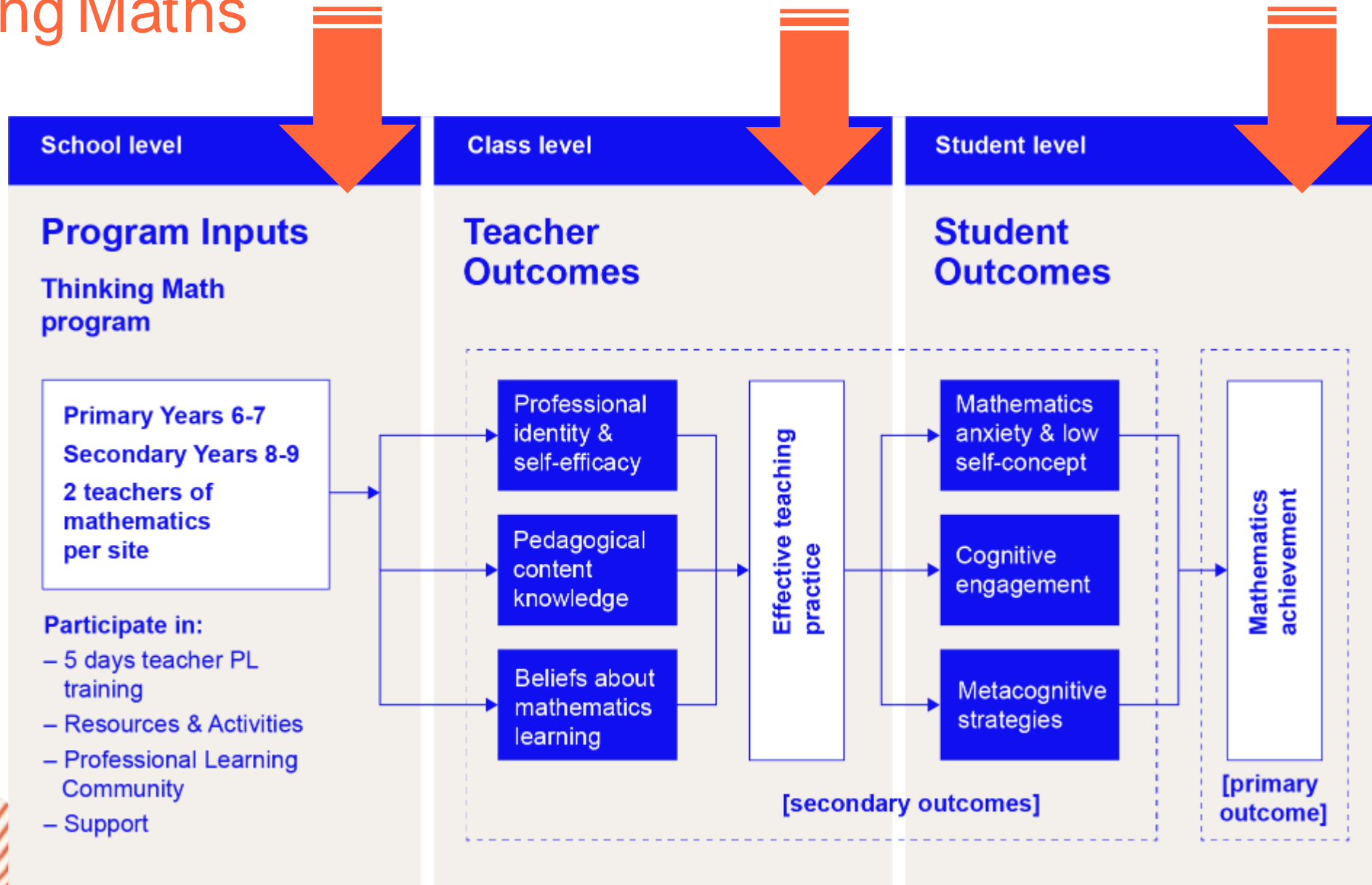
## Does the program work?

- Did Thinking Maths develop middle-school students (Years 6-9) maths achievement above typical learning growth?
- Did Thinking Maths improve students' a) maths self-efficacy, b) cognitive engagement in learning and c) metacognition?
- Did Thinking Maths increase teachers' a) pedagogical content knowledge, b) beliefs about maths teaching and learning and c) professional identity?

## To what exact and how?

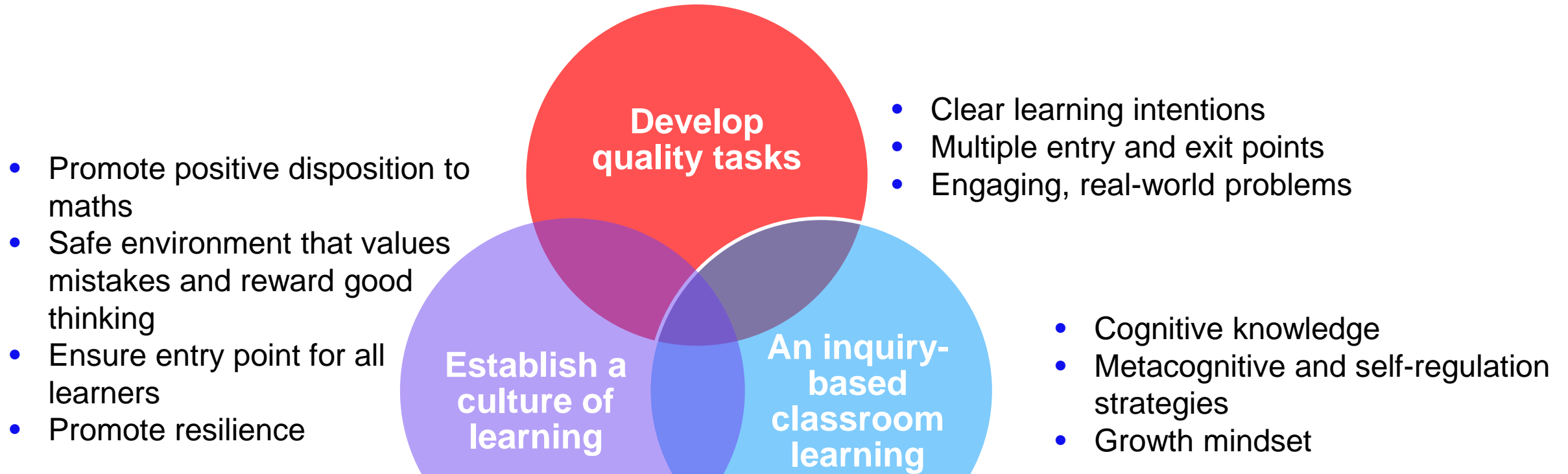
- How cost-effective is the program?
- What are the conditions for success and how the program can be improved?

# Thinking Maths



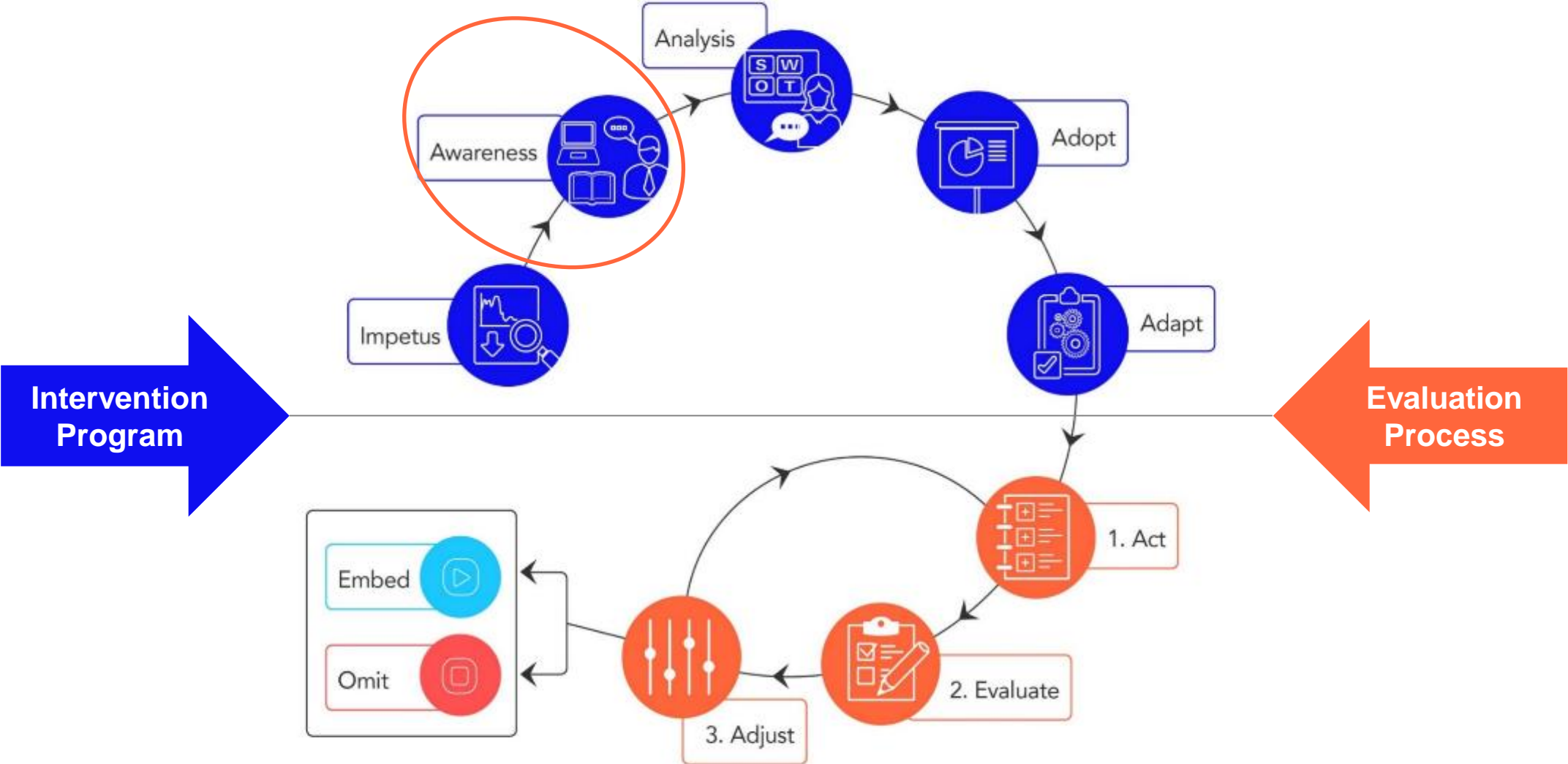
# Thinking Maths strategies

The PL sessions help teachers deliver an inquiry-based approach that focused on three areas:



**And also activities, and resources;  
Professional learning community and  
professional support**

# Awareness stage



# Awareness: What is the evidence telling us?



# Effect Sizes

Effect size is 'the size of the effect' from the intervention – the magnitude of the difference between the average, or mean, outcomes in two different intervention groups.

American statistician Jacob Cohen (1969) suggests using the following as a guide:

- A 'small' effect size is **0.2**
- A 'medium' effect size is **0.5**
- A 'large' effect size is **0.8**

However, in education research, **effect sizes** will generally range from -.5 to +1.75 in most **educational** contexts.

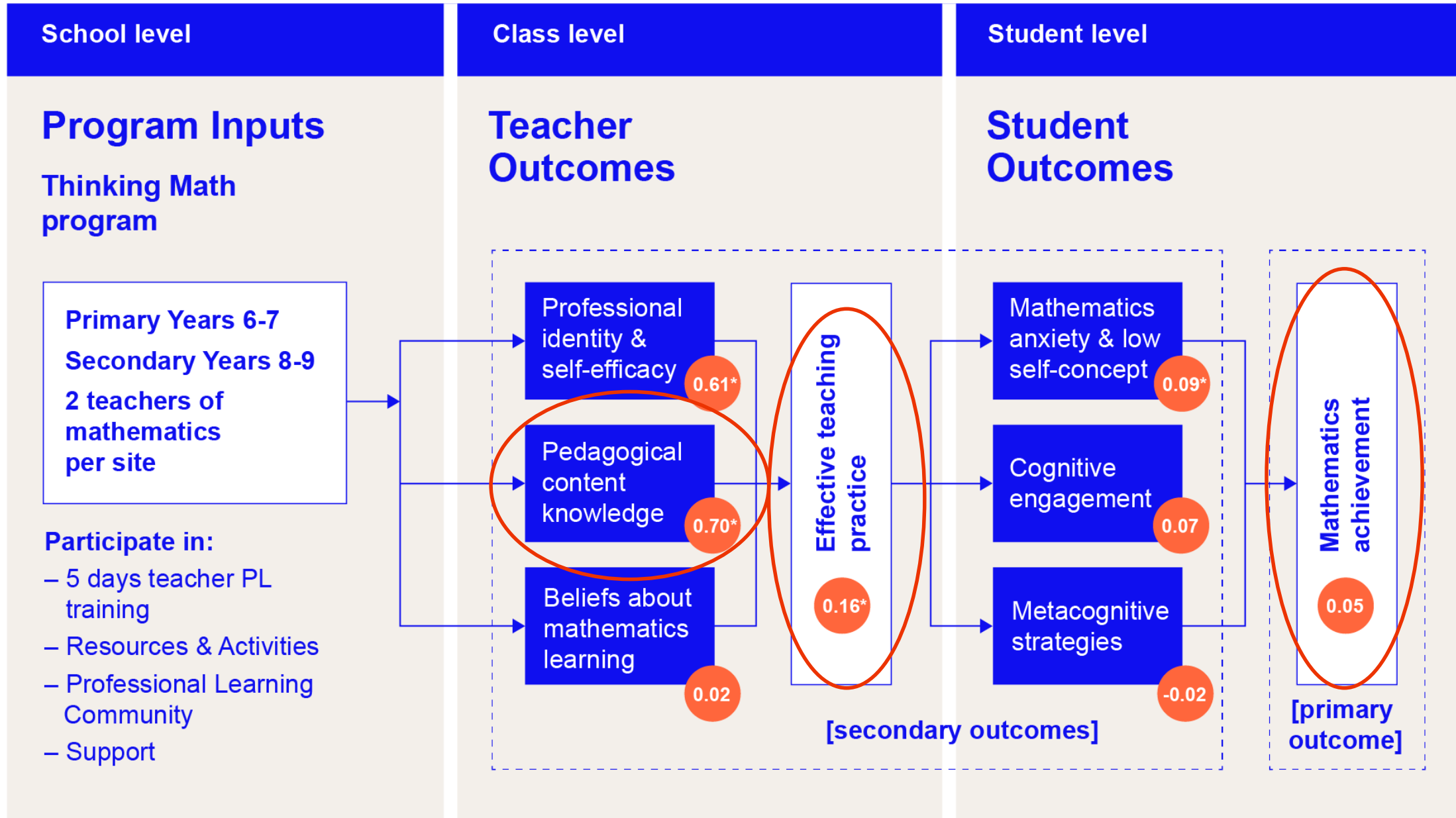


# E4L Effect Size and Months of additional progress


Effect size from	to	Months' additional progress
-0.04	0.04	0
0.05	0.09	1
0.10	0.18	2
0.19	0.26	3
0.27	0.35	4
0.36	0.44	5
0.45	0.52	6
0.53	0.61	7
0.62	0.69	8
0.70	0.78	9
0.79	0.87	10
0.88	0.95	11

- The effect size of one year's instruction at primary school is about 1 SD of learning progress (Glass, 1981)
- Based on this, we divide 1 by 12 to get 1 month's worth of progress (an effect size of 0.09)
- Months of progress is always proportional to effect size – a bigger effect size equates to more months' of progress.

# Results



# Findings

Intervention vs control	Effect size [95% CI]	Estimated months progress*	E4L security rating+	Number of students	P value	E4L cost rating
All students	0.05 [0.00 – 0.10]	+1		7068 students in 158 schools	0.38	\$\$\$\$\$
Primary Years 5-7	0.14 [0.08 – 0.19]	+2	N/A	5013 students in 119 schools	0.05	\$\$\$\$\$
Secondary Years 8-10	-0.16 [-0.25 – -0.07]	-2	N/A	2055 students in 56 schools	0.05	\$\$\$\$\$
School Card holders	0.11 [-0.04 – 0.27]	+1	N/A	666 students in 118 schools	0.21	\$\$\$\$\$

# Summary of Findings

## Thinking Maths

<b>Program summary</b> A three-term professional learning program for Years 6-9 maths teachers to engage middle school students' maths learning.			
<b>Program Developer</b> South Australia Department for Education			
<b>Independent Evaluator</b> Australian Council for Educational Research (ACER)			<b>Type of Trial</b> Efficacy
<b>Students</b> 7,068	<b>Schools</b> 158	<b>Program Grant</b> \$0	<b>Evaluation Grant</b> \$195,000
<b>Costs</b> \$ \$ \$ \$ \$	<b>Security</b> 🔒 🔒 🔒 🔒 🔒	<b>Months Impact</b> +1	

- Students who received Thinking Maths made, on average, one month's additional progress in maths (not statistically significant)
- Critical differences between year levels.
  - +2 months impact on Primary
  - 2 months impact on Secondary
- Substantial impact on teachers' knowledge but this improvement was not fully translated into impact on students' outcomes.
- Secondary schools faced more barriers in implementing the program (time-tabling, structures and curriculum)

# Reflect and Discuss



*What are your reactions to the findings?*

*Do they reflect what you know  
or think about the impact of professional  
learning, its teaching strategies and  
implementation on primary and secondary  
maths learning?*

# What does it mean for practice?

**Thinking Maths is promising for Primary schools**, what can schools learn from this?

- Schools should consider implementing Thinking Maths' inquiry-based strategies in school i.e., Metacognition (feedback and asking effective questions). What are the considerations for effective implementation?
  - ✓ Be clear about the impetus and goals
  - ✓ Embed an effective professional learning culture
  - ✓ Adapt curriculum structures
  - ✓ Provide coaching and resources to support teacher capacity
  - ✓ School leadership team co-ownership
  - ✓ In-school evaluation



# What does it mean for practice?

**Thinking Maths is promising for Primary schools**, what can schools learn from this?

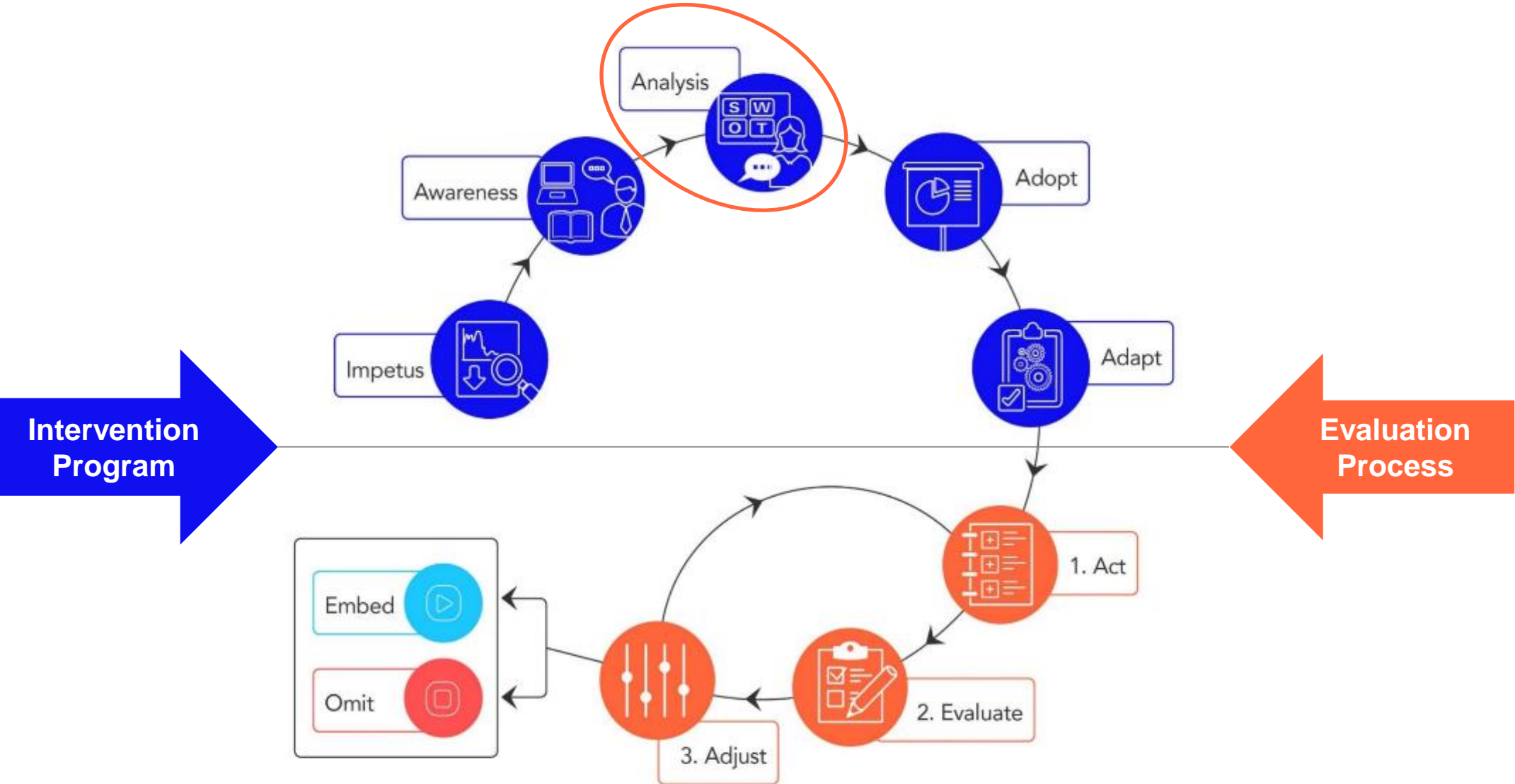
- Schools should consider the cost-effectiveness and the high impact on teachers' knowledge and think about either purchasing the program or adapting its teaching strategies in primary schools
- Think about 1) how school structures and support inquiry-based approaches and 2) professional learning to support teachers implementing Thinking Maths strategies

**There was no evidence of Thinking Maths' effectiveness for Secondary schools**, what can schools learn from this?

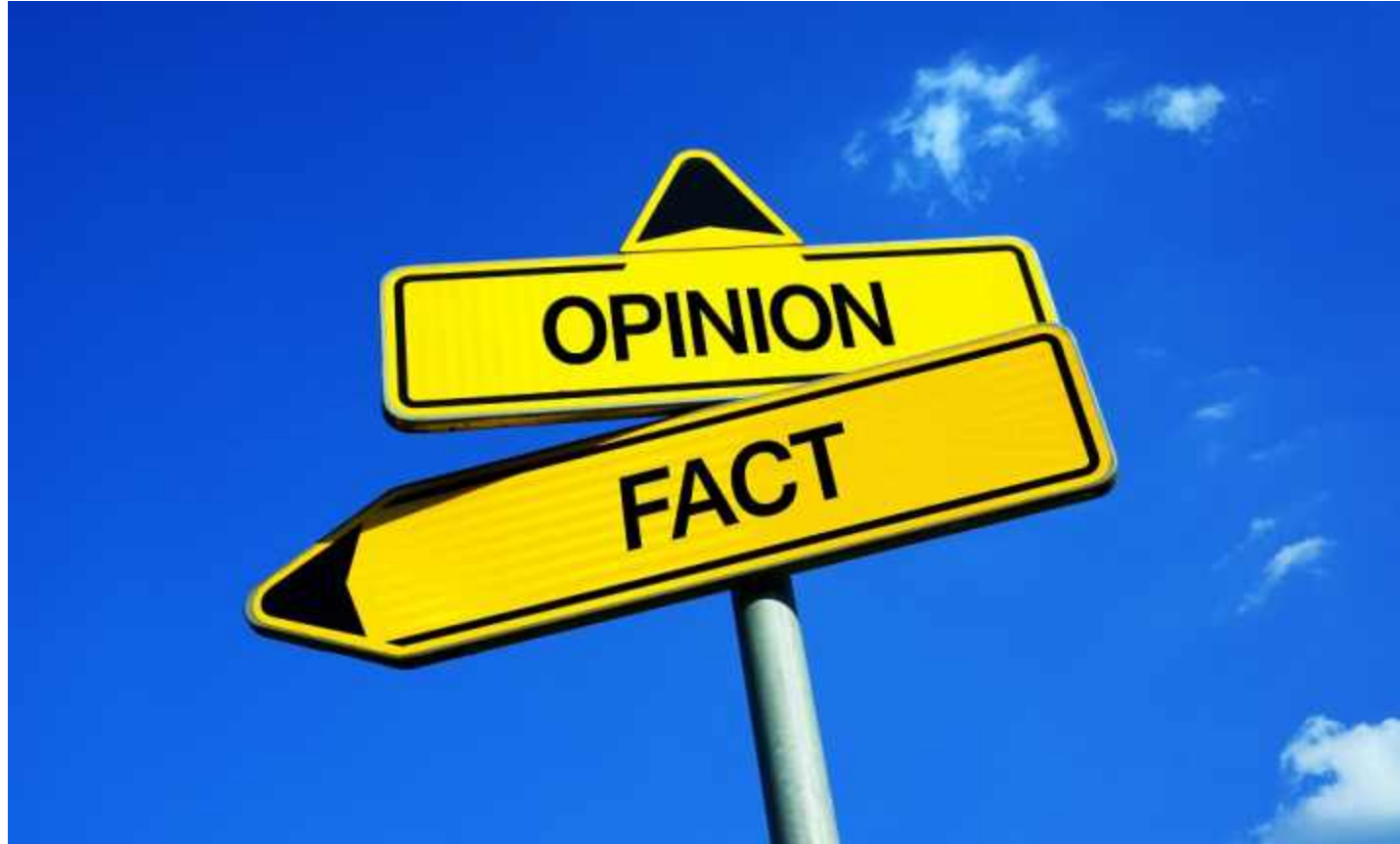
- Schools should consider the cost-effectiveness and the high impact on teachers' knowledge and think about either purchasing the program or adapting its teaching strategies in primary schools
- Schools should think carefully about the school structures and timetabling in secondary schools to support implementing Thinking Maths' inquiry-based strategies.

=> What other considerations?

# Analysis stage



# Analysis: Looking into the wider evidence base



# Metacognition and self-regulation

**High impact, very low cost, based on extensive evidence**

Metacognition and self-regulation approaches have consistently high levels of impact.

Average cost

\$ \$ \$ \$ \$

Evidence security

🔒 🔒 🔒 🔒 🔒

Months' impact

+7

## 1.2

### Understand how students learn

Demonstrate knowledge and understanding of research into how students learn and the implications for teaching.

## 1.5

### Differentiate teaching to meet the specific learning needs of students across the full range of abilities

Demonstrate knowledge and understanding of strategies for differentiating teaching to meet the specific learning needs of students across the full range of abilities.

# Metacognition and self regulation

- Metacognition and self-regulation approaches aim to help students think about their own learning more explicitly, often by teaching them specific strategies for planning, monitoring and evaluating their learning.
- Self-regulated learning can be broken into three essential components:
  - **cognition** - the mental process involved in knowing, understanding, and learning e.g. subject specific - making different marks with a brush or using different methods to solve equations in maths;
  - **metacognition** – learners monitor and purposely direct their learning e.g. checking our memorisation technique was accurate or selecting the most appropriate cognitive strategy for the task we are undertaking;
  - **motivation** - willingness to engage our metacognitive and cognitive skills e.g. undertake a tricky revision task now – affecting current wellbeing – as a way of improving our future wellbeing.



# Metacognition and self regulation

Strategy	Effect size	Definition	Description
Help-seeking: peers, teachers, adults	0.60	Explaining to someone else, asking questions, answering questions	Using a study partner.
Keeping records, monitoring	0.59	Recording of information related to study tasks.	Note taking, summarising.
Rehearsing, memorising	0.57	Memorization of material by overt or covert strategies	Writing a mathematics formula down until it is remembered.
Goal setting / planning	0.49	Goals, sub-goals, timeline	Making lists to accomplish during studying.
Self monitoring	0.45	Observing and tracking one's own performance and outcomes, often recording the study outputs	Keeping records of study outputs.



# What does the research show?

Teaching students cognitive strategies alone is not enough...

- When paired with cognitive strategies, metacognitive strategies have been shown to increase the understanding and ability of students with mathematics learning difficulties and disabilities to solve mathematics problems.  
*(Pfannenstiel, Bryant, Bryant, & Porterfield, 2015)*
- Secondary school students who received cognitive and metacognitive strategy instruction outperformed peers who received typical math instruction.  
*(Montague, Enders, & Dietz, 2011; Pfannenstiel, Bryant, Bryant, & Porterfield, 2015)*

# Strategies for Maths teaching practice

- Establish maths goals to focus learning
- Implement tasks that promote reasoning and problem solving
- Use and connect mathematical representations
- Facilitate meaningful mathematical discourse (metacognition and feedback)
- Pose purposeful questions
- Build procedural fluency from conceptual understanding
- Support productive struggle in learning maths
- Elicit and use evidence of student thinking

# Questions to ask

## **Before engagement with a topic**

- Why are we studying this?
- Why is this topic important?
- What do I already know about this topic?
- How does this topic relate to what we previously studied?

## **During engagement in topic**

- How can I connect this to what I already know?
- What questions do I have?
- What am I confused about?
- How does this work?
- What are the reasons or evidence being provided?
- Whose point of view is being represented?

## **At the end of a topic**

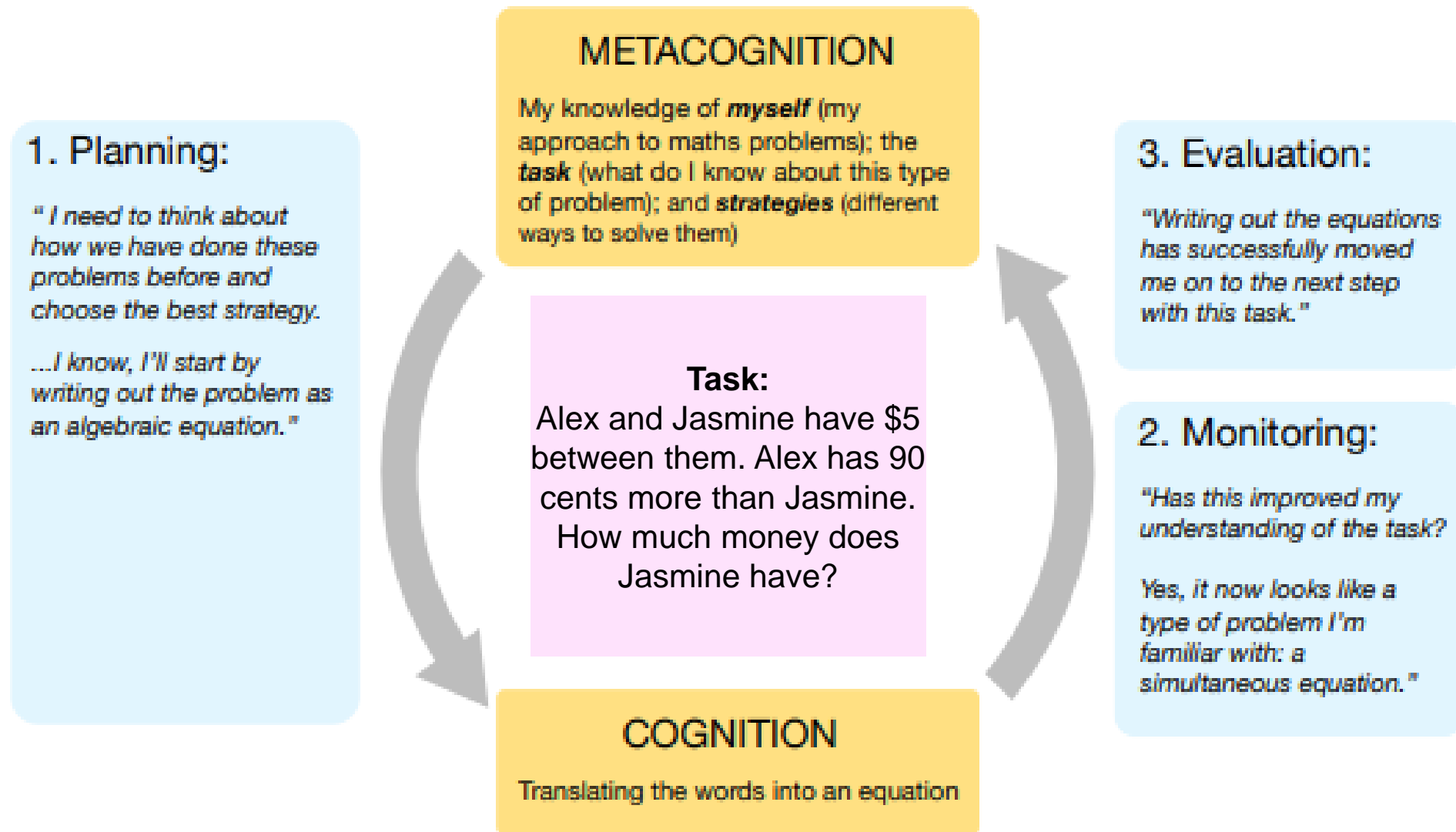
What are the most important ideas and concepts?

What do we need to know more about?

How has this change what I know?

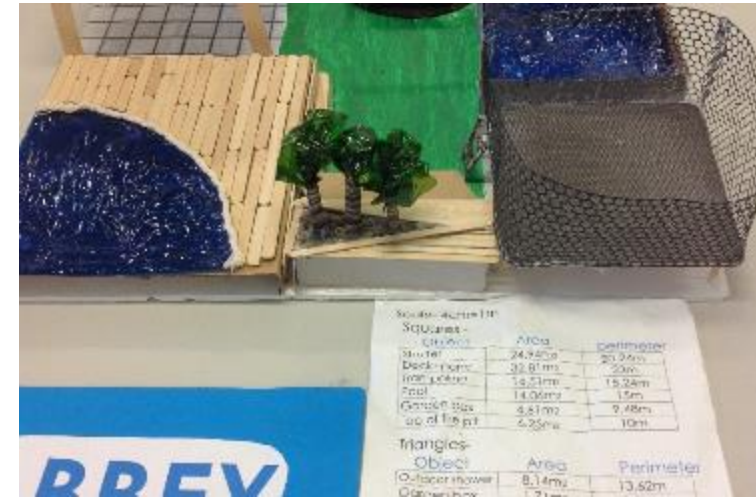
How can I use this later?

# Self-Regulation Cycle – Four Steps



# Case Study: Grange Primary School

- Teachers who attended the Year long program - try out in class, reflect, adjust
- Strong research base, used readings. Designed real problem solving tasks, students saw purpose
- Teaching on to other staff - replicated activities in professional learning teams, staff meetings
- Transferability across to years 3-5 at Partnership and school level
- Employ a Mathematics coach in 2019
- Build upon teacher excitement- student growth, what students are capable of by teachers and students sharing practice
- Continue teachers presenting short 5 minute masterclass to colleagues
- Outcomes: This has resulted in a substantial maths achievement growth in the schools' NAPLAN maths data and students' dispositions towards maths.





# Randomised Controlled Trials commissioned

Program	Description	Schools	Evaluator	Partner	Investment
<b>Thinking Maths</b>	Teacher professional learning intervention to make maths instruction deeper, more personalised and more engaging.	158 schools (7,068 students)	ACER	SA Department (\$350,000)	\$195,000
<b>MiniLit</b>	Small-group reading intervention for struggling Year 1 students, focusing on five keys: (1) phonemic awareness; (2) phonics; (3) fluency; (4) vocabulary; and (5) comprehension.	9 schools (237 students)	MCRI/MGSE	NSW DET	\$450,000
<b>QuickSmart Numeracy</b>	A small-group tuition intervention to increase automaticity in maths and reduce cognitive load.	23 schools (293 students)	University of Newcastle	Sydney Catholic	\$686,000
<b>Resilient Families</b>	School-based family intervention program to increase parent engagement, student social and emotional learning skills to aid healthy adolescent development.	14 schools (700 students)	Western Sydney University	VicHealth (\$100,000)	\$86,000



# Current progress in Learning Impact Fund

<div><div>MiniLit</div><div>Active</div><div>Small-group reading intervention for struggling Year 1 students.</div><div><div>Developer</div><div>Multit</div></div><div><div>Type of trial</div><div>Efficacy</div></div><div><div>Project progress</div><div><div></div></div></div></div>	<div><div>QuickSmart Numeracy</div><div>Active</div><div>Small-group student tutoring intervention to increase fluency and automaticity in maths.</div><div><div>Developer</div><div>SiMERR National Research Centre at the University of New England</div></div><div><div>Type of trial</div><div>Effectiveness</div></div><div><div>Project progress</div><div><div></div></div></div></div>
<div><div>Resilient Families</div><div>Active</div><div>School-based social-emotional learning program involving parental engagement.</div><div><div>Developer</div><div>Deakin University</div></div><div><div>Type of trial</div><div>Developmental</div></div><div><div>Project progress</div><div><div></div></div></div></div>	<div><div>Thinking Maths</div><div>Completed</div><div>Teacher professional learning for middle school maths teachers (Years 6-9).</div><div><div>Developer</div><div>South Australian Department for Education</div></div><div><div>Type of trial</div><div>Efficacy</div></div><div><div>Cost</div><div>\$ \$ \$ \$ \$</div></div><div><div>Security</div><div>🔒 🔒 🔒 🔒 🔒</div></div><div><div>Months' impact</div><div>+1</div></div></div>

# Questions?



# Thinking Maths

<https://www.evidenceforlearning.org.au/lif/our-projects/thinkingmaths/>



# Where to now?

- Join our Evidence Informed Educator Network  
[evidenceforlearning.org.au/evidence-informed-educators/join/](https://evidenceforlearning.org.au/evidence-informed-educators/join/)
- Subscribe to our newsletter for updates [evidenceforlearning.org.au/](https://evidenceforlearning.org.au/)
- Follow us on Twitter [@E4Ltweets](https://twitter.com/E4Ltweets) and Facebook [Evidence for Learning](https://www.facebook.com/EvidenceforLearning)
- Comments and feedback please [tvaughan@evidenceforlearning.org.au](mailto:tvaughan@evidenceforlearning.org.au)



Helping great practice become  
common practice in education



[info@evidenceforlearning.org.au](mailto:info@evidenceforlearning.org.au) | [evidenceforlearning.org.au](http://evidenceforlearning.org.au) | @E4Ltweets

# Appendix 1: Features of effective

Strategy	Effect size	Definition	Description
Support from school leaders	0.84	Seen as part of achieving school-wide goals (Alton-Lee, 2008)	Embedded in a school improvement strategy within professional learning communities
Deepening both subject matter and pedagogical content knowledge	0.56	Content-focussed, how to teach specific content and how students learn (Scher & O'Reilly, 2009)	Teaching deep knowledge of a concept and the skills for transfer to students
Include cognitive guided instruction tools linked to student learning	0.59	Specific tools to support teachers to help students learn	Teachers provided with a classification of additional and subtraction problems and descriptions of variations in students' thinking around those problems
Linked to clear and relevant goals related to student outcomes	0.35	Linked to clear student learning goals, amplified by school leaders' participation in goal setting (Alton-Lee, 2011)	Goals are school-wide and clearly understood by participating teachers