EVIDENCE FOR LEARNING

Thinking Maths

Learning Impact Fund Evaluation Report

A professional learning program supporting teachers to engage middle-school students in mathematics

Addendum to the Evaluation Report

September 2018

ACER

Independent Evaluators:

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About the evaluator

The project was independently evaluated by a team from the Australian Council for Educational Research (ACER): Hilary Hollingsworth, Katherine Dix and Toby Carslake.

ACER is one of the world's leading educational research centres. As an international, independent, non-profit, non-government organisation, ACER generates its entire income through contracted research and development projects, and through developing and distributing products and services, with operating surplus directed back into research and development.

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We would also like to recognise the pioneering work of Pauline Carter and Maureen Hegarty, along with the Thinking Maths team at the South Australian Department for Education. From the very beginning of this project, they have been incredibly helpful, open and supportive – a partnership that has contributed significantly to the success of the evaluation.

ACER would also like to extend their gratitude and thanks to the many school communities involved in the research. We received sustained cooperation and support from principals, teachers, and students in the schools who participated in the trial. We thank all of these communities for their efforts, without which the evaluation could not have proceeded.

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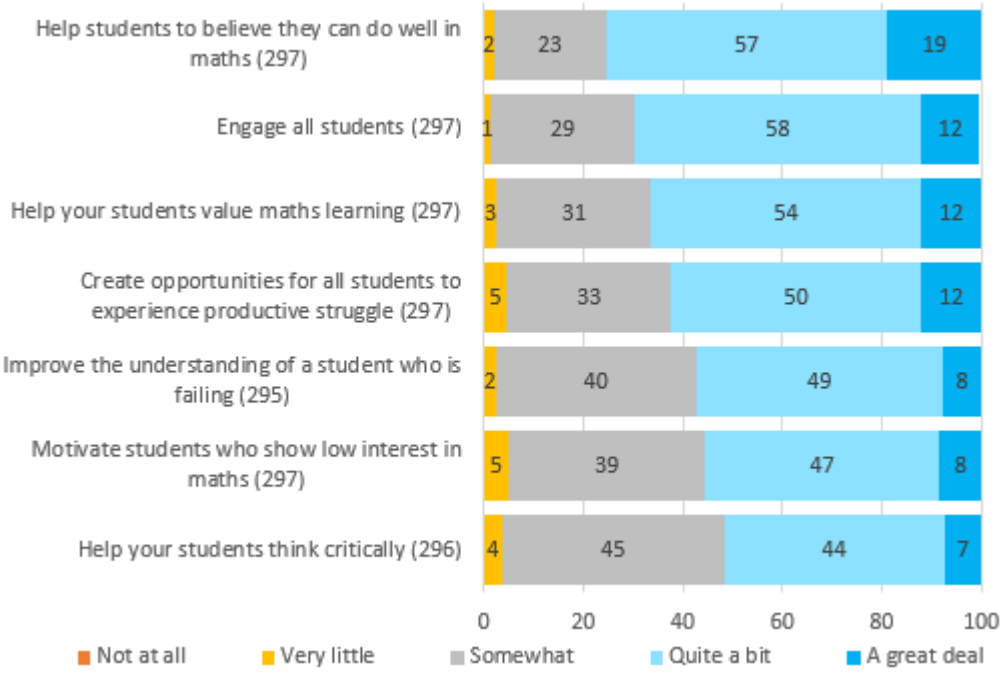
Overview of secondary outcome measures

The baseline views of all participating teachers (n=304) and students (n=5951) in treatment and control groups are presented in the following figures.

Teacher professional identity and self-efficacy

The views of teachers' professional identity and self-efficacy were gauged through seven items. Teachers were asked to what extent they could do various tasks when teaching maths. The percentage of responses for each task at baseline is presented in Figure A1, sorted from most to least positive. Three-quarters of teachers (76%) reported that they could *help students to believe they can do well in maths*, while half (51%) thought that they could *help students to think critically* at least quite a bit.

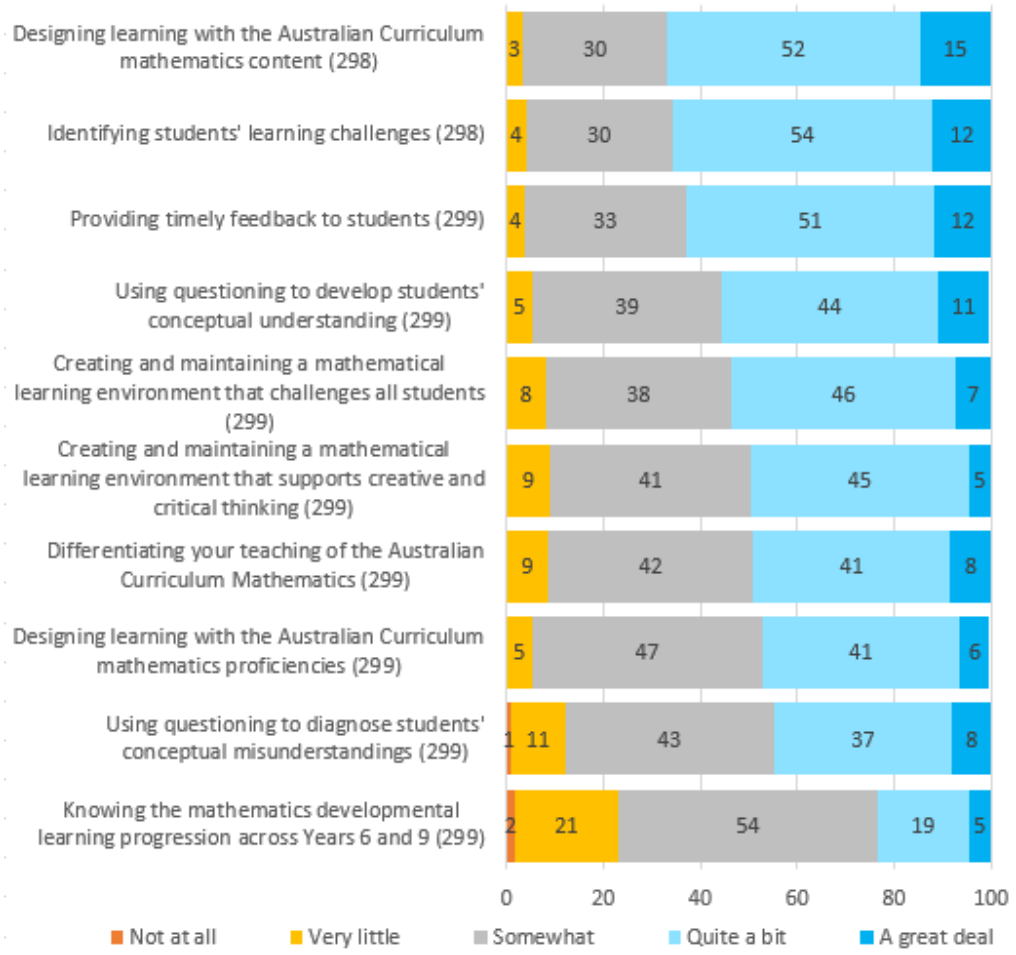
Figure A1. Teacher professional identity and self-efficacy – baseline views



Teacher pedagogical and content knowledge

The views of teachers' pedagogical and content knowledge were gauged through 10 items. Teachers were asked how confident they were in a number of areas. The percentage of responses for each area at baseline is presented in Figure A2, sorted from most to least positive. Two-thirds of teachers (67%) were quite confident about *designing learning with the Australian Curriculum mathematics content*. Teachers were less confident about *using questioning to diagnose students' conceptual misunderstandings* (45%), or *knowing the mathematics developmental learning progression across Years 6 and 9* (24% were quite or very confident).

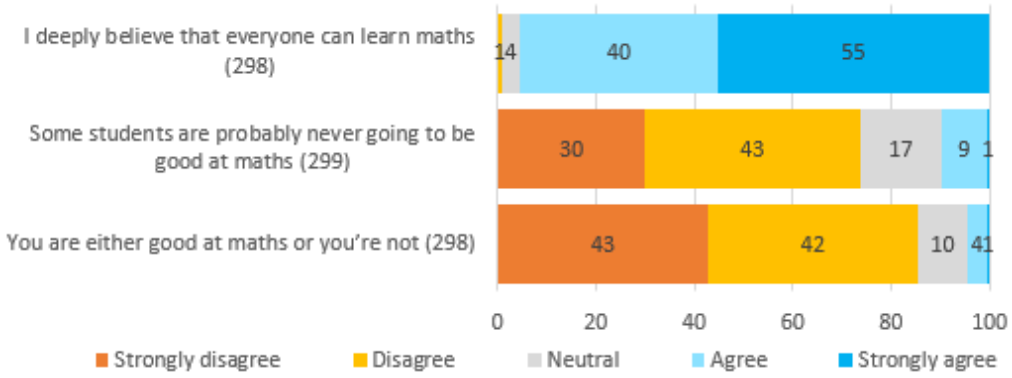
Figure A2. Teacher pedagogical and content knowledge – baseline views



Teacher beliefs about mathematics learning

Teachers' beliefs about mathematics learning were gauged through three items. Teachers were asked to what extent they agreed or disagreed. The percentage of responses for each item at baseline is presented in Figure A3, sorted from most to least positive. Most teachers (95%) *deeply believed that everyone can learn maths*. One in ten teachers (10%) agreed or strongly agreed that *some students are probably never going to be good at maths*, and 5% of teachers agreed that, *you are either good at maths or you're not*. These two negatively worded items, as reflected by the greater majority of teachers who disagreed to the items, were reverse scored prior to scale construction, such that a higher rating reflected more positive beliefs, in keeping with the other measures.

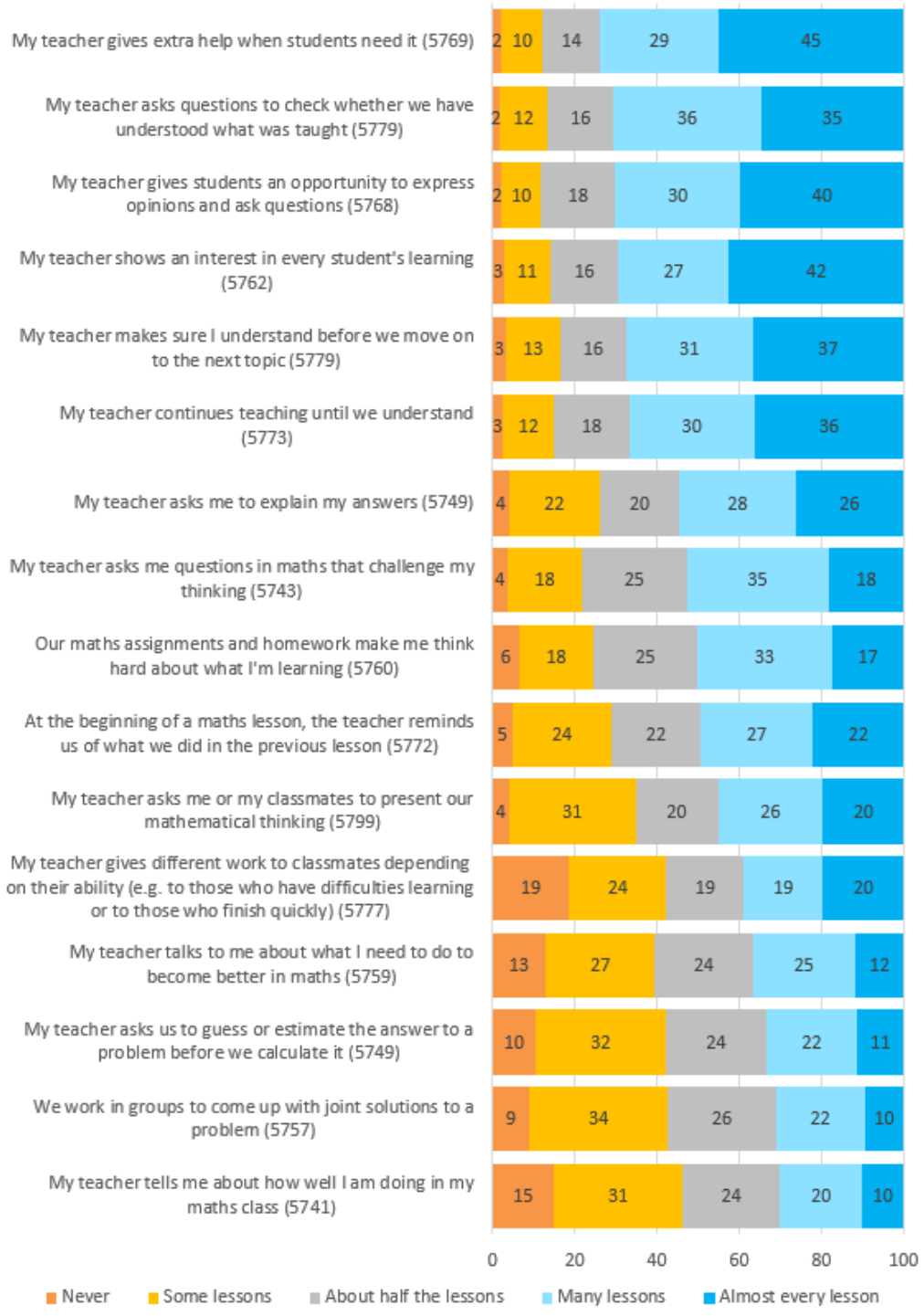
Figure A3. Teacher beliefs about mathematics learning – baseline views



Students' learning through effective teaching practice

Rather than teachers assessing their own effective teaching practices, a set of 16 items were rated by students about their mathematics teacher. The percentage of responses for each task at baseline is presented in Figure A4, sorted from most to least positive. Three-quarters of students (74%) reported that their *teacher gives extra help when students need it* in many or almost every lesson. Students were less likely, on a regular basis, to *work in groups to come up with joint solutions to a problem* (32%) or have their *teacher tell them how well they are doing in maths class* (30%).

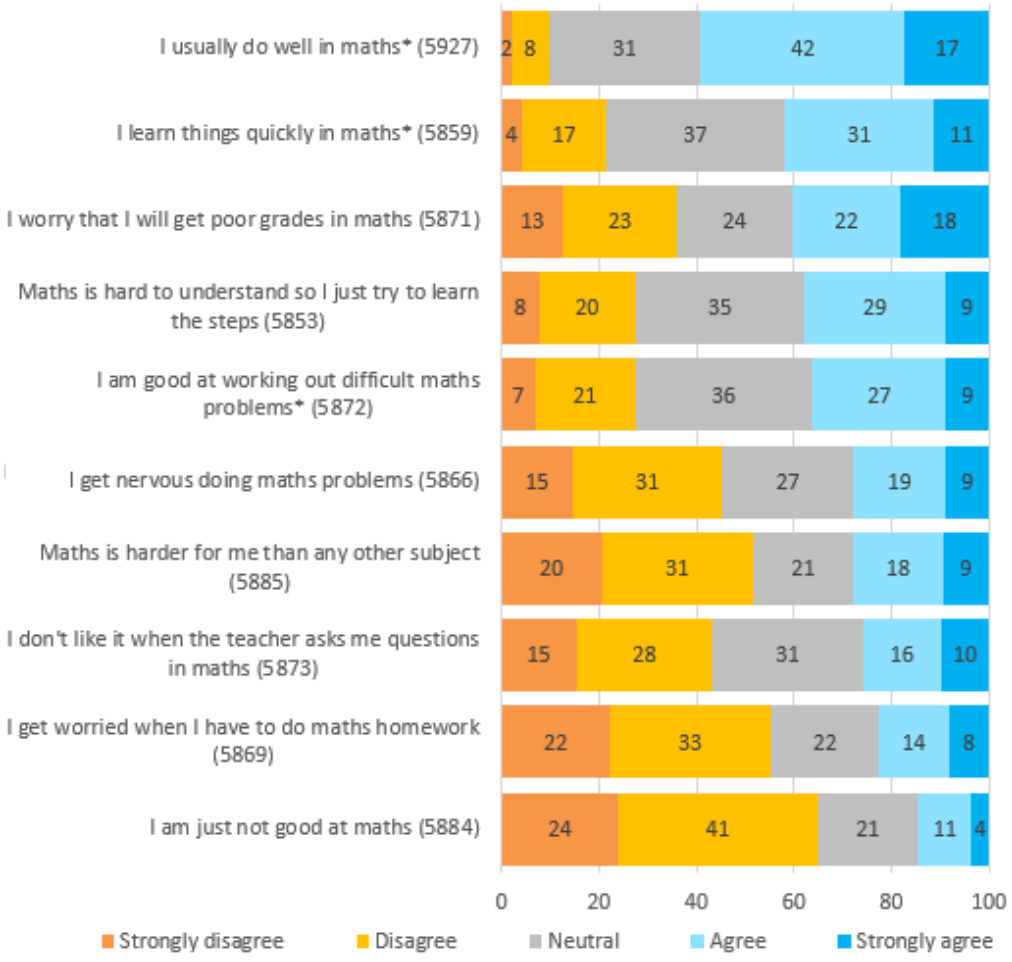
Figure A4. Students' learning through effective teaching practice – baseline views



Students' mathematics anxiety and low self-concept

Students' mathematics anxiety and low self-concept were assessed by 10 items using a mix of positively and negatively worded statements. Prior to scale construction, the positively worded items were reverse scored so that a high score on the derived variable indicated high mathematics anxiety and poor self-concept. The percentage of responses for each item at baseline is presented in Figure A5, sorted from most to least positive. Almost 60% students believed that they *usually do well in maths*, while 15% of students felt that they were *just not good at maths*.

Figure A5. Students' mathematics anxiety and low self-concept – baseline views

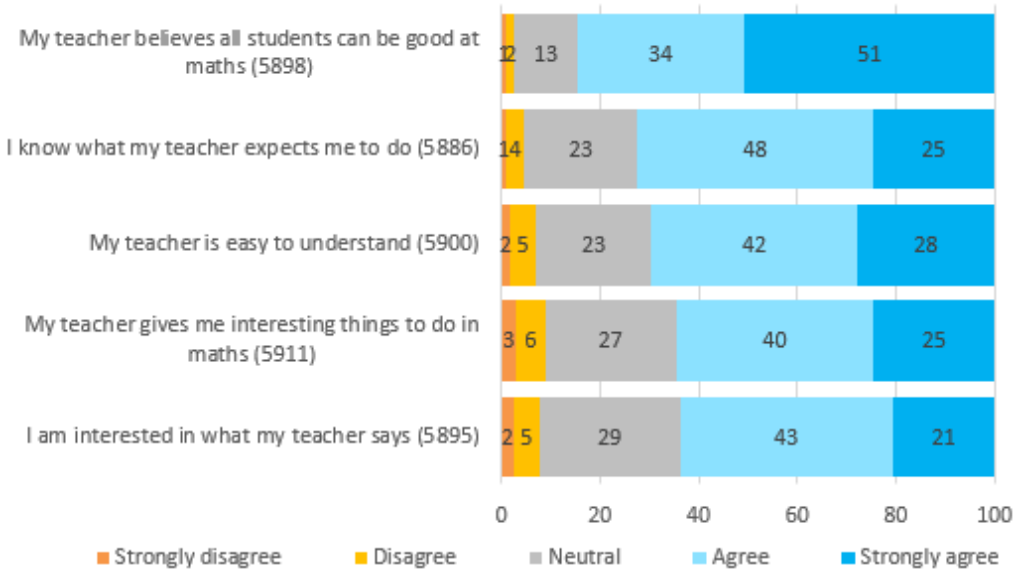


* items were reverse scored prior to scale construction

Students' cognitive engagement

Five items assessed students' cognitive engagement in mathematics. The percentage of responses at baseline is presented in Figure A6, sorted from most to least positive. Most students (85%) agreed or strongly agreed that their *teacher believed all students can be good at maths*, and 64% of students were *interested in what their teacher said*.

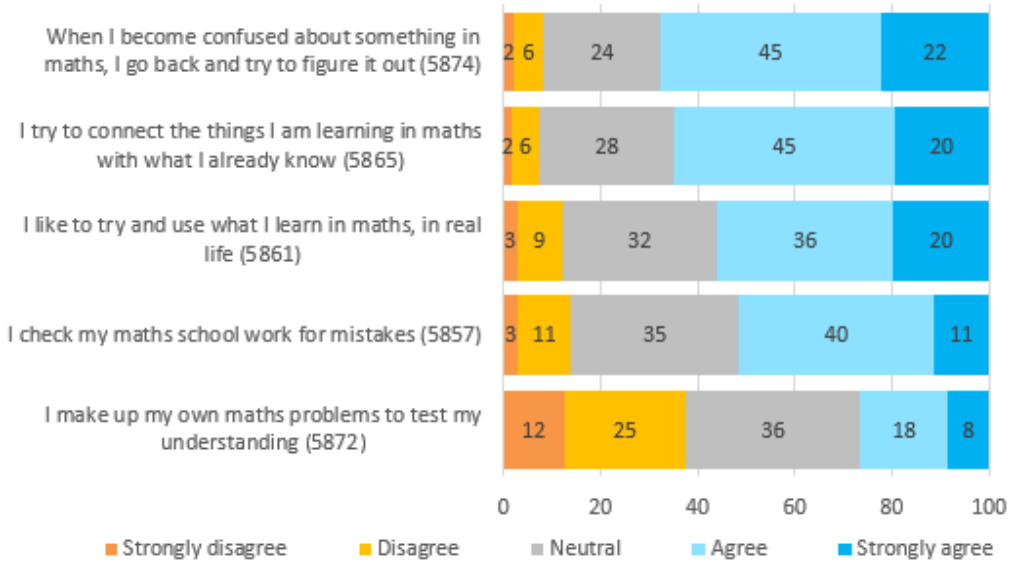
Figure A6. Students' cognitive engagement – baseline views



Students' metacognitive strategies

Students' metacognitive strategies were assessed by five items. The percentage of responses for each strategy at baseline is presented in Figure A7, sorted from most to least positive. Over two-thirds of students (68%) agreed or strongly agreed that *when they became confused about something in maths, they went back and tried to figure it out*. A quarter of students (26%) *made up their own maths problems to test their understanding*.

Figure A7. Students' metacognitive strategies – baseline views



HLM model specifications

The following tables present the results of the basic specifications, with prior attainment and the intention to treat (ITT) indicator as the main explanatory variables, together with school-level clustering to account for students nested in schools. Estimates for the main covariates are reported.

Table A1. Intention-to-treat HLM analysis of primary outcomes - basic specifications, including those used for effect size calculations

Primary outcome	Model coefficient	Stand. error	Residual SD: σ_i, σ_s	95% CI	p
Main analysis: Students' mathematics achievement (PATM17)					
Thinking Maths treatment	0.38	0.44	7.10, 2.41	1.29 [-0.91 – 1.67]	0.38
Intercept	128.42	0.45		1.31 [127.11 – 129.73]	0.00
PATM16 (prior achievement)	124.77	0.43		1.29 [123.48 – 126.06]	0.00
Subgroup analysis: Primary Years 5-7					
Thinking Maths treatment	1.02	0.53	7.06, 2.59	1.43 [-0.41 – 2.45]	0.06
Intercept	127.29	0.54		1.45 [125.85 – 128.74]	0.00
PATM16 (prior achievement)	123.31	0.49		1.38 [121.93 – 124.68]	0.00
Subgroup analysis: Secondary Years 8-10					
Thinking Maths treatment	-1.18	0.59	7.10, 1.96	1.50 [-2.68 – 0.32]	0.05
Intercept	131.00	0.65		1.58 [129.42 – 132.57]	0.00
PATM16 (prior achievement)	128.39	0.64		1.57 [126.82 – 129.96]	0.00
Subgroup analysis: School Card holders					
Thinking Maths treatment	0.83	0.65	7.08, 1.65	1.59 [-0.76 – 2.41]	0.21
Intercept	125.89	0.64		1.56 [124.33 – 127.46]	0.00
PATM16 (prior achievement)	122.02	0.60		1.52 [120.50 – 123.54]	0.00

Table A2. Intention-to-treat HLM analysis of secondary outcomes - basic specifications, including those used for effect size calculations

Secondary outcomes	Model coefficient	Stand. error	Residual SD: σ_i, σ_s	95% CI	p
Teachers' professional identity and self-efficacy (TPID)					
Thinking Maths treatment	0.33	0.07	0.52, 0.16	0.50 [-0.17 – 0.84]	0.00
Intercept	3.85	0.03		0.35 [3.50 – 4.21]	0.00
Teachers' pedagogical and content knowledge (TPCK)					
Thinking Maths treatment	0.37	0.06	0.48, 0.22	0.49 [-0.11 – 0.86]	0.00
Intercept	3.79	0.03		0.35 [3.44 – 4.15]	0.00
Teachers' beliefs about mathematics learning (TBEL)					
Thinking Maths treatment	0.01	0.08	0.55, 0.28	0.55 [-0.53 – 0.56]	0.87
Intercept	4.25	0.04		0.39 [3.87 – 4.64]	0.00
Students' learning through effective teaching practice (SETL)					
Thinking Maths treatment	0.12	0.04	0.67, 0.21	0.39 [-0.27 – 0.50]	0.01
Intercept	3.47	0.02		0.27 [3.20 – 3.74]	0.00
Students' mathematics anxiety and low self-concept (SASE)					
Thinking Maths treatment	0.07	0.03	0.78, 0.16	0.36 [-0.29 – 0.43]	0.04
Intercept	2.74	0.02		0.25 [2.49 – 2.99]	0.00
Students' cognitive engagement (SCOG)					
Thinking Maths treatment	0.05	0.04	0.68, 0.23	0.40 [-0.36 – 0.45]	0.26
Intercept	3.86	0.02		0.28 [3.58 – 4.14]	0.00
Students' metacognitive strategies (SMET)					
Thinking Maths treatment	-0.02	0.03	0.67, 0.18	0.36 [-0.38 – 0.35]	0.63
Intercept	3.43	0.02		0.25 [3.18 – 3.68]	0.00

Table A3. Intention-to-treat HLM analysis of secondary outcomes – subgroup specifications, including those used for effect size calculations

Secondary outcomes	Model coefficient	Stand. error	Residual SD: σ_i, σ_s	95% CI	p
Teachers' professional identity and self-efficacy (TPID)					
Treatment effect in Primary Years 5-7	0.44	0.08	0.53, 0.16	0.55 [-0.11 – 0.99]	0.00
Treatment effect in Secondary Yeas 8-10	0.06	0.10	0.50, 0.08	0.63 [-0.56 – 0.69]	0.54
Teachers' pedagogical and content knowledge (TPCK)					
Treatment effect in Primary Years 5-7	0.46	0.08	0.45, 0.28	0.54 [-0.08 – 1.00]	0.00
Treatment effect in Secondary Years 8-10	0.19	0.10	0.51, 0.03	0.63 [-0.44 – 0.82]	0.07
Teachers' beliefs about mathematics learning (TBEL)					
Treatment effect in Primary Years 5-7	-0.04	0.09	0.52, 0.26	0.58 [-0.63 – 0.54]	0.62
Treatment effect in Secondary Years 8-10	0.13	0.15	0.63, 0.28	0.75 [-0.62 – 0.88]	0.37
Students' learning through effective teaching practice (SETL)					
Treatment effect in Primary Years 5-7	0.12	0.05	0.65, 0.21	0.42 [-0.29 – 0.54]	0.01
Treatment effect in Secondary Years 8-10	0.07	0.08	0.69, 0.24	0.56 [-0.49 – 0.63]	0.42
Treatment effect in School Card holders	-0.03	0.07	0.67, 0.19	0.54 [-0.56 – 0.51]	0.72
Students' mathematics anxiety and low self-concept (SASE)					
Treatment effect in Primary Years 5-7	0.05	0.04	0.79, 0.14	0.37 [-0.32 – 0.43]	0.14
Treatment effect in Secondary Years 8-10	0.15	0.06	0.73, 0.12	0.46 [-0.31 – 0.61]	0.01
Treatment effect in School Card holders	0.07	0.06	0.74, 0.03	0.49 [-0.42 – 0.56]	0.26
Students' cognitive engagement (SCOG)					
Treatment effect in Primary Years 5-7	0.06	0.05	0.66, 0.22	0.43 [-0.36 – 0.49]	0.20
Treatment effect in Secondary Years 8-10	-0.01	0.09	0.70, 0.28	0.59 [-0.60 – 0.57]	0.90
Treatment effect in School Card holders	-0.03	0.08	0.69, 0.24	0.55 [-0.58 – 0.52]	0.73
Students' metacognitive strategies (SMET)					
Treatment effect in Primary Years 5-7	-0.02	0.04	0.68, 0.17	0.39 [-0.41 – 0.36]	0.58
Treatment effect in Secondary Years 8-10	-0.02	0.05	0.63, 0.11	0.43 [-0.45 – 0.42]	0.72
Treatment effect in School Card holders	-0.03	0.06	0.64, 0.15	0.49 [-0.53 – 0.46]	0.61

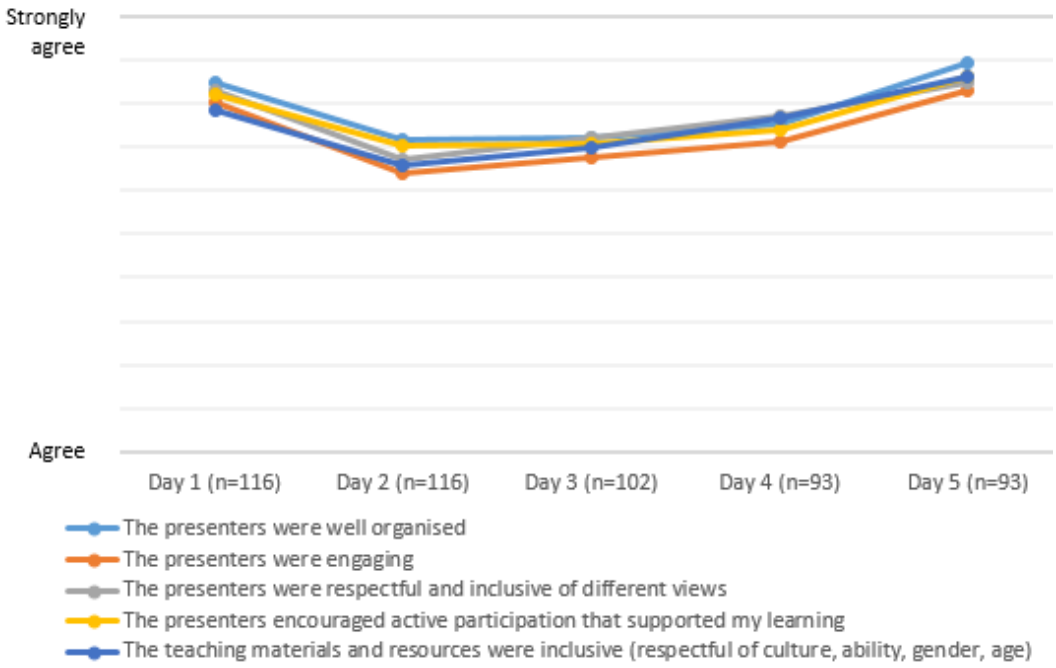
Overview of process measures

Results from the teacher Thinking Maths PL Feedback form are presented in the following figures.

Professional learning days

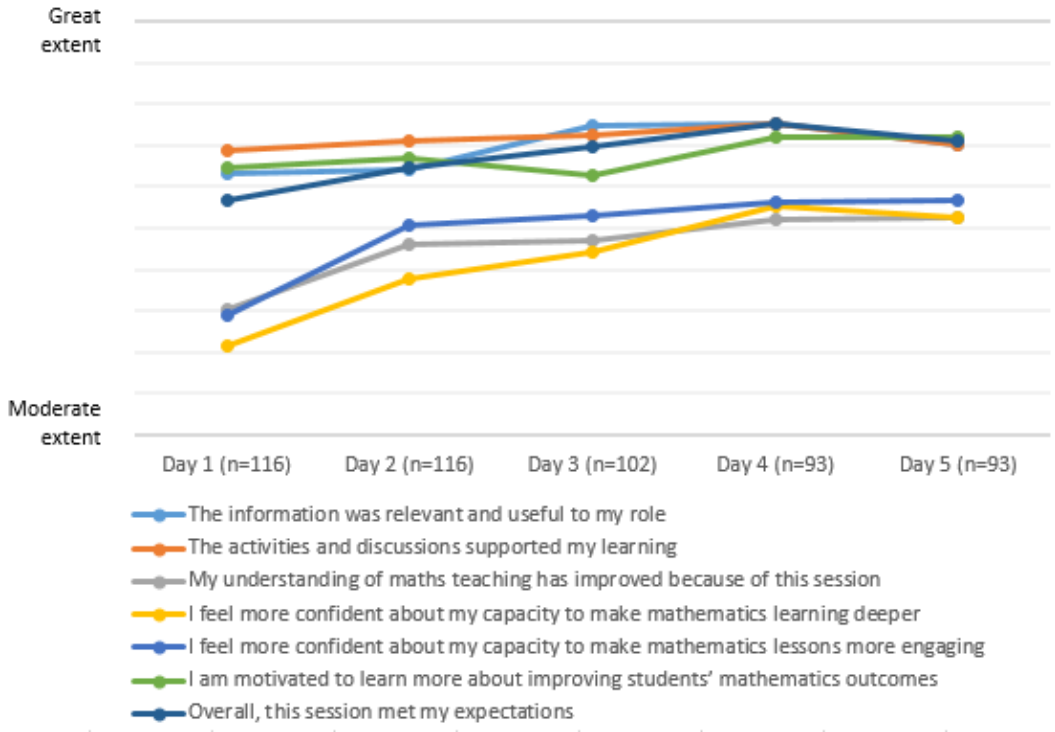
Figure A8 presents the averaged response of teachers to the five items that assessed the quality of delivery on each of the five PL days. As typical with anything new, teachers gave high praise on the first day and then provided a more measured assessment thereafter. The results suggest that the high quality of delivery was maintained over the five days.

Figure A8. Quality of delivery over the five professional learning days



An additional seven probing questions were asked to gauge the quality and impact of the program more broadly. Figure A9 presents the averaged response of teachers to the seven items that assessed the quality of the Thinking Maths program on each of the five PL days. The results suggest that the high regard for the program improved over the five PL days, particularly with regard to raising confidence and understanding in teaching mathematics. Paired t-tests of Day 1 and Day 5 responses found statistically significant ($p<0.05$) improvements in confidence ($d=0.34$) and understanding ($d=0.26$), equivalent to a small practical effect.

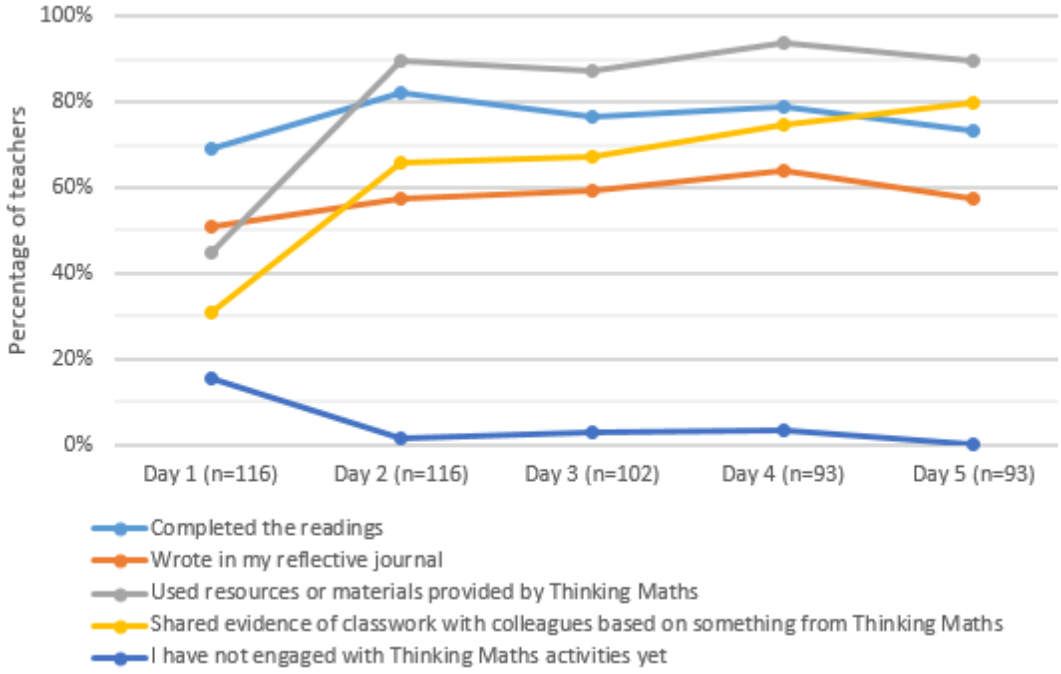
Figure A9. Professional learning engagement and impact



Activities and resources

Figure A10 presents the averaged response of teachers to the items that assessed their engagement with the Thinking Maths activities and resources prior to and in the periods between each of the five PL days. Not surprisingly, teachers' reports in the lead up to Day 1, show lower engagement with the activities with 16% of teachers reporting not to have engaged with Thinking Maths activities yet. The results suggest that a good level of engagement and participation across the eight month intervention was maintained.

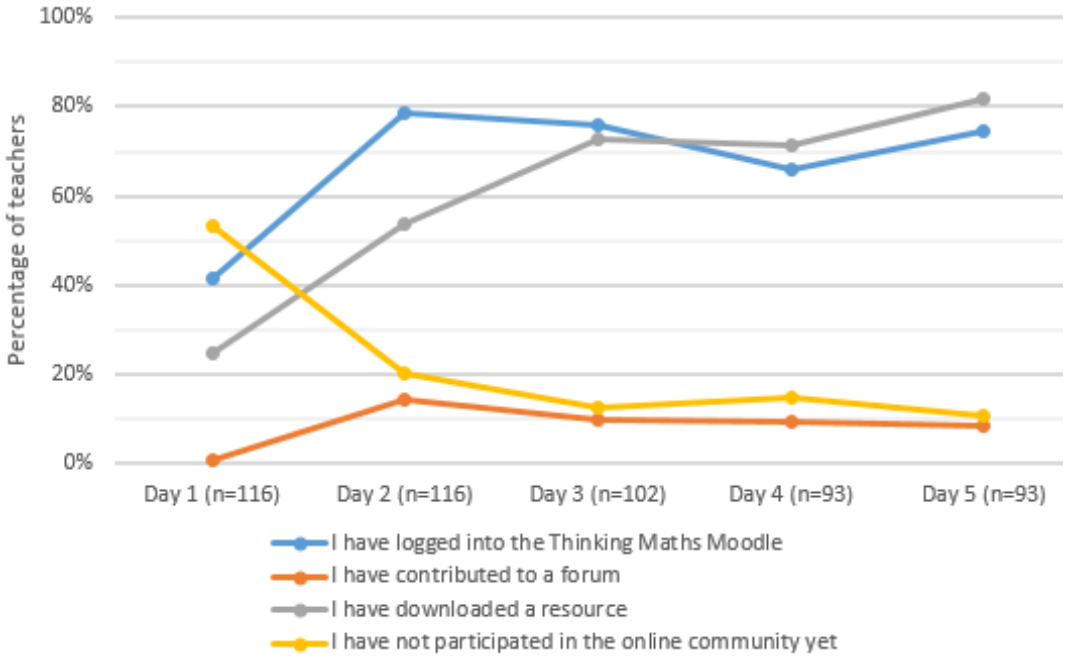
Figure A10. Engagement with Thinking Maths activities



Professional learning community

Figure A11 presents the averaged response of teachers to the items that assessed their participation in the online community prior to and in the periods between each of the five PL days. Not surprisingly, teachers' reports in the lead up to Day 1, show low engagement with over half of the teachers (53%) reporting not to have participated in the Thinking Maths Moodle yet. However, there continued to be a group of teachers (13%) who did not engage by Days 3, 4 or 5.

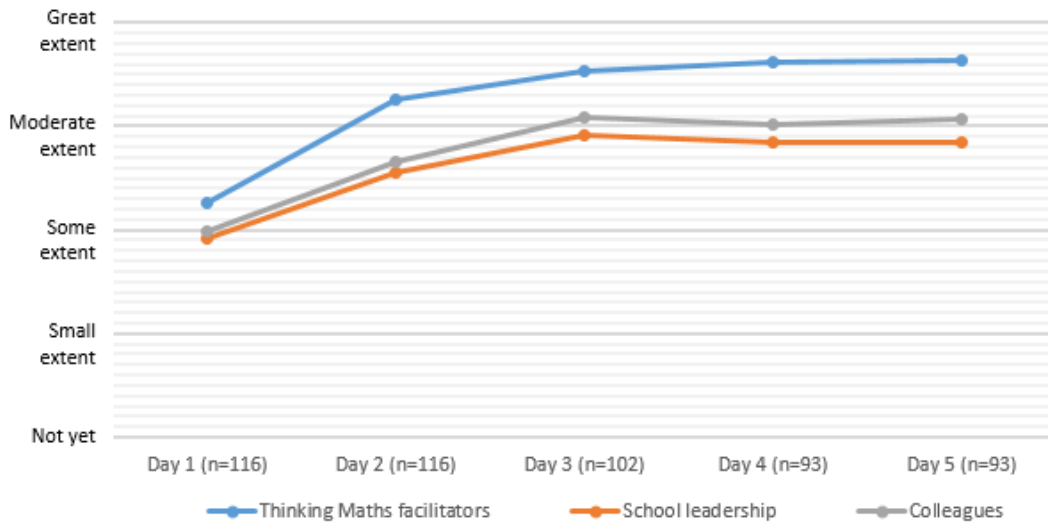
Figure A11. Engagement in online professional learning community



Support

Figure A12 presents the averaged response of teachers to the items that gauged the extent of support by the program and within their school prior to and in the periods between each of the five PL days. Not surprisingly, teachers' reports in the lead up to Day 1, show lower support and suggest that teachers were feeling supported to some extent. The extent of the level of support felt by teachers increased throughout the program, particularly with regard to the support provided by the Thinking Maths facilitators.

Figure A12. Support for implementation



Student Survey

Student Survey: About Learning Mathematics

What is your name? (First name, last name) _____

What is the name of your maths teacher? _____

What is the name of your school? _____

What year are you in? (please circle) **Year 5** **Year 6** **Year 7** **Year 8** **Year 9** **Year 10**

Here are some statements students have made about maths. Please tell us whether you agree or disagree with them.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I usually do well in maths	○	○	○	○	○
I am just not good at maths	○	○	○	○	○
I learn things quickly in maths	○	○	○	○	○
I am good at working out difficult maths problems	○	○	○	○	○
Maths is harder for me than any other subject	○	○	○	○	○
It's ok to make mistakes in maths	○	○	○	○	○
I know what my teacher expects me to do	○	○	○	○	○
I am interested in what my teacher says	○	○	○	○	○
My teacher is easy to understand	○	○	○	○	○
My teacher believes all students can be good at maths	○	○	○	○	○
My teacher gives me interesting things to do in maths	○	○	○	○	○

Here are some more statements students have made about maths. Please tell us whether you agree or disagree with them.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I expect maths class to be difficult for me	○	○	○	○	○
I check my maths school work for mistakes	○	○	○	○	○
I get nervous doing maths problems	○	○	○	○	○
I try to connect the things I am learning in maths with what I already know	○	○	○	○	○
I get worried when I have to do maths homework	○	○	○	○	○
I like to try and use what I learn in maths, in real life	○	○	○	○	○
Maths is hard to understand so I just try to learn the steps	○	○	○	○	○
I worry that I will get poor grades in maths	○	○	○	○	○
When I become confused about something in maths, I go back and try to figure it out	○	○	○	○	○
I don't like it when the teacher asks me questions in maths	○	○	○	○	○
I try hard to understand what the teacher is saying in maths	○	○	○	○	○
I make up my own maths problems to test my understanding	○	○	○	○	○

How often do these things happen in your maths lessons?

	Never	Some lessons	About half the lessons	Many lessons	Almost every lesson
My teacher asks me or my classmates to present our mathematical thinking	○	○	○	○	○
My teacher asks questions to check whether we have understood what was taught	○	○	○	○	○
At the beginning of a maths lesson, the teacher reminds us of what we did in the previous lesson	○	○	○	○	○
My teacher asks me to explain my answers	○	○	○	○	○
Our maths assignments and homework make me think hard about what I'm learning	○	○	○	○	○
My teacher makes sure I understand before we move on to the next topic	○	○	○	○	○
My teacher gives different work to classmates depending on their ability (e.g. to those who have difficulties learning or to those who finish quickly)	○	○	○	○	○
We work in groups to come up with joint solutions to a problem	○	○	○	○	○
My teacher asks us to guess or estimate the answer to a problem before we calculate it	○	○	○	○	○
My teacher asks me questions in maths that challenge my thinking	○	○	○	○	○
My teacher tells me about how well I am doing in my maths class	○	○	○	○	○
My teacher talks to me about what I need to do to become better in maths	○	○	○	○	○
My teacher shows an interest in every student's learning	○	○	○	○	○
My teacher gives extra help when students need it	○	○	○	○	○
My teacher continues teaching until we understand	○	○	○	○	○
My teacher gives students an opportunity to express opinions and ask questions	○	○	○	○	○

What do you like best about maths at the moment?

Thank you for your help

Teacher Survey

About Teaching Mathematics

Your school is one of 160 schools across South Australia participating in the evaluation of Thinking Maths in 2017, and you have been identified to participate in this evaluation. The important information that we are gathering in this survey about learning and teaching mathematics in the transition years will inform the future rollout of the Thinking Maths program.

There are no right or wrong answers. please answer each question as best you can. Responses will be de-identified and only summarised results will be reported.

Please email this completed form to katherine.dix@acer.edu.au to find out into which round of Thinking Maths your school has been randomly allocated.

Thank you for your support.

About you

Your name:	
Name of school:	

To register for Thinking Maths you were asked to nominate a participating class. What is the year level of that class? If it is a composite class please select the highest year level of that class.

○ Year 5 ○ Year 6 ○ Year 7 ○ Year 8 ○ Year 9 ○ Year 10

Are you female or male?

○ Female ○ Male

What is the highest level in mathematics that you have studied?

○ Year 10 or below
○ Year 11
○ Year 12
○ Certificate
○ Diploma or Associate Diploma
○ Bachelor degree (with or without honours)
○ Graduate Diploma or Graduate Certificate
○ Master's Degree
○ Doctoral Degree

What is the highest teaching qualification you have completed?

○ Certificate
○ Diploma or Associate Diploma
○ Bachelor Degree (with or without Honours)
○ Graduate Diploma or Graduate Certificate
○ Master's Degree
○ Doctoral Degree
○ Other _____

What is the major field of study in your teaching qualification?
If you have more than one area of specialisation, please indicate the most recent.

- ○ Special Education
- ○ Early Childhood
- ○ Primary
- ○ Middle-School
- ○ Secondary
- ○ Combined F-12
- ○ Other _____

As part of your teaching qualifications, was mathematics one of your areas of specialisation?

○ Yes ○ No

How many years teaching experience do you have:

Only numbers may be entered in these fields.	Years	Months
Altogether as a teacher of maths?		
As a teacher of maths at the year level of your participating class?		

Teaching mathematics

Please indicate how much you agree or disagree with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am confident in my abilities to teach maths	○	○	○	○	○
I think I am skilled at teaching maths	○	○	○	○	○
I feel competent as a teacher	○	○	○	○	○
A good teacher makes learning maths easy	○	○	○	○	○
You are either good at maths or you're not	○	○	○	○	○
I deeply believe that everyone can learn maths	○	○	○	○	○
A good teacher provides extra work for the best students	○	○	○	○	○
Some students are probably never going to be good at maths	○	○	○	○	○
A good teacher provides easy work for students who struggle so they can succeed	○	○	○	○	○

What do you reward and value in your classroom when teaching maths?

With respect to your mathematics teaching, how often do you work with colleagues to:

	Never	Rarely	Some-times	Often	Always
Try out new ideas?	○	○	○	○	○
Collaborate in planning and preparing instructional materials?	○	○	○	○	○
Discuss how to teach a particular topic?	○	○	○	○	○
Share what you have learned from your teaching experiences?	○	○	○	○	○

How confident are you in the following areas?

	Not at all	Very little	Some-what	Quite a bit	A great deal
Designing learning with the Australian Curriculum mathematics proficiencies	○	○	○	○	○
Designing learning with the Australian Curriculum mathematics content	○	○	○	○	○
Knowing the mathematics developmental learning progression across Years 6 and 9	○	○	○	○	○
Differentiating your teaching of the Australian Curriculum Mathematics	○	○	○	○	○
Creating and maintaining a mathematical learning environment that challenges all students	○	○	○	○	○
Creating and maintaining a mathematical learning environment that supports creative and critical thinking	○	○	○	○	○
Using questioning to develop students' conceptual understanding	○	○	○	○	○
Using questioning to diagnose students' conceptual misunderstandings	○	○	○	○	○
Identifying students' learning challenges	○	○	○	○	○
Providing timely feedback to students	○	○	○	○	○

When teaching maths, how often do you do the following?

	Never	Some lessons	About half the lessons	Many lessons	Almost every lesson
Make learning active, hands on and experimental	○	○	○	○	○
Bring interesting hands-on materials to class	○	○	○	○	○
Relate the lesson to students' daily lives	○	○	○	○	○
Provide rich opportunities for students to learn from each other	○	○	○	○	○
Get students to work in groups to come up with joint solutions to a problem	○	○	○	○	○
Let students direct their learning	○	○	○	○	○
Ask students to guess or estimate the solution to a problem before working through it properly	○	○	○	○	○
Use effective questioning to elicit reasons and explanations	○	○	○	○	○
Craft effective questions that extend your students	○	○	○	○	○
Respond to difficult questions from your students	○	○	○	○	○
Adjust your lessons to meet the needs of individual students	○	○	○	○	○
Provide appropriate extension for very capable students	○	○	○	○	○

When teaching maths, how often do you do the following?

	Never	Some lessons	About half the lessons	Many lessons	Almost every lesson
Use a wide variety of assessment strategies	○	○	○	○	○
Design learning activities that have multiple entry and exit points appropriate for your students	○	○	○	○	○
Summarise what students should have learned from the lesson	○	○	○	○	○
Provide feedback to students about their work	○	○	○	○	○
Praise students for good effort	○	○	○	○	○
Guide students to expose a misconception in their thinking and allow them to self-correct	○	○	○	○	○
Prompt students to explain their thinking when they are confused	○	○	○	○	○
Gauge students' understanding of what you have taught	○	○	○	○	○
Foster student creativity and curiosity in maths	○	○	○	○	○
Encourage students to make mistakes and learn from them	○	○	○	○	○
Involve students in assignments or projects	○	○	○	○	○
Assign homework	○	○	○	○	○

When teaching maths, to what extent can you do the following?

	Not at all	Very little	Some-what	Quite a bit	A great deal
Engage all students	○	○	○	○	○
Help your students think critically	○	○	○	○	○
Improve the understanding of a student who is failing	○	○	○	○	○
Motivate students who show low interest in maths	○	○	○	○	○
Help your students value maths learning	○	○	○	○	○
Help students to believe they can do well in maths	○	○	○	○	○
Create opportunities for all students to experience productive struggle	○	○	○	○	○

Please indicate how often you do each of the following activities.

	Never	Once or twice a year	Once a term	Once or twice a month	Once a week or more
Share what I have read from the professional literature with colleagues (reference books, journal articles, teacher magazines, etc.)	○	○	○	○	○
Participate in online discussions	○	○	○	○	○
Try out new approaches and strategies when I teach maths	○	○	○	○	○
Share effective maths resources I have found with colleagues	○	○	○	○	○
Keep a professional journal	○	○	○	○	○
Participate in professional learning related to maths	○	○	○	○	○

Thank you

Please email this completed form to katherine.dix@acer.edu.au
to find out into which round of Thinking Maths your school has been randomly allocated.

Student survey: About Learning Mathematics

We also ask you to administer the student survey with your nominated class before Friday 17 March 2017.
It will take about 20 minutes to complete

To access the student survey please use the following link with your students:

http://tiny.cc/math-survey

Professional Learning Feedback Form

Thinking Maths PL Feedback Form

Your feedback is very important to us and will help ensure that these professional learning events are effective and meet the learning needs of participants. Your assistance in completing this short survey is greatly appreciated.

There are 12 questions in this survey

Presentation

[]Thinking about the session you attended today or most recently, please indicate how much you agree or disagree with the following statements.

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The presenters were well organised	○	○	○	○	○
The presenters were engaging	○	○	○	○	○
The presenters were respectful and inclusive of different views	○	○	○	○	○
The presenters encouraged active participation that supported my learning	○	○	○	○	○
The teaching materials and resources were inclusive (respectful of culture, ability, gender, age)	○	○	○	○	○

Session impact

[]Thinking about the session you attended today or most recently, to what extent do the following statements reflect your experience?

Please choose the appropriate response for each item:

	Not at all	To a small extent	To some extent	To a moderate extent	To a great extent
The information was relevant and useful to my role	○	○	○	○	○
The activities and discussions supported my learning	○	○	○	○	○
My understanding of maths teaching has improved because of this session	○	○	○	○	○
I feel more confident about my capacity to make mathematics learning deeper	○	○	○	○	○
I feel more confident about my capacity to make mathematics lessons more engaging	○	○	○	○	○
I am motivated to learn more about improving students' mathematics outcomes	○	○	○	○	○
Overall, this session met my expectations	○	○	○	○	○

[]Please describe ways that this session could be improved.

Please write your answer here:

Community and activity

[]In what ways have you participated in the Thinking Maths online professional community in the last month?

Please choose **all** that apply:

- ☐ I have logged into the Thinking Maths Moodle
- ☐ I have contributed to a forum
- ☐ I have downloaded a resource
- ☐ I have not participated in the online community yet

[]Which of the following Thinking Maths activities have you engaged in during the last month?

Please choose **all** that apply:

- ☐ Completed the readings
- ☐ Wrote in my reflective journal
- ☐ Used resources or materials provided by Thinking Maths
- ☐ Shared evidence of classwork with colleagues based on something from Thinking Maths
- ☐ I have not engaged with Thinking Maths activities yet

[]Which activity above has been particularly useful? Please explain.

Please write your answer here:

Program impact

[]Thinking about your participation in the Thinking Maths program so far, to what extent do the following statements reflect your experience?

Please choose the appropriate response for each item:

	Not yet	To a small extent	To some extent	To a moderate extent	To a great extent
Thinking Maths has helped me to increase student engagement in my maths classes	○	○	○	○	○
Thinking Maths has helped me to better understand maths	○	○	○	○	○
Thinking Maths has helped me to support all students to work at or above grade level	○	○	○	○	○
Thinking Maths has increased my use of effective instructional strategies in my maths classes	○	○	○	○	○
Thinking Maths has increased the extent to which my instruction is aligned with the Australian Curriculum	○	○	○	○	○
Thinking Maths has had an impact on my instructional practices that will last	○	○	○	○	○

Support for implementation

[]To what extent have you felt well-supported over the last month to implement Thinking Maths strategies and activities in your classroom?

Please choose the appropriate response for each item:

	Not yet	To a small extent	To some extent	To a moderate extent	To a great extent
By the Thinking Maths facilitators	○	○	○	○	○
By your school leadership	○	○	○	○	○
By your colleagues	○	○	○	○	○

[]What barriers have hindered your implementation of Thinking Maths strategies or activities with your class during the last month?

Give examples of how these barriers have impacted your practice.

Only answer this question if the following conditions are met:
TOKEN:ATTRIBUTE_4 > 1

Please write your answer here:

[]What has facilitated your implementation of Thinking Maths strategies or activities with your class during the last month?

Give examples of how these facilitators have impacted your practice.

Only answer this question if the following conditions are met:
TOKEN:ATTRIBUTE_4 > 1

Please write your answer here:

[]Please describe ways that the Thinking Maths program, overall, might be improved.

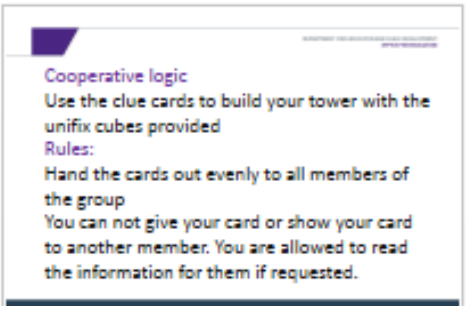
Only answer this question if the following conditions are met:
TOKEN:ATTRIBUTE_4 > 1

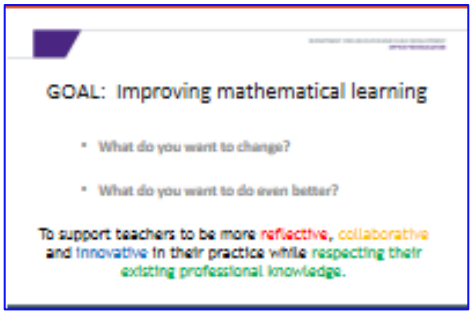
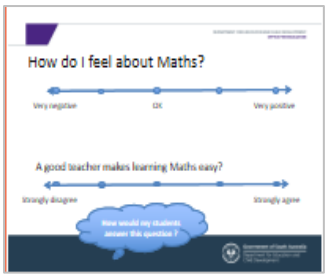
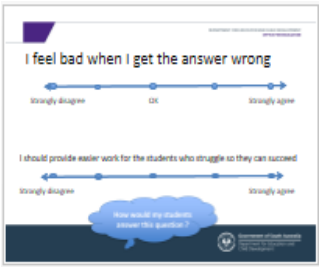
Please write your answer here:

[]Thank you for your time, we do appreciate it.

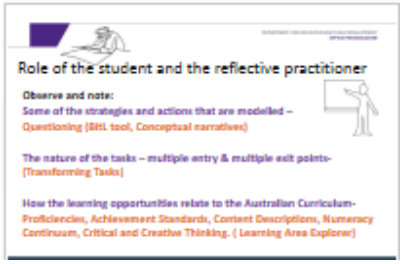
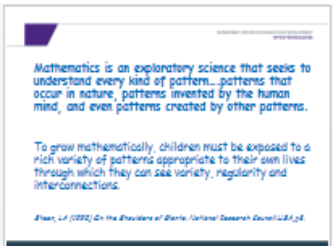
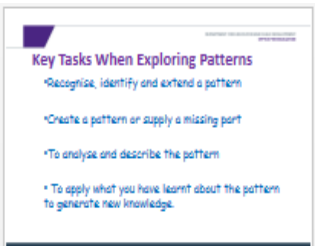
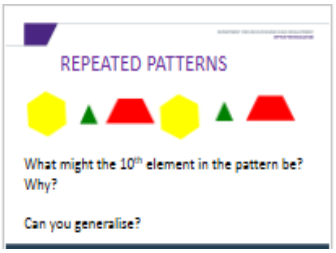
Please click on the 'submit' button below to ensure we receive your responses.

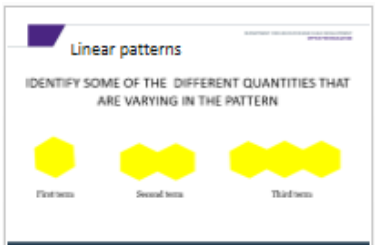
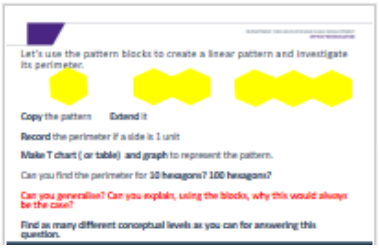
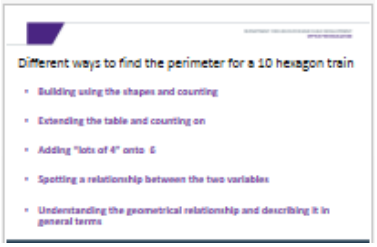
Thinking Maths
Professional Learning Session, Day 1

Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning
8.30 am registration 9am start 15 min	**Whole class:** Patterning and Generalisations (pp101) Introductions and Welcome to Country.  Overview of Thinking Maths and learning objectives. Presenters - Welcome. Distribute participant folder and Van DeWalle reference text Student Centred Learning. Between PL days participants will be directed to read and trail some of the activities in the chapter pertaining to the area of mathematics focussed on in the next PL day. Explain how the Edmodo community will be used to distribute relevant reading provide copies of tasks and is a forum for teacher questions and sharing. All participants are expected to contribute one idea before next PL day. Show the Leading Learning website. Show the animated video 'What is Mathematics For?' If group have not viewed it. Call for people to share 'one thing that stood out for you'.
9.15am	**Group work**: Teachers grouped 5 or 6 to a table, do the Cooperative logic activity. Open ended activity, working together, lots of discussion and engagement. Presenters circulating around tables asking questions, modelling good inquiry, extending understanding. Presenters - Introduce 'Cooperative logic' activity (pp) using very explicit instruction. This activity supports students to work together democratically and focusses on reasoning, communication, in particular, mathematical language. There is also a possibility of an alternative solution depending on interpretation and this encourages negotiation, suggestions for more clarity in the clues. An extension is to get students to develop their own sets of clues for their mystery tower (personalising their learning and creating their own knowledge).  

Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning
9.30	**Whole class:** Presenters – Discussion about: • Definitions and speaking the same language. Intention of the activity, content, process, teamwork, collaboration, mirror/reflection/rotation/visualisation. • Creating a culture – explaining right or wrong, creating a less threatening environment, asking lots of questions, modelling good pedagogy (e.g. Was there only one way to do it? Where might this go?). Asking questions that provide intellectual stretch (e.g. What are you going to do now? Record it, design their own, describe the clues yourself is challenging). • Lesson approach – warm up activity (valuing the class), body of lesson, tying it all together by sharing at end. Warm up activity can be ambiguous. It doesn't need to be perfect and in fact if it isn't, it provides an important chance to discuss how it could be improved, which shifts the 'expert' away from the teacher.
9.40	**Whole class:** Presenters – Discussion about GOALS of this course (pp)  This is a personal and collaborative journey. Reflect on your practice, your classroom, your students. What do you do well and don't want to lose? What frustrates or worries you in relation to student learning? What do you want to change? Make it context relevant. 'We are not the experts' so it's very important to share your professional knowledge with others on your table.
9.45	**Individual work:** How do I feel about Maths? (pp) Attitudes, beliefs and dispositions affect the learning environment that we create when learning mathematics/ What experiences have forged your attitudes and dispositions towards mathematics? What about your students? Consider, in particular those learners who are upmost in your mind as the ones who need more support and those who need more challenge?   

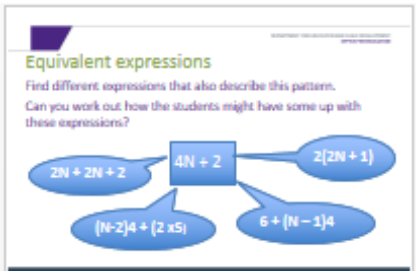
Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning
	Teachers complete the following form, as a pre-assessment of their views about maths. 
9.50	**Whole class discussion**: When do you reward the classroom?  Trying not to focus just on when they get it right. Think deeply about when you reward and what messages you are sending. The Free Online course is a short accessible experience for all teachers and many have used these provocations with their students tochallenge their beliefs about themselves as mathematicians. The section that Jo Boaler presents on Brain Plasticity has a huge impact on the majority of participants because it challenges the widely held belief that you either can or can't do Maths and it is a fixed ability. You-tube clips: growth mindset and brain plasticity : http://learnteachlead.ca/projects/jo-boaler/?video=0&active=0:http://www.youcubed.org/brain-science/ What messages are kids getting (e.g. parent wasn't good at maths; sent to the floor for support because 'you're' not good at maths). Promote a 'mind growth' headset. Kids do think that they are rubbish and you have to overcome their negative thinking and beliefs. Are we offering the same opportunities and experiences for success to all kids?

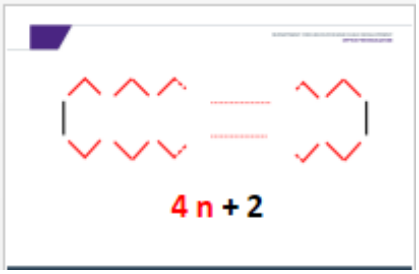
Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning
10.00	**Whole class:** Our learning intention is to build on your existing good practice for effective teaching and learning of Mathematics (pp).  Not setting these tasks to see what you can or cannot do nor how fast you can do it. You need to keep two students in your mind at all times. Would this activity have an appropriate entry point and exit point for both these very different learners. Teachers have 2 roles – 1) the student; 2) the reflective practitioner (pp). Presenters - Observe the way we have asked questions, how we model good teaching behaviour.  Participants are challenged to wear 2 hats. One as a learner as they tackle the tasks (metacognition). Also their feelings and emotions- putting them in the place of the learners in their class. The other as the reflective practitioner who is noticing the presenter's learning design, questioning, responsiveness and how that impacts the learners in this task.
10.10	**Whole group:** "shoulders of giants" – sets the scene. Presenters - The focus for today is Patterning and algebraAlgebra. Discussion – evidence of good maths thinking - it is important for teachers, in particularly secondary, to reconceptualise algebra as more 'algebraic thinking' rather than abstract representations and rules. Repeated patterns activity (pp) – 1 minute.   

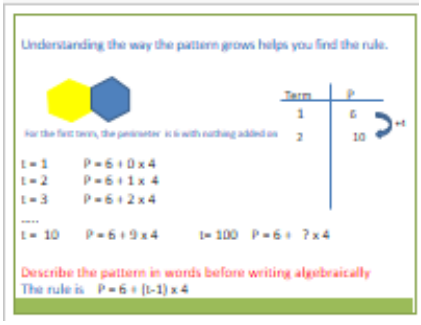
Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning
10.20	**Group work:** Linear patterns. (pp1) There are a number of quantities varying in this pattern. The number of hexagons, the number of vertices (corners), the area of the train, the perimeter, the number of vertical sides, the number of oblique sides (on an angle). We are going to explore two of these, the number of hexagons and the perimeter of the shape. (pp2) In this example a physical model is used to identify a linear pattern. Students can link a numerical pattern to a spatial concrete model. They can identify and describe the pattern in words and generalise it to a longer train. The goal of this learning is NOT 'to find the formula'.  
11.00	Morning break
11.20	**Whole group discussion**: In the discussion about the activity, encourage participants to think about how algebraic thinking develops. The most important thing is to discourage the "quest" for a formula. Require all students to describe their pattern in words before they attempt an abstract algedraic expression if in fact they ever do. They can generalise without doing this. Reward good thinking, reward early. Identify what the learning intention might be that you want all learners to achieve. Accept and in fact encourage that everyone will have a different experiences and hence different learning outcomes that are meaningful to them. Discussion on trying to change culture about 'algebraic thinking' – numbers and patterns. "I use to be good at maths until they mixed in the alphabet". 
12.00	**Whole group:** Equivalent expressions – independent and dependent bariables – be explicit and link to real world examples (science). How do these expressions connect to 1. a verbal explanation of the pattern2. the geometrical construction of train eg. 4n plus 2 . The 2 are the first vertical side and the last. The lots of 4 refer to the two top and two bottom sides in a v formation for each hexagon. Can you explain how the other students saw the pattern developing? This exercises also demonstrates to students that algebraic expressions can look very different but still give the same value (answer) for every train.

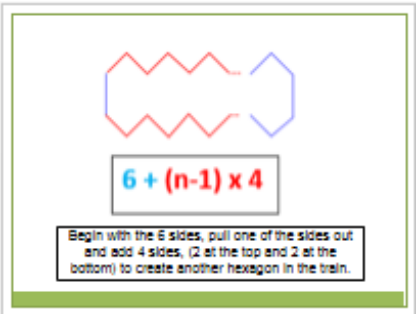
Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning

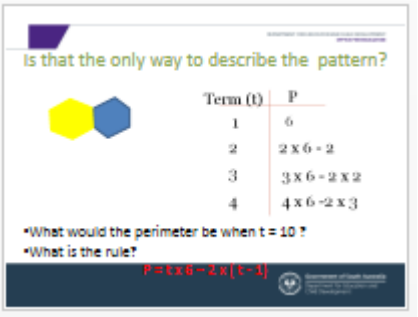
There is a need to be able to simplify different algebraic expressions to get them into a simpler form and also to be able to see which ones are effectively the same.

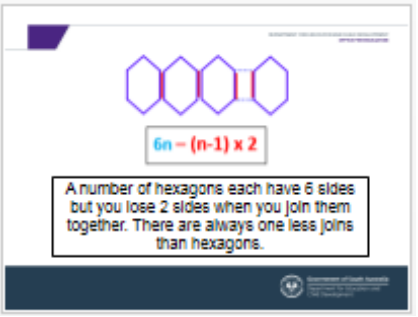


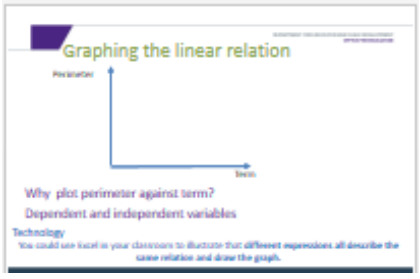




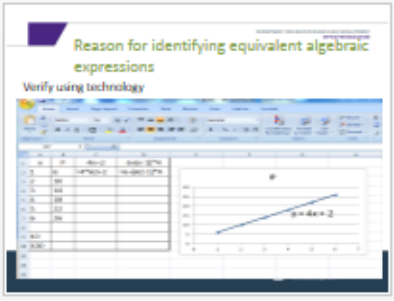
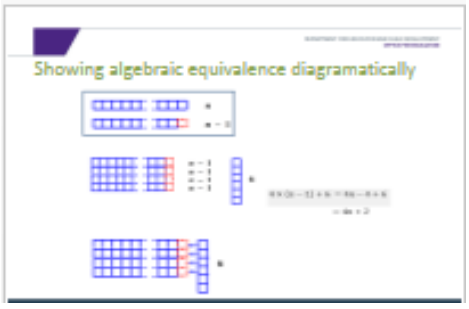
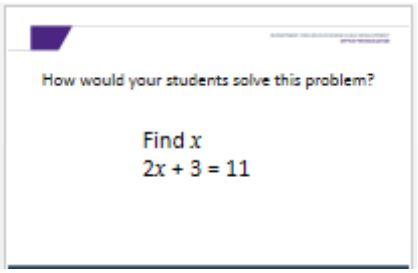
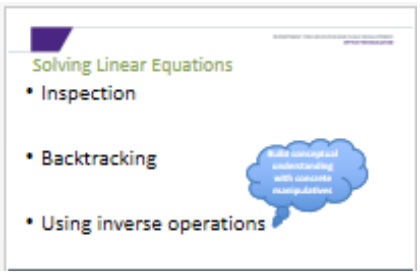








Graphing is a great way to visually represent a linear pattern. Here the Term (or the No. of hexagons) is the independent variable because we are controlling this by increasing the train by adding on hexagon each time. The Dependent variable id the Perimeter because the perimeter depends on the no. of hexagons in the train. Why is the graph useful? We can see the linear pattern but really we should not join the points with a line as, in this case, the no. of hexagons can't be a fraction. Mathematicians use a dotted line in this case. The line can be continued to predict perimeters of trains we have not built. We could also look at perimeters on the vertical axis and read across and down to find out how many hexagons we would need. This also introduces to the idea of 'slope' of a line. Every hexagon we add increases the perimeter by 4 and this is constant for a linear pattern.

Session Map	Thinking Maths PL Day 1: Patterning and Generalisations | Differentiating Learning
	A short clip explains this process it has been recorded using free software called Jing and it can be viewed using Medialite (free download). It shows how Excel can be used to check if algebraic expressions give the same answers. It does not prove it as you can't check every possible number but it does verify that it is working for some. Students are introduced to using formulae and graphing using Excel. They can pause and review. They can also easily make their own Jings to demonstrate their understanding of other using the technology and representing patterns graphically using technology.  
12.15	**Group task:** How would your students solve…   Secondary teachers will solve this problem using an inverse operations algorithm with almost identical setting out. Primary teachers often use more conceptual methods similar to the very visual Singaporean Bar method. This activity highlights the different approaches taken by the 2 sectors of schooling. The Primary method has a strong conceptual basis and is good mathematical thinking. It is not necessarily a method that is transferable to more complex equations (non-linear). The secondary method is highly abstract and can be performed as an algorithm with limited understanding. Inverse operations is transferable to more complex equations and it conforms with written mathematical protocols. While both methods have benefits the concern is that the connections and contrasts may not discussed part of the student learning. Secondary teachers may not be recognising and building on prior learning. Primary teachers may not be exposing their learners to the formal written language of mathematics. National Library of Virtual Manipulatives: have digital objects which support both the concrete and abstract methods of solving linear equations. http://nlvm.usu.edu/en/nav/category_g_3_t_2.html
1.00	Lunch break

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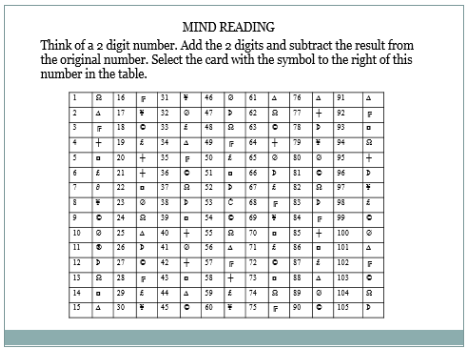
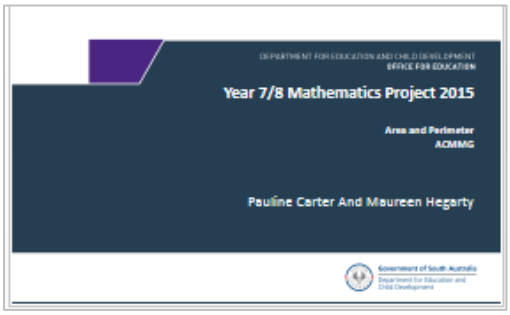
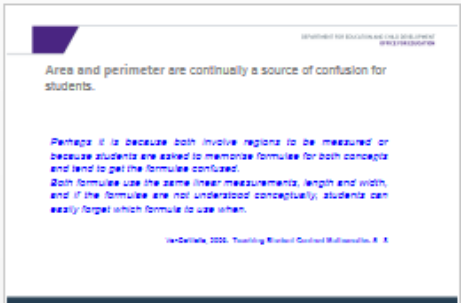
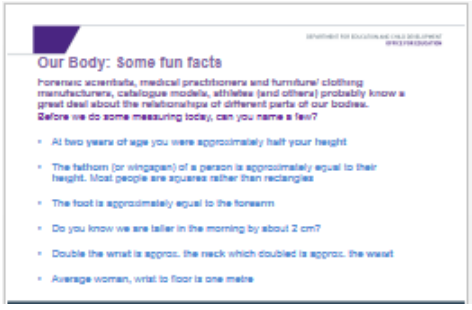
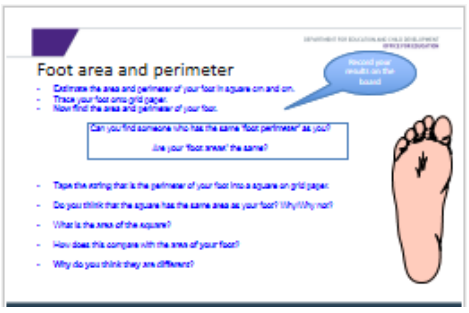
1.35	**Whole group:** Mind reading activity (pp103) – to engage and get them on board. Mind reading. Use an accomplice to change the power point grid when students are not watching. Get a student to come to the white board and perform the calculation for a 2 digit number. Give them a set of cards with the symbols on them and you also hold a set. Think of a 2 digit number. Add the 2 digits and subtract the result from the original number. Select the card with the symbol to the right of this number in the table.  MIND READING Think of a 2 digit number. Add the 2 digits and subtract the result from the original number. Select the card with the symbol to the right of this number in the table. Before you ask the student to hold up the card with the symbol on give your card with the symbol which is next to the multiples of 9 on this particular grid to a student near you. Ask both students to hold up their cards.
1.50	**Individual task:** Our body – area and perimeter (pp 103).  Year 7/8 Mathematics Project 2015 Area and Perimeter AOMMG Pauline Carter And Maureen Hegarty  Area and perimeter are continually a source of confusion for students. Perhaps it is because both involve regions to be measured or because students are asked to memorise formulae for both concepts and tend to get the formulae confused. Both formulae use the same linear measurements, length and width, and if the formulae are not understood conceptually, students can easily forget which formula to use when. Estimate the area of your foot. Tables contain a range of materials – grid paper, string, scissors, pencils, etc.  Our Body: Some fun facts Forensic scientists, medical practitioners and furniture/ clothing manufacturers, catalogue models, athletes (and others) probably know a great deal about the relationships of different parts of our bodies. Before we do some measuring today, can you name a few? • At two years of age you were approximately half your height • The fathom (or wingspan) of a person is approximately equal to their height. Most people are squares rather than rectangles • The foot is approximately equal to the forearm • Do you know we are taller in the morning by about 2 cm? • Double the wrist is approx. the neck which doubled is approx. the waist • Average woman, wrist to floor is one metre  Foot area and perimeter • Estimate the area and perimeter of your foot in square cm and cm. • Trace your foot onto grid paper. • Now find the area and perimeter of your foot. Record your results on the board Can you find someone who has the same 'foot perimeter' as you? Are your 'foot areas' the same? • Tape the string that is the perimeter of your foot into a square on grid paper. • Do you think that the square has the same area as your foot? Why/Why not? • What is the area of the square? • How does this compare with the area of your foot? • Why do you think they are different? Estimation is very valuable in getting students thinking about what would be a reasonable answer. It also stimulates student thinking in a safe environment where everyone can have a guess. Allow students to change their estimate with reasons, once they have more information but always keeping a record of their thinking.

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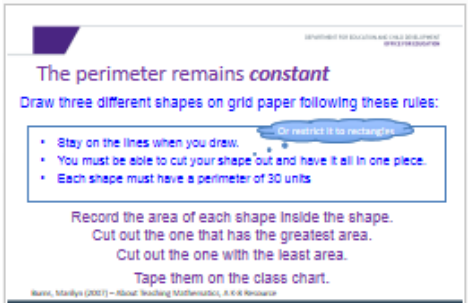
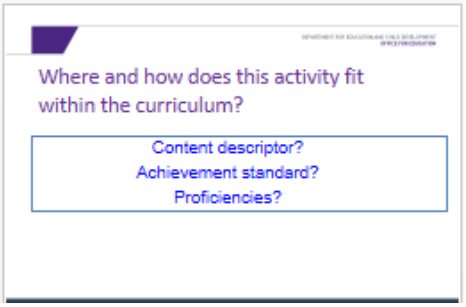
	For some learners, it is counter-intuitive that shapes with the same perimeter have different areas. The foot perimeter & area data confronts learners with this misconception and their first response is often that an error has been made. A demonstration of a loop of string formed into square slowly reshaped into a very long thin rectangle. Finally into a line with zero area, further challenges that misconception.   The square has the maximum area for a shape drawn on grid paper but a circle would be the shape with overall maximum area. In 3D a bubble forms into a spherical shape to maximise volume and minimise surface area. How would this fit into your curriculum? Where and how would you use it? Reference this activity to the TfEL Learning Area Explorer for Year 7 and Year 8. See how the concepts develop over time. Note that the task covers more than one area of mathematics and more than one substrand. Check also, the 4 Proficiencies and the Achievement Standards. It is also important to check the General Capability Continua, in particular those of Numeracy and the Critical and Creative Thinking (CCT). Teachers often find it difficult to develop students in CCT. The continuum for this capability can be used to determine the level of student thinking in the task design and also in students' work.
2.50	**Whole group:** Reading reflection chapter 19. Developing in and between unit work measurement concepts. • Commitment to action - do something in the next 24 hrs that you have learnt from today. • Something you have tried – bring something to share. • Next date – do reading for discussion at start of next session. • What worked well? What could be improved? Sticky notes completed by teachers as they leave.
3pm	Finish