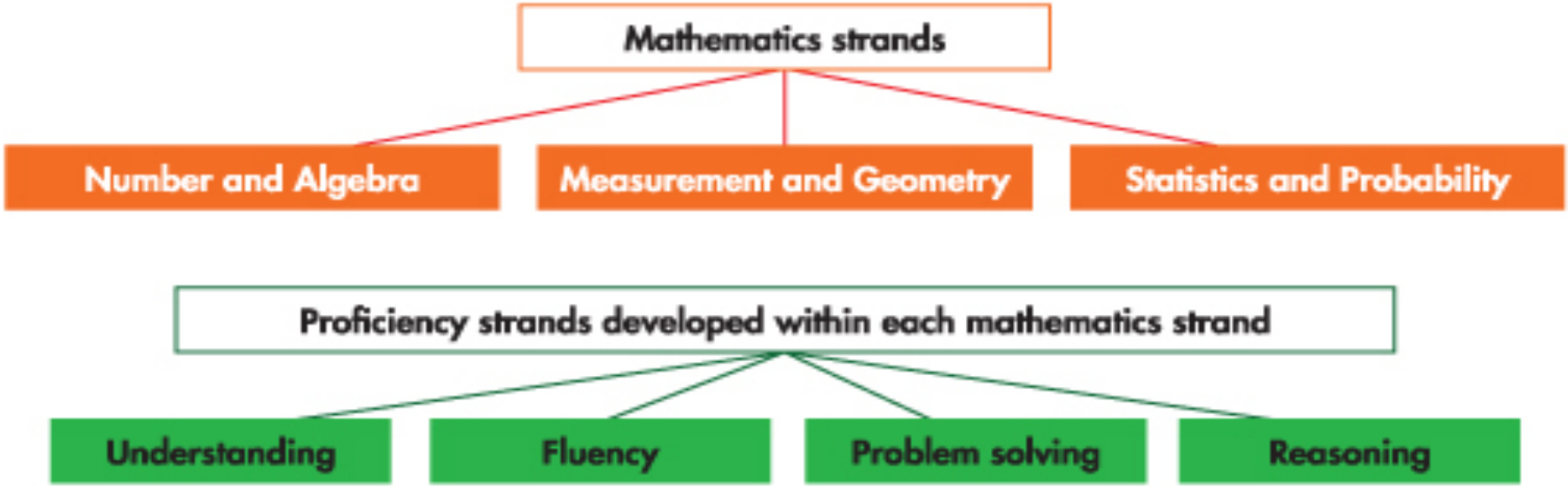
PROFICIENCIES

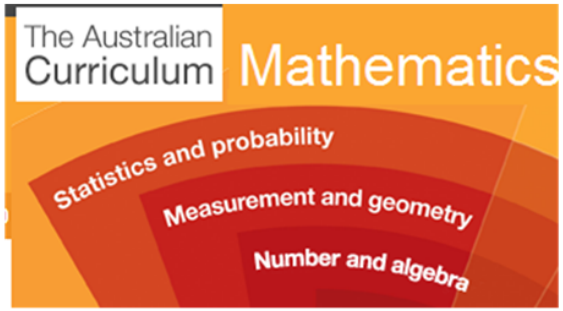
STRAND

Building teachers' pedagogy practices in reasoning, to improve students' dispositions towards Mathematics

The Australian Curriculum: Mathematics is organised around the interaction of three content strands and four proficiency strands.
The **content strands** are *Number and Algebra*, *Measurement and Geometry*, and *Statistics and Probability*. **They describe what is to be taught and learnt.**



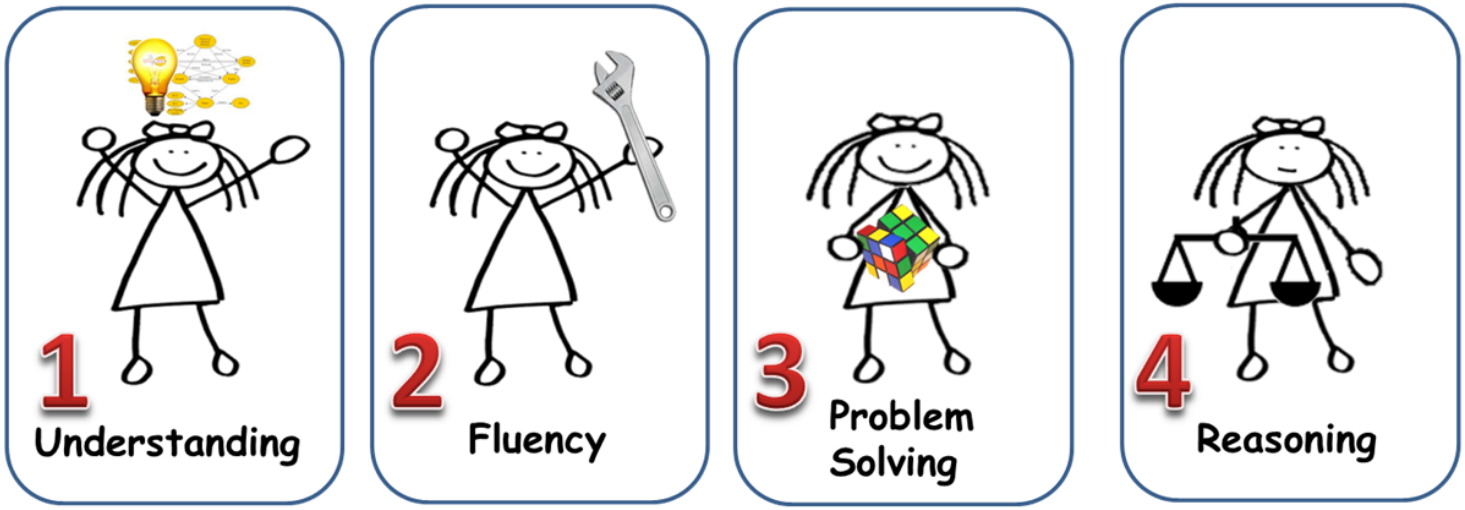
The **proficiency strands** are *Understanding*, *Fluency*, *Problem Solving*, and *Reasoning*. **They describe how content is explored or developed, that is, the thinking and doing of mathematics. They provide the language** to build in the developmental aspects of the learning of mathematics and have been incorporated into the content descriptions of the three content strands described above.



The Four Proficiency Strands

aka "Working Mathematically"

http://www.australiancurriculum.edu.au/Mathematics/Content-structure



*Conceptual Understanding**

Procedural Fluency

Strategic Competence

Adaptive Reasoning

* See also Chapter 2 of Peter Sullivan's 2011 ACER report at http://research.acer.edu.au/aer/13/

http://exzuberant.blogspot.com.au/2011/10/working-mathematically-picture-essay.html

What the world needs:

What mathematicians do:

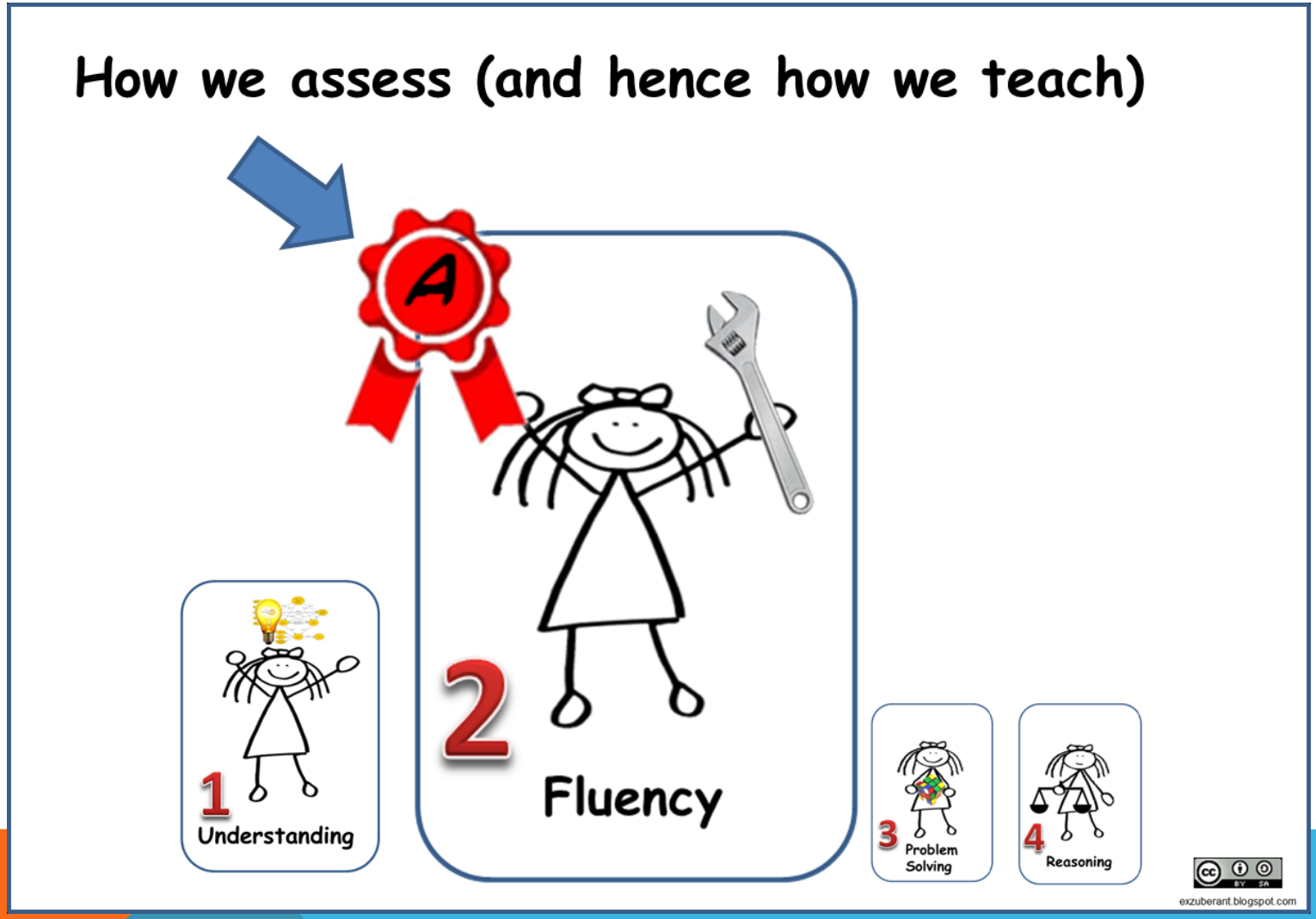
1 Understanding

2 Fluency

3 Problem Solving

4 Reasoning

Calculators & Wolfram Alpha will help me with this.


How we assess (and hence how we teach)
A
1
Understanding
2
Fluency
3
Problem Solving
4
Reasoning
exzuberant.blogspot.com

BUT WHY?

PRODUCTIVE DISPOSITION

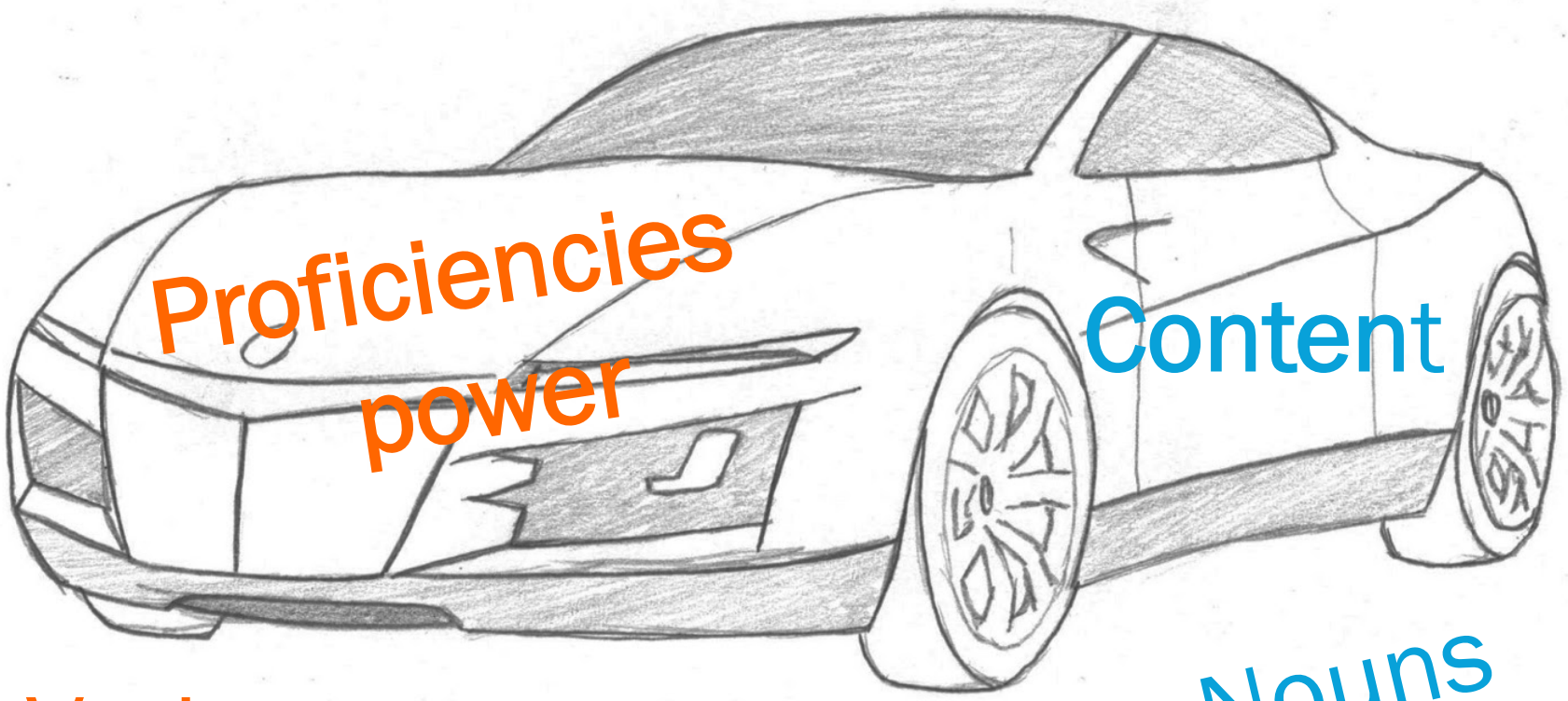
The Fifth Proficiency

"I can do mathematics."
"Mathematics is fun and useful."
There's a place in my life for maths."
.....hard to assess, and not in the Australian Curriculum ... but perhaps the most important of all?

Engaging in mathematical activity is the key to success. Seeing mathematics as sensible, useful, and doable—if you work at it—and being willing to do the work. Developing a productive disposition requires frequent opportunities to make sense of mathematics, to recognize the benefits of perseverance, and to experience the rewards of sense making in mathematics.

MINDSET

PROFICIENCIES GIVE POWER TO THE CONTENT



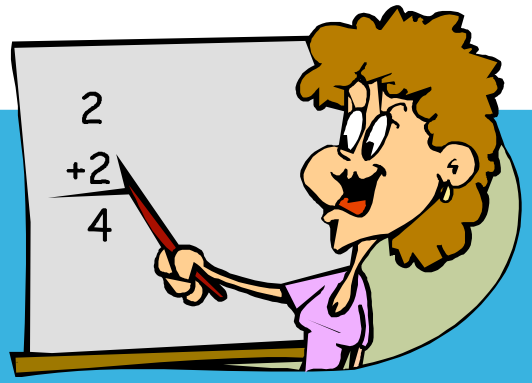
Verbs

Nouns

DEFINITIONS

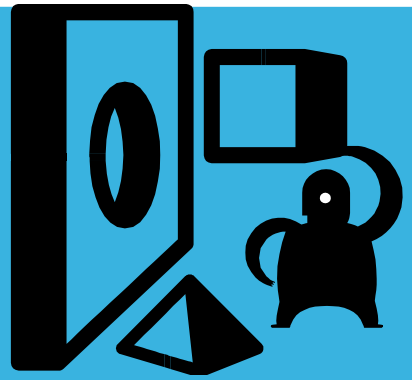
In the curriculum they are described in the following way by the writers.

Fluency involves students developing skills in choosing appropriate procedures, carrying out procedures flexibly, accurately, efficiently and appropriately, and recalling factual knowledge and concepts readily. Students are fluent when they calculate answers efficiently, when they recognise robust ways of answering questions, when they choose appropriate methods and approximations, when they recall definitions and regularly use facts and, when they can manipulate expressions and equations to find solutions.

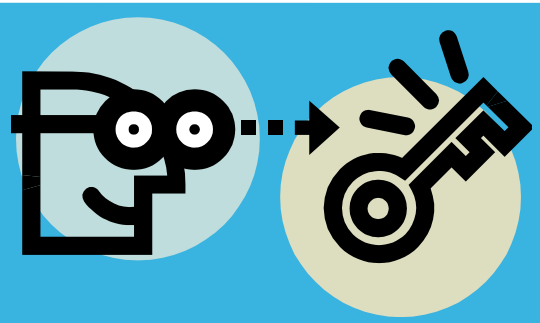


Reasoning involves students developing an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising. Students are reasoning mathematically when they explain their thinking, when they deduce and justify strategies used and conclusions reached, when they adapt the known to the unknown, when they transfer learning from one context to another, when they prove that something is true or false and when they compare and contrast related ideas and explain their choices.

Problem Solving involves students developing the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively. Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable.

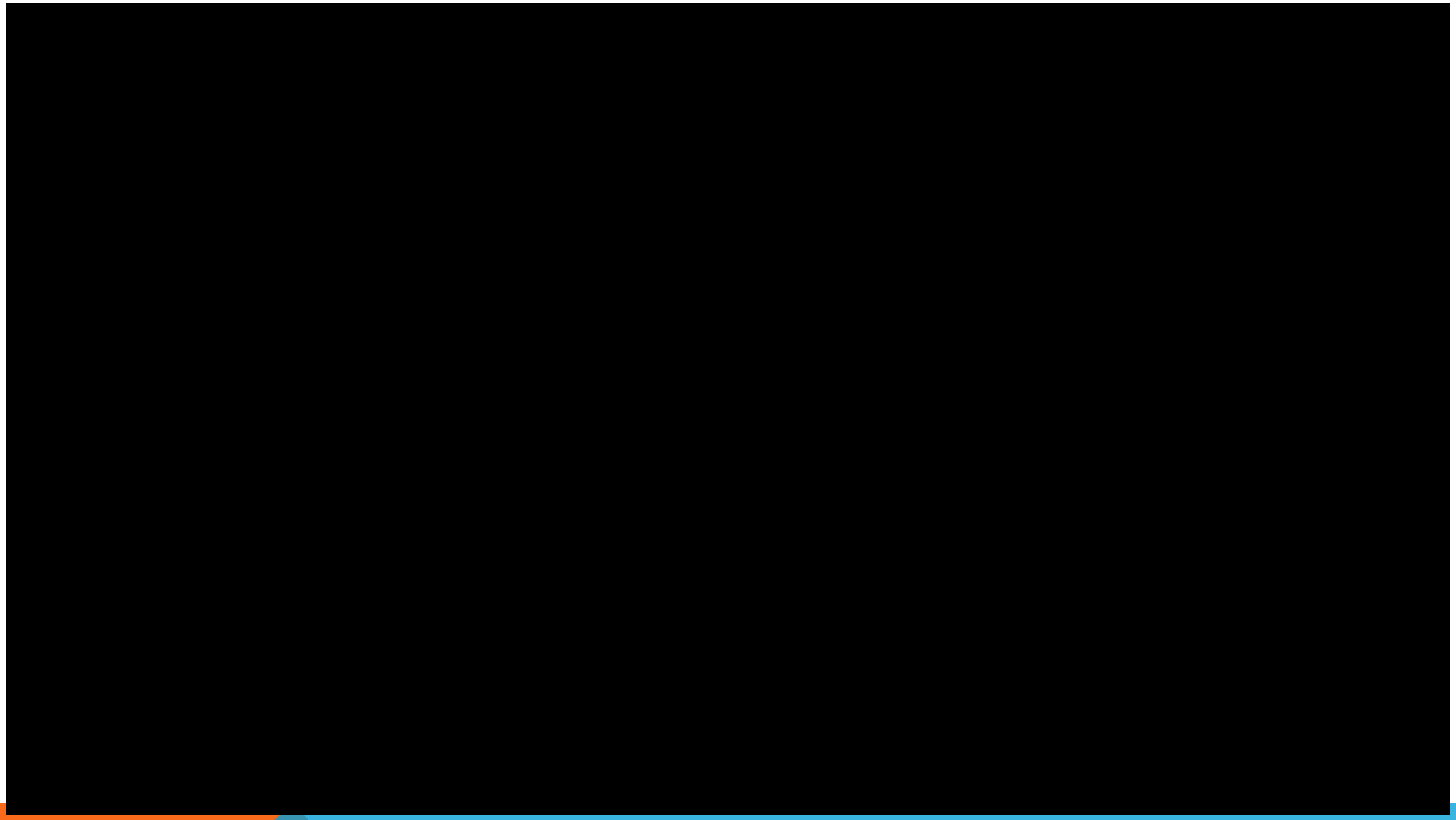


Understanding involves students building a robust knowledge of adaptable and transferable mathematical concepts. They make connections between related concepts and progressively apply the familiar to develop new ideas. They develop an understanding of the relationship between the 'why' and the 'how' of mathematics. Students build understanding when they connect related ideas, when they represent concepts in different ways, when they identify commonalities and differences between aspects of content, when they describe their thinking mathematically and when they interpret mathematical information (ACARA., 2010).



http://www.youtube.com/watch?v=EgEkjMRxOtg

Experience should precede instruction.



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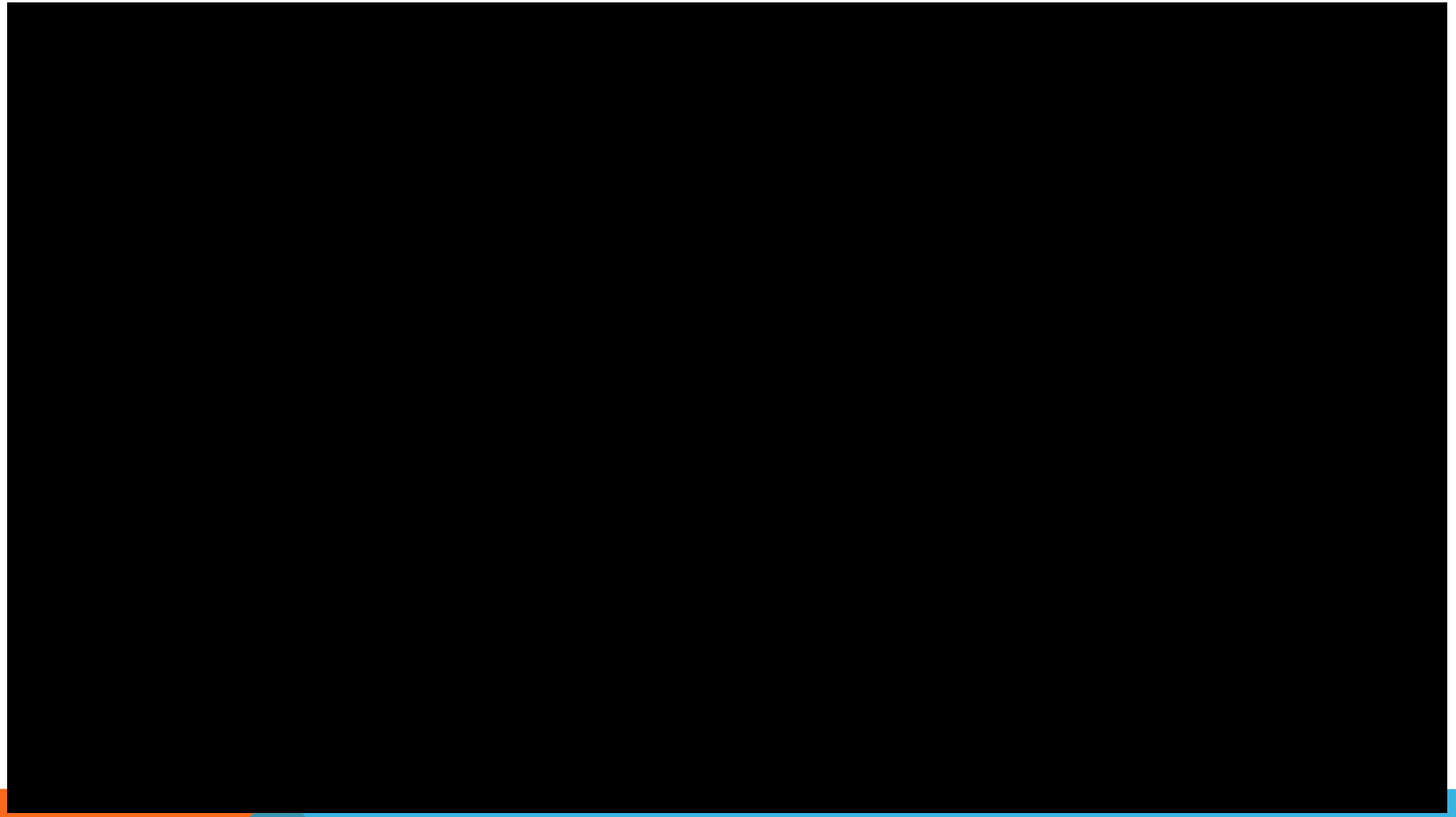
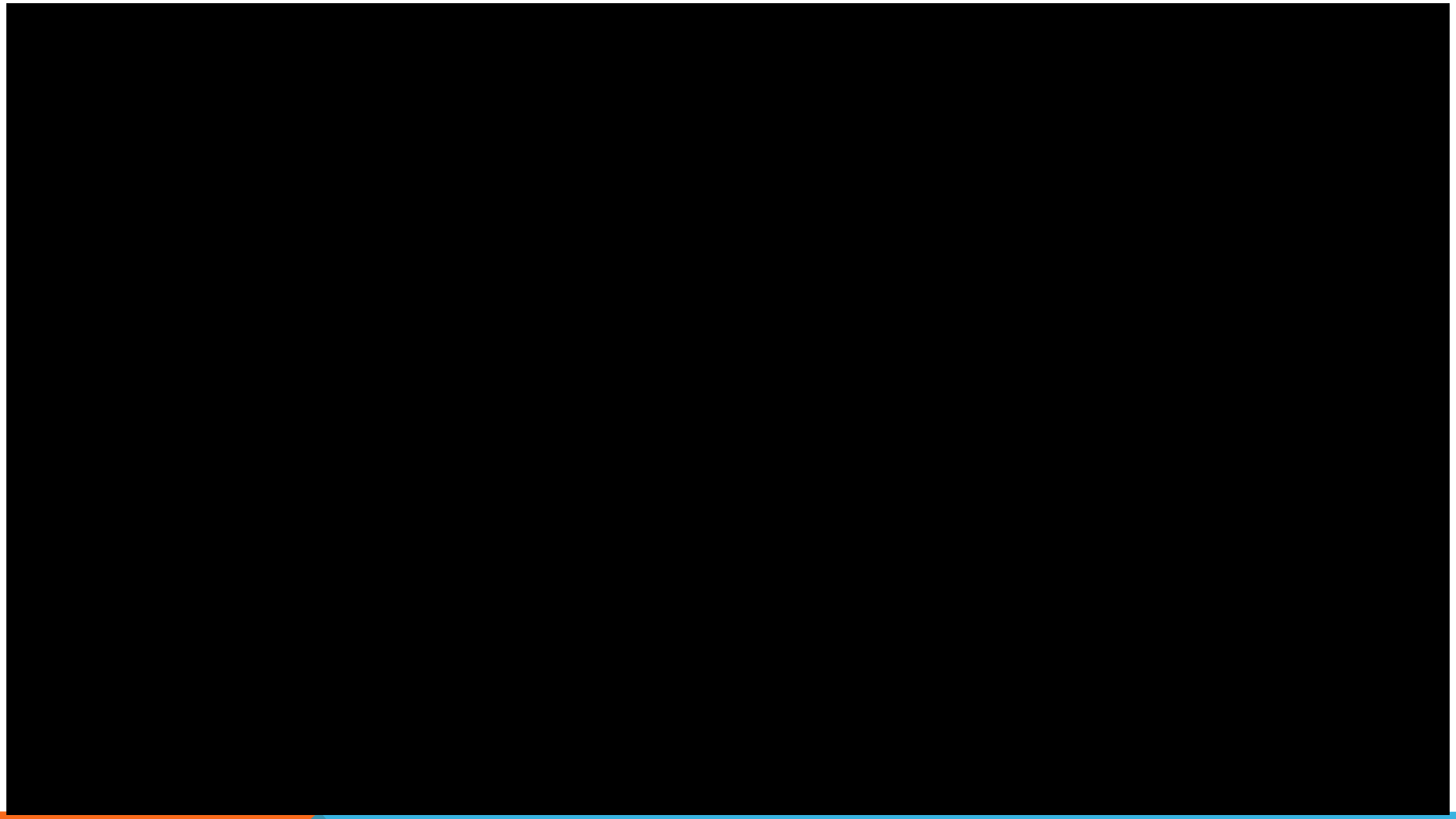
https://www.youtube.com/watch?v=89YWHwlR5u0



http://www.youtube.com/watch?v=450-Z-UirOE

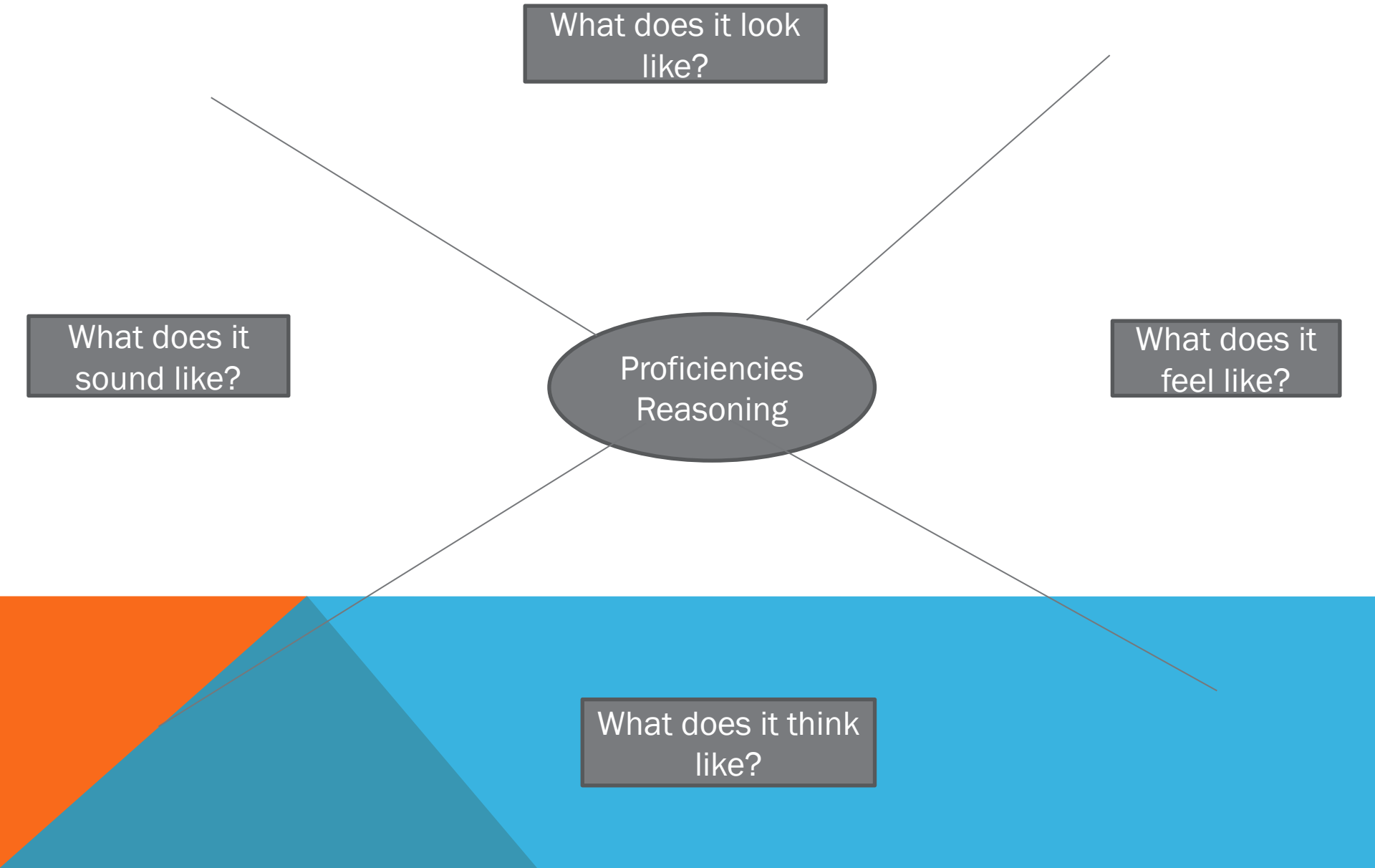


https://www.youtube.com/watch?v=tbjqfTaT5co

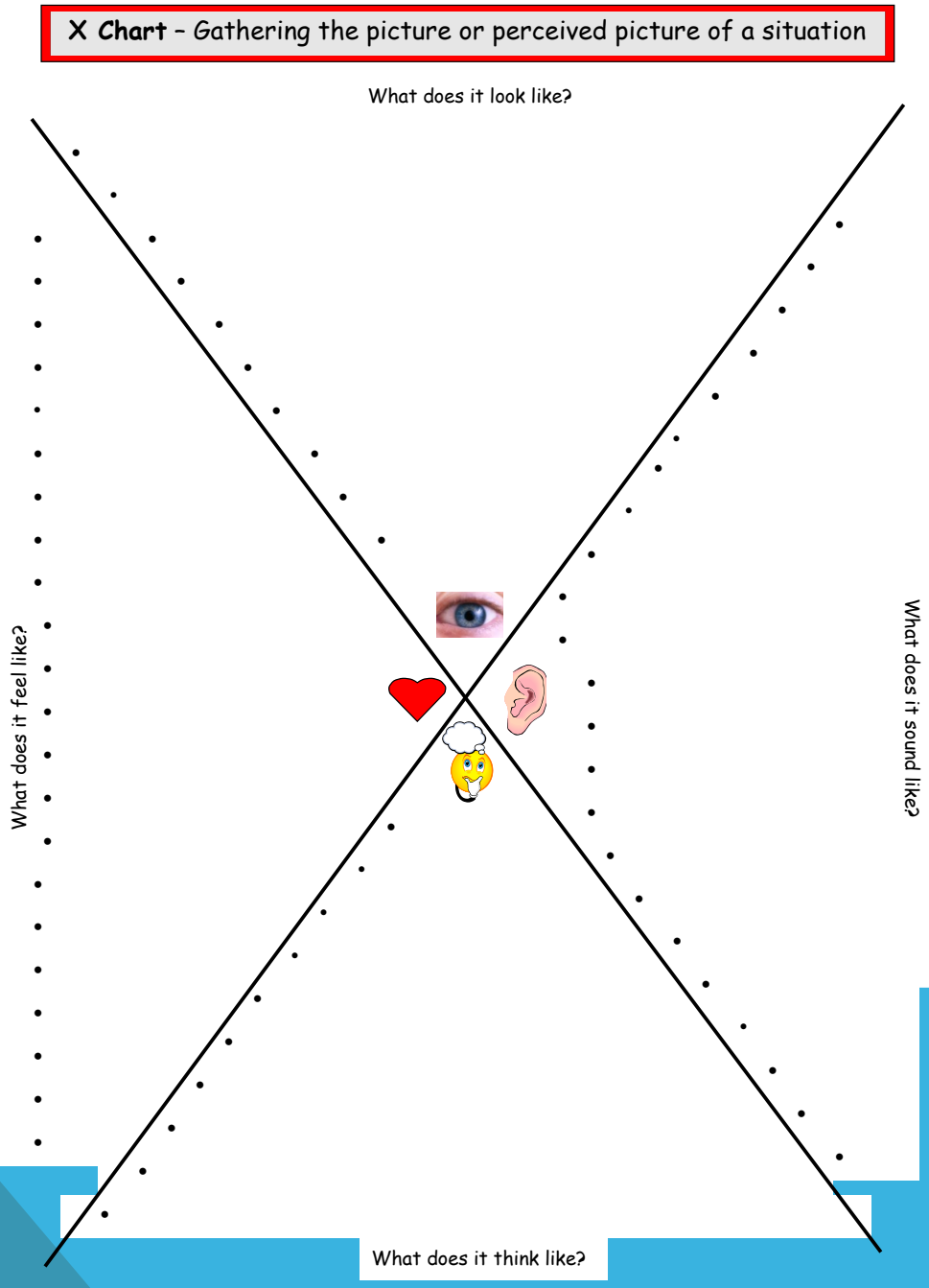
HTTPS://WWW.YOUTUBE.COM/WATCH?V=BXRPY1FJVU4

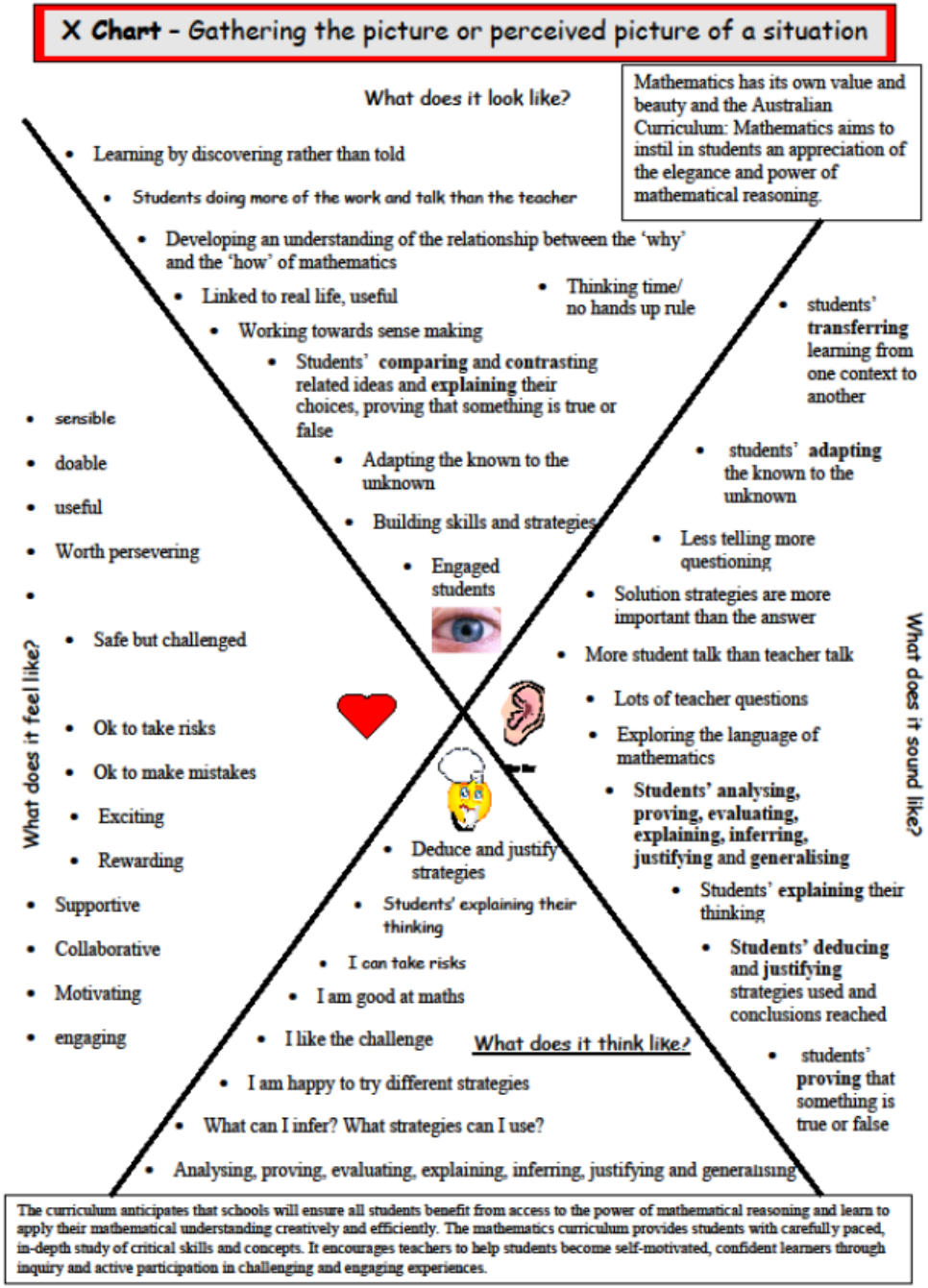
Jo Boaler

Gathering the picture or perceived picture of a situation



DEVELOP THIS X CHART TO ENCAPSULATE WHAT REASONING LOOKS, FEELS, THINKS AND SOUNDS LIKE.





The curriculum anticipates that schools will ensure all students benefit from access to the power of mathematical reasoning and learn to apply their mathematical understanding creatively and efficiently. The mathematics curriculum provides students with carefully paced, in-depth study of critical skills and concepts. It encourages teachers to help students become self-motivated, confident learners through inquiry and active participation in challenging and engaging experiences.

The Questions

Pedagogy

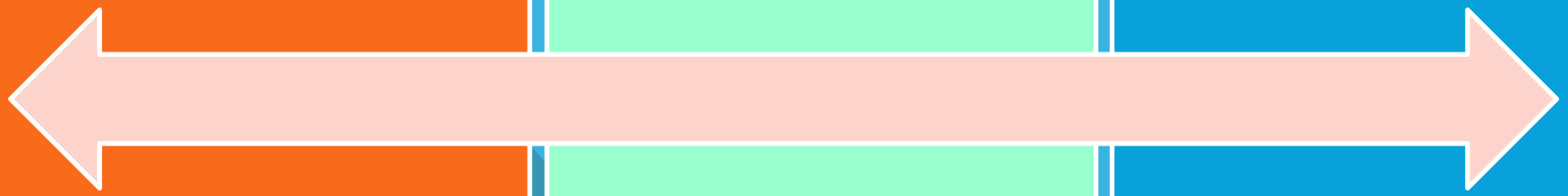
What pedagogical practices are deemed suitable for implementation and maintenance of the strand reasoning?

Reasoning

To what extent are students' mathematical dispositions increased with the inclusion of reasoning and suitable pedagogical practices?

Disposition

What conclusions can be drawn about pedagogical practices, student dispositions and the inclusion of reasoning?



Theoretical Framework

Constructivism

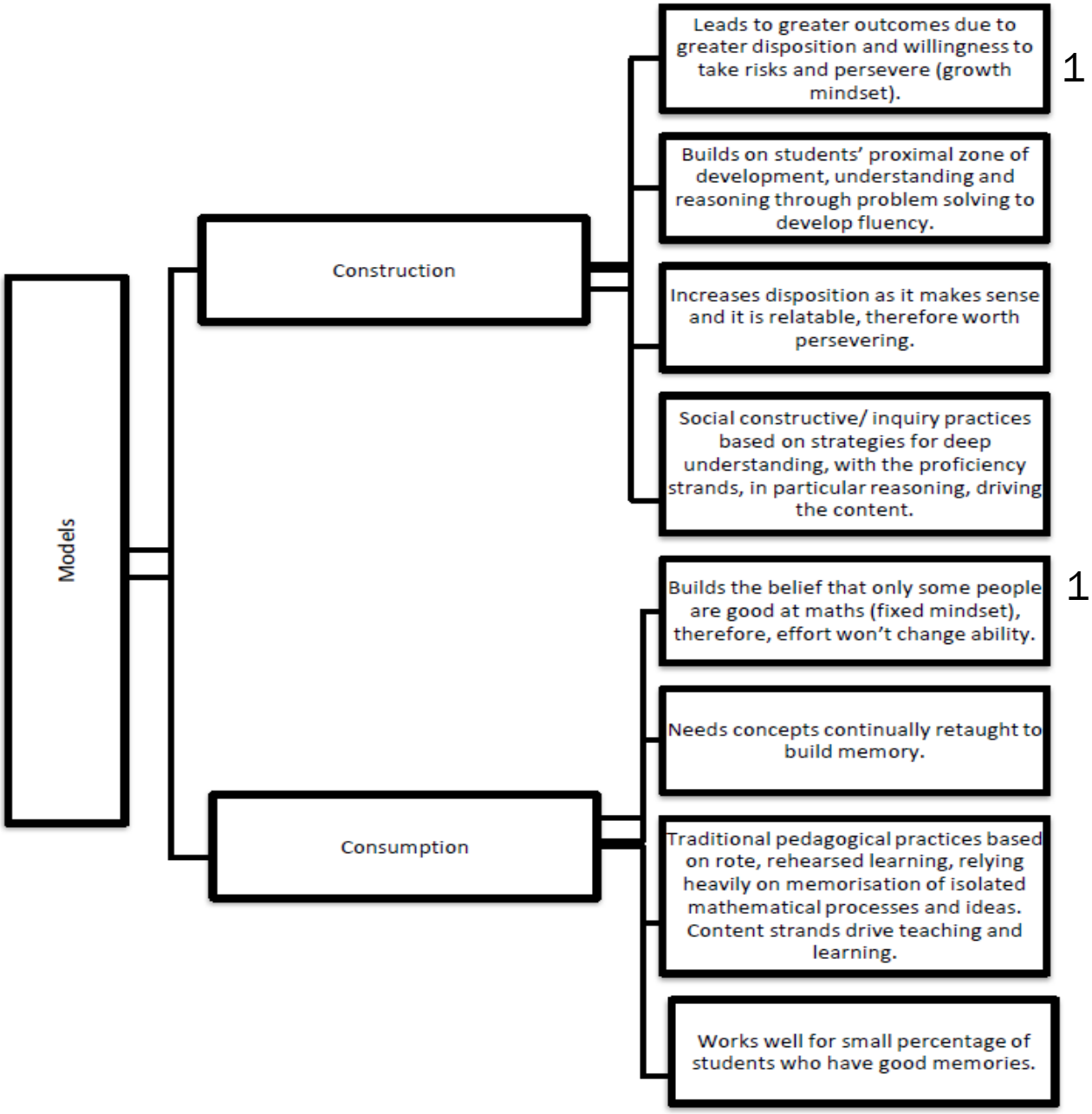


Figure 6.1. Construction and consumption models.

A repertoire of pedagogical practices that take into account the proficiencies in mathematics teaching and learning.

Discussion

Journaling

Planning for reasoning

Inquiry questioning

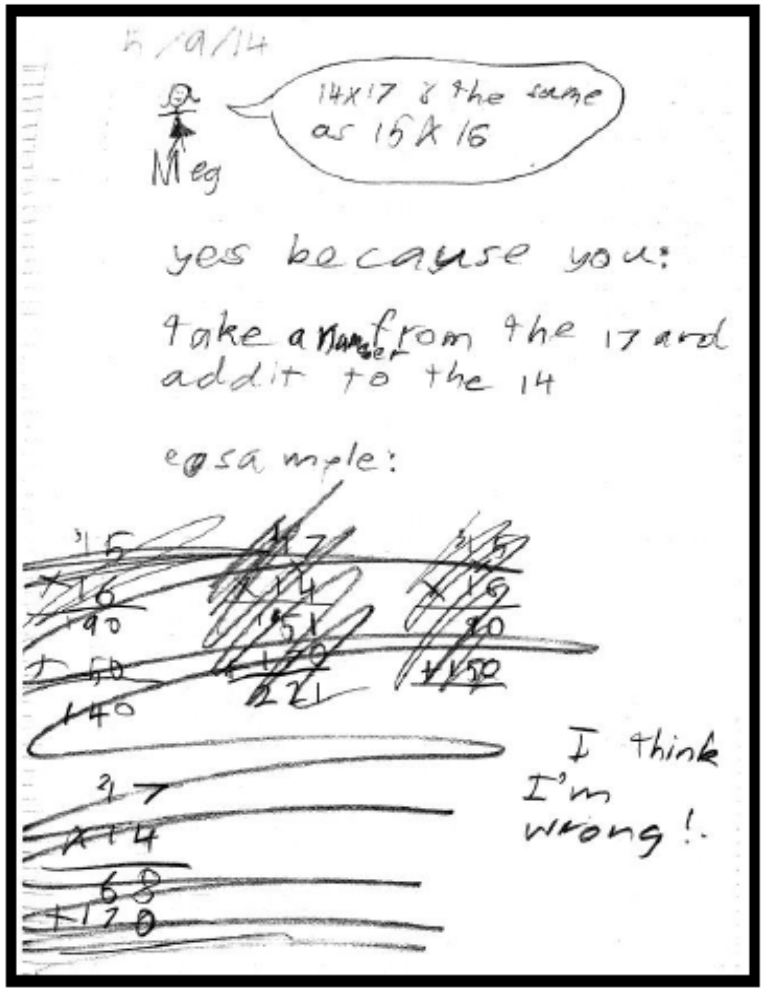
Rich tasks

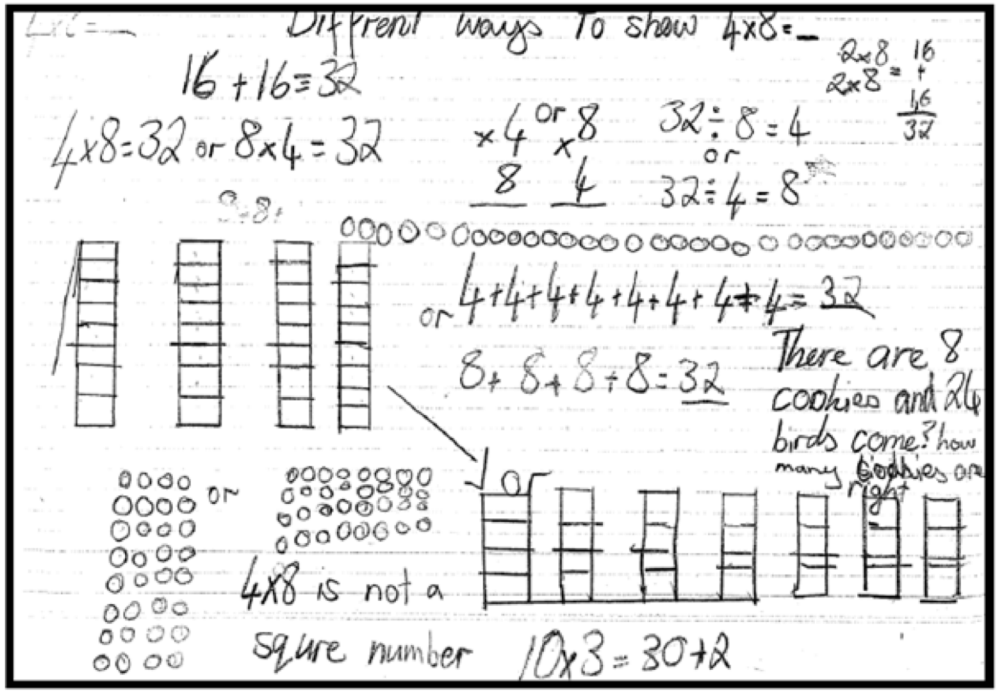
materials

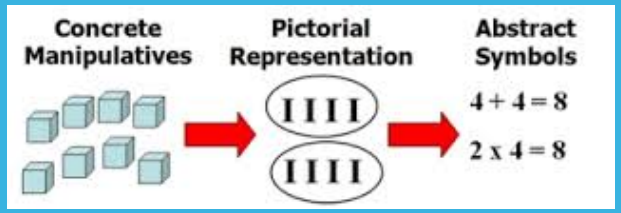
Problem solving Inquiry

Journaling

http://www.ascd.org/publications/educational-leadership/feb17/vol74/num05/Why-Should-Students-Write-in-Math-Class¢.aspx







Explore different ways to do things

6 +3=9
but so does 5+4

The way you do things is not always the only way to do them.

Respect other people's way of thinking.

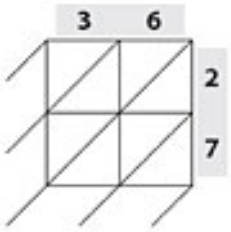
Why/ How does this work?

36 x 27 = What?

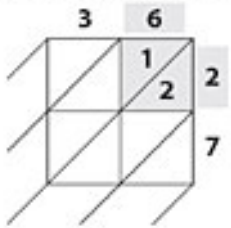
```
  36
x 27
 252
+72
 972
```

The traditional solution at left gives you the same result as a multiplication grid, an alternate way to solve math problems:

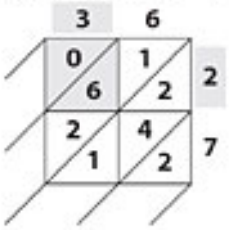
1. Set it up on a grid like this:



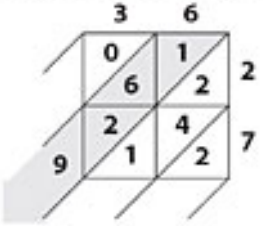
2. Since 6 x 2 = 12, insert the "12" in the triangles like this:



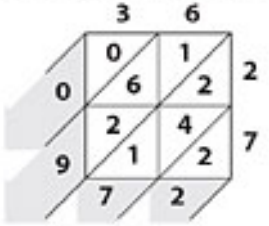
3. Fill out the rest. Use a zero if it's less than 10, as with 3 x 2 = 6:



4. Time to think diagonally. Add each column, like 1 + 6 + 2 = 9:

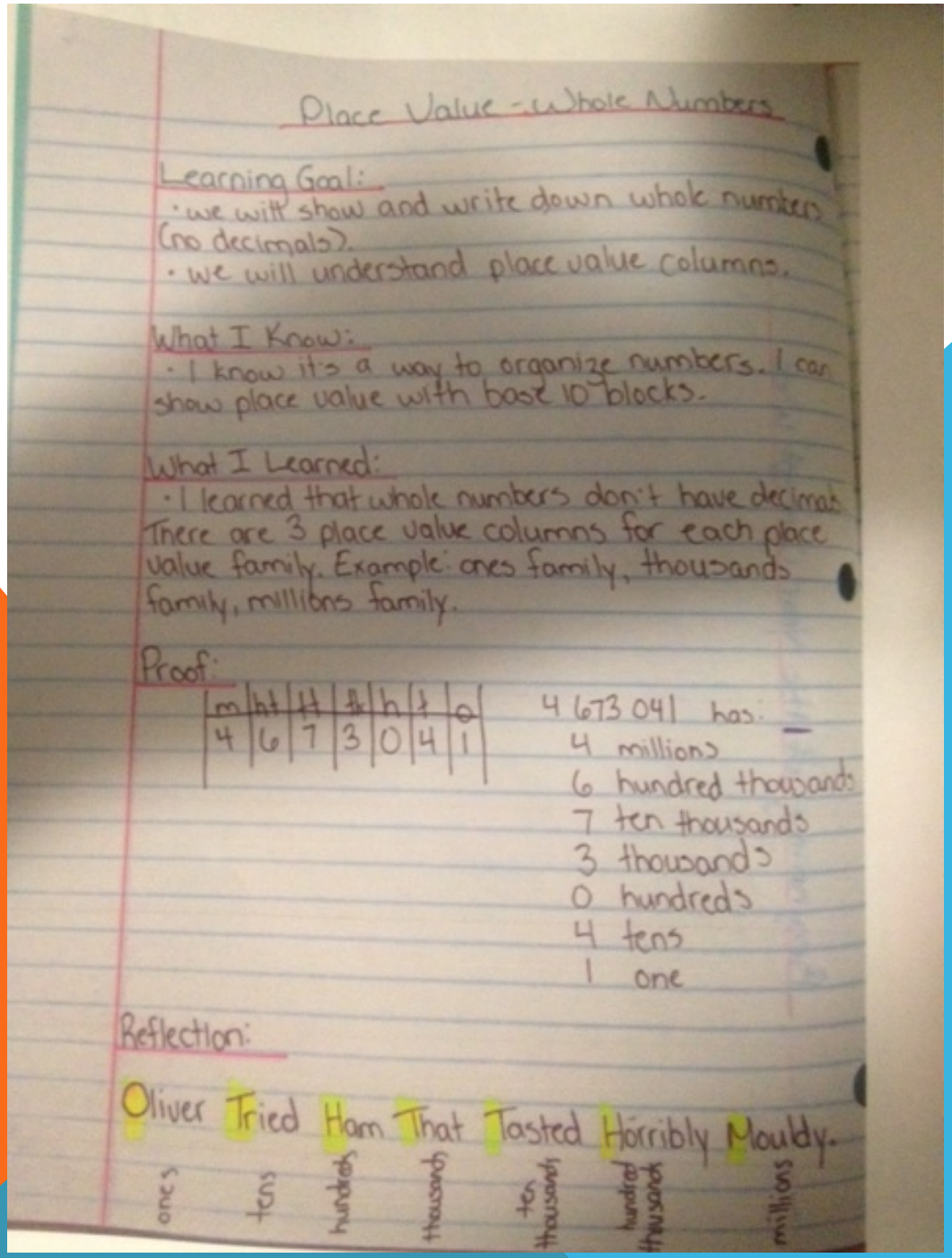


5. Putting those together (0972) gives you the answer: **972**.



Source: Ivy Hall Elementary School Web site

Chicago Tribuner Chuck Burke



Place Value - Whole Numbers

Learning Goal:
- we will show and write down whole numbers (no decimals).
- we will understand place value columns.

What I Know:
- I know it's a way to organize numbers. I can show place value with base 10 blocks.

What I Learned:
- I learned that whole numbers don't have decimals. There are 3 place value columns for each place value family. Example: ones family, thousands family, millions family.

Proof:

m	ht	tt	th	h	t	o
4	6	7	3	0	4	1

4 673 041 has:
4 millions
6 hundred thousands
7 ten thousands
3 thousands
0 hundreds
4 tens
1 one

Reflection:

Oliver Tried Ham That Tasted Horribly Mouldy.

ones tens hundreds thousands ten thousands hundred thousands millions

JOURNAL

Learning goal :

What I know:

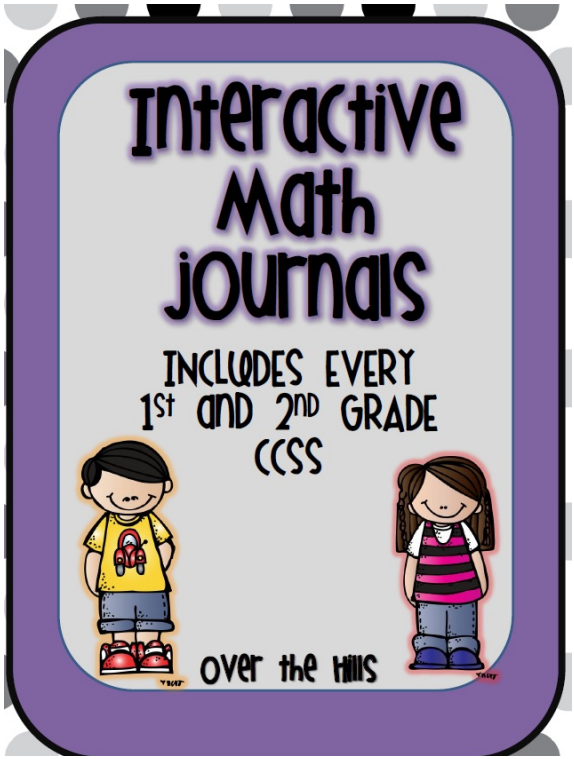
What I learned:

Proof:

Reflection:

How can you relate it to real-life?

JOURNAL EXAMPLE



LEFT SIDE GUIDELINES:

I know: Students write 1-2 sentences about what they already know about this topic. (NEEDS TO BE DONE BEFORE LEFT SIDE ACTIVITY).

I learned: Students write down what they learned about this topic. This is completed after whole class activity.

Reflection: Students write a thoughtful reflection and show their learning in their own way. Also, ADD their feelings(draw an expression face).

Reflection Ideas:
Draw a picture
Make a chart or graph
Write a story problem
Make a connection
Write a poem or rhyme

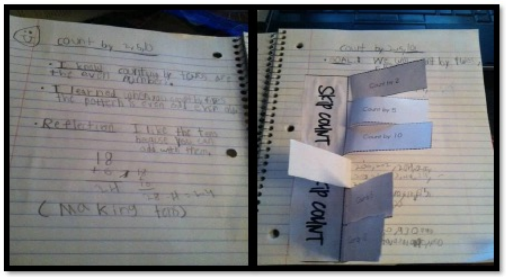
Procedure:

•Students will begin by flipping to the next clean page and on the LEFT SIDE writing the Lesson Title and underline it.
•Next, students will write the headers for the other sections:
•I know(they write in here now, too)...PRIOR KNOWLEDGE
•I learned...(after concept is taught)
•Reflection...(after concept)
•On the RIGHT side, students write the Lesson Title and Learning Goal.

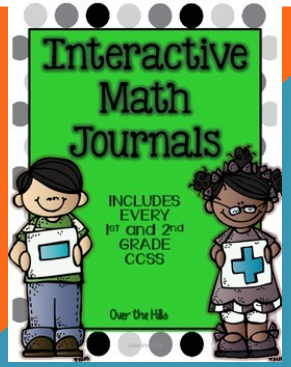
•Step 1:Students cut out whole foldable.
•Step 2: Cut the flaps with the dotted lines.
•Step 3: Glue the side with SKIP COUNT down to the notebook and fold back flaps.
•Step 4: Students write numbers that match each flap.

Vocabulary Used:

Goal: We can count by 2s, 5s, and 10s.



I had students start at 0 for the top foldable and we completed it together. The bottom one students could pick any number as a starting point.



http://www.teacherspayteachers.com/Product/Interactive-Math-Journals-ALL-1st-and-2nd-grade-CCSS-included-622700 cost $12.50

This product will change your way of thinking about and teaching math! With the changeover to the Common Core Standards, students must dig deeper and really understand their mathematical thinking. These journals will HELP!

JOURNALING RESOURCES

http://www.ascd.org/publications/educational-leadership/feb17/vol74/num05/Why-Should-Students-Write-in-Math-Class¢.aspx

http://www.k-5mathteachingresources.com/

http://www.k-5mathteachingresources.com/support-files/preview-5th-gd-mj.pdf

http://www.pinterest.com/cawhittaker/interactive-notebooks/

http://www.pinterest.com/pin/13299699522062423O/

http://www.teacherspayteachers.com/Product/4th-Grade-Interactive-Math-Notebook-Operations-Algebraic-Thinking-794723

http://www.teacherspayteachers.com/Product/5th-Grade-Interactive-Math-Notebook-OA-NBT-855767

http://nrich.maths.org/frontpage

You tube clips

http://m.youtube.com/watch?v=cRUMe8wD600
http://m.youtube.com/watch?v=_BZHqUVvXcI

http://m.youtube.com/watch?v=U_KkpZUqLEc

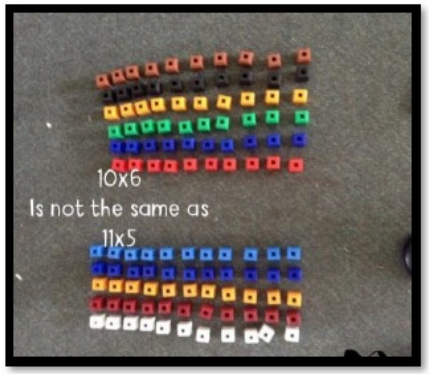
http://m.youtube.com/watch?v=BNHb9SLF56E

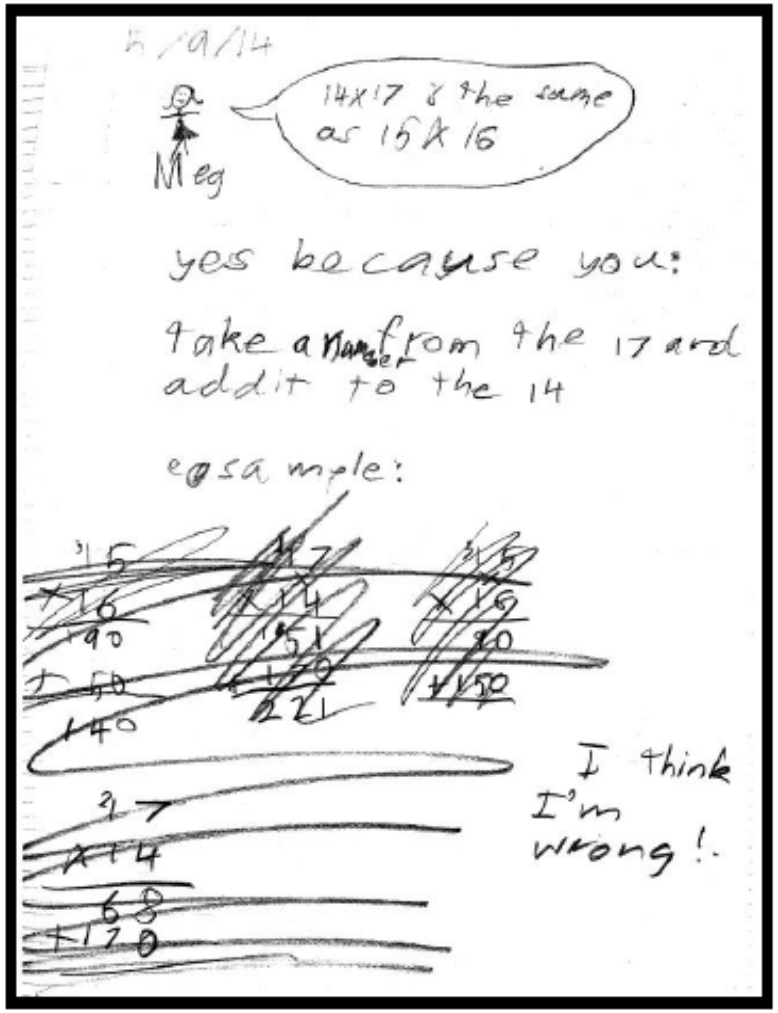
http://m.youtube.com/watch?v=oA64HXxutx4

Problem Solving

Inquiry tasks

seen in the image below. The original problem was *14×17 is the same as 15×16* and was changed to *11×5 is the same as 10×6, prove it*. This took long multiplication out of the equation and was easier to make and compare the arrays.





Materials to prove

Meg says that 14×17 will have the same answer as 15×16. Why do you think that Meg has made this connection? Do you agree/or disagree? Prove it.

Sumblocks - keldindustries.com

http://www.keldindustries.com/

Questioning for Inquiry rather than answers.

Primas

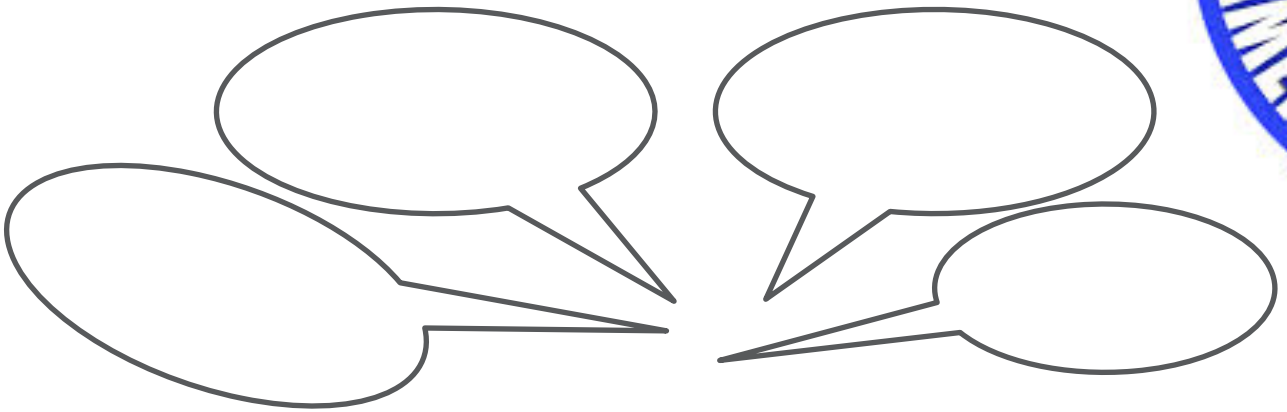
3. Five principles for effective questioning

1. Plan to use questions that encourage thinking and reasoning

Really effective questions are planned beforehand. It is helpful to plan *sequences* of questions that build on and extend students' thinking.
A good questioner, of course, remains flexible and allows time to follow up responses.

Beginning an inquiry	• What do you already know that might be useful here? • What sort of diagram might be helpful? • Can you invent a simple notation for this? • How can you simplify this problem? • What is known and what is unknown? • What assumptions might we make?
Progressing with an inquiry	• Where have you seen something like this before? • What is fixed here, and what can we change? • What is the same and what is different here? • What would happen if I changed this.. to this...? • Is this approach going anywhere? • What will you do when you get that answer? • This is just a special case of ... what? • Can you form any hypotheses? • Can you think of any counterexamples? • What mistakes have we made? • Can you suggest a different way of doing this? • What conclusions can you make from this data? • How can we check this calculation without doing it all again? • What is a sensible way to record this?
Interpreting and evaluating the results of an inquiry	• How can you best display your data? • Is it better to use this type of chart or that one? Why? • What patterns can you see in this data? • What reasons might there be for these patterns? • Can you give me a convincing argument for that statement? • Do you think that answer is reasonable? Why? • How can you be 100% sure that is true? Convince me! • What do you think of Anne's argument? Why? • Which method might be best to use here? Why?
Communicating conclusions and reflecting	• What method did you use? • What other methods have you considered? • Which of your methods was the best? Why? • Which method was the quickest? • Where have you seen a problem like this before? • What methods did you use last time? Would they have worked here? • What helpful strategies have you learned for next time?

Discussion



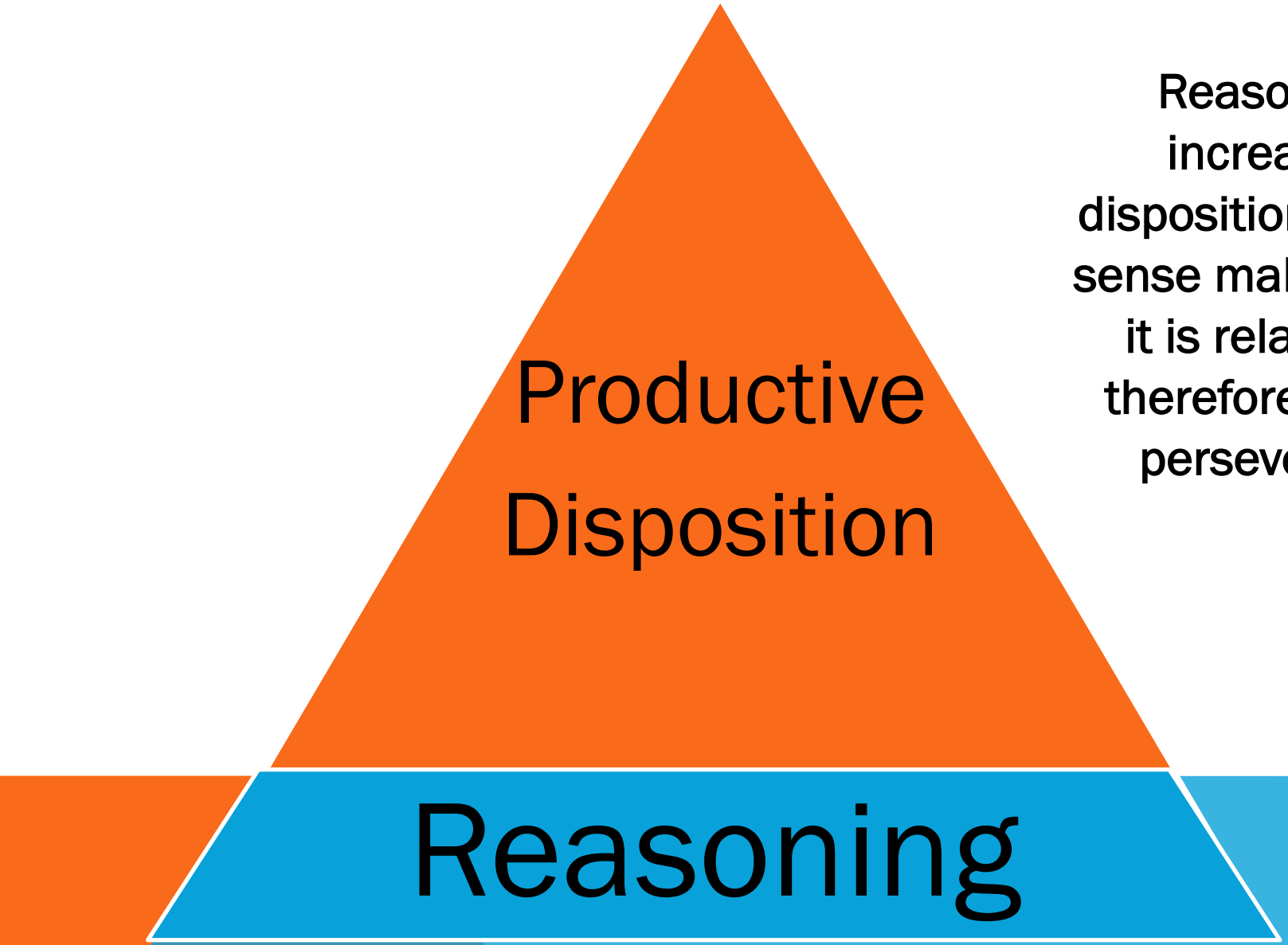
Learn about learning

Planning

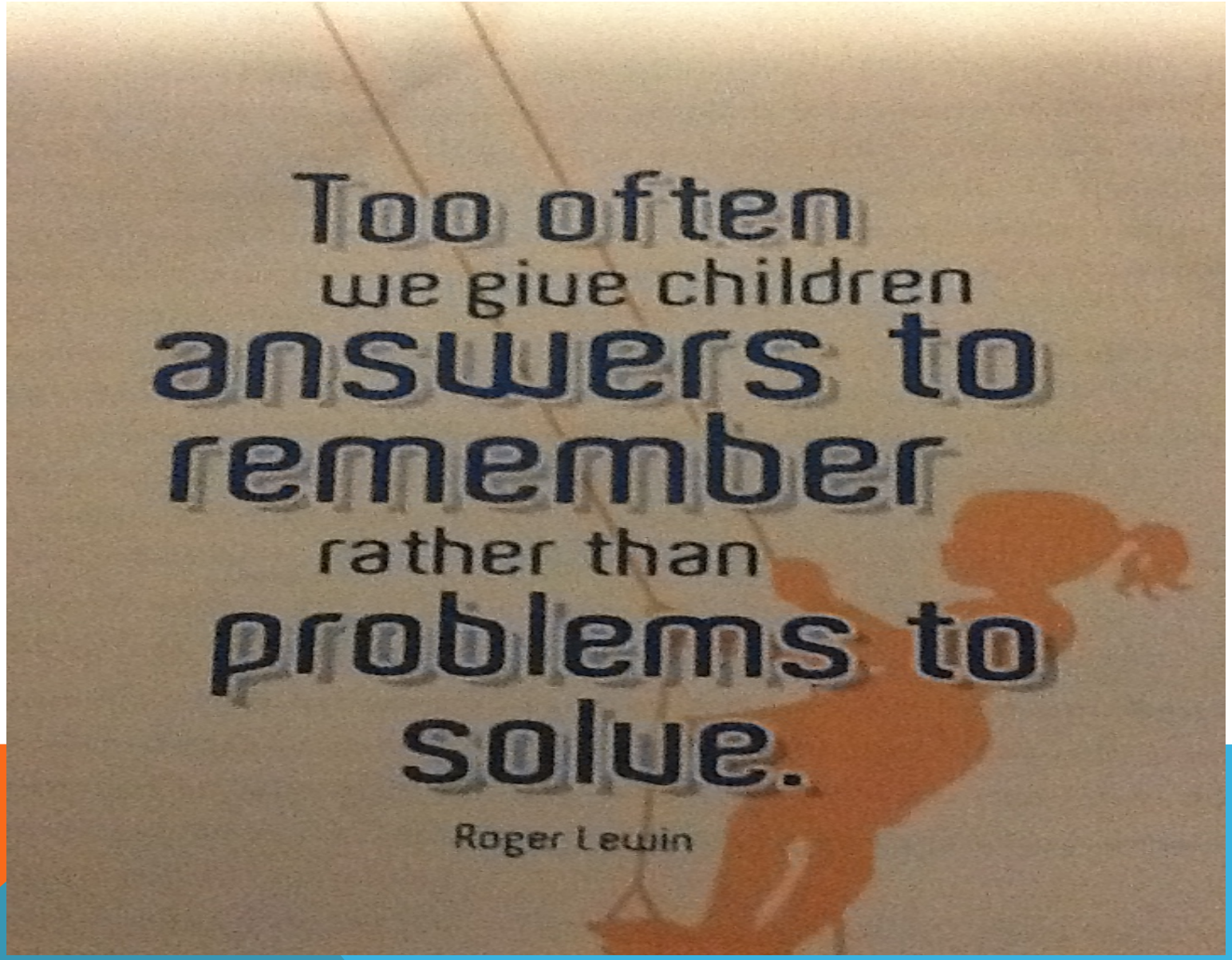
What

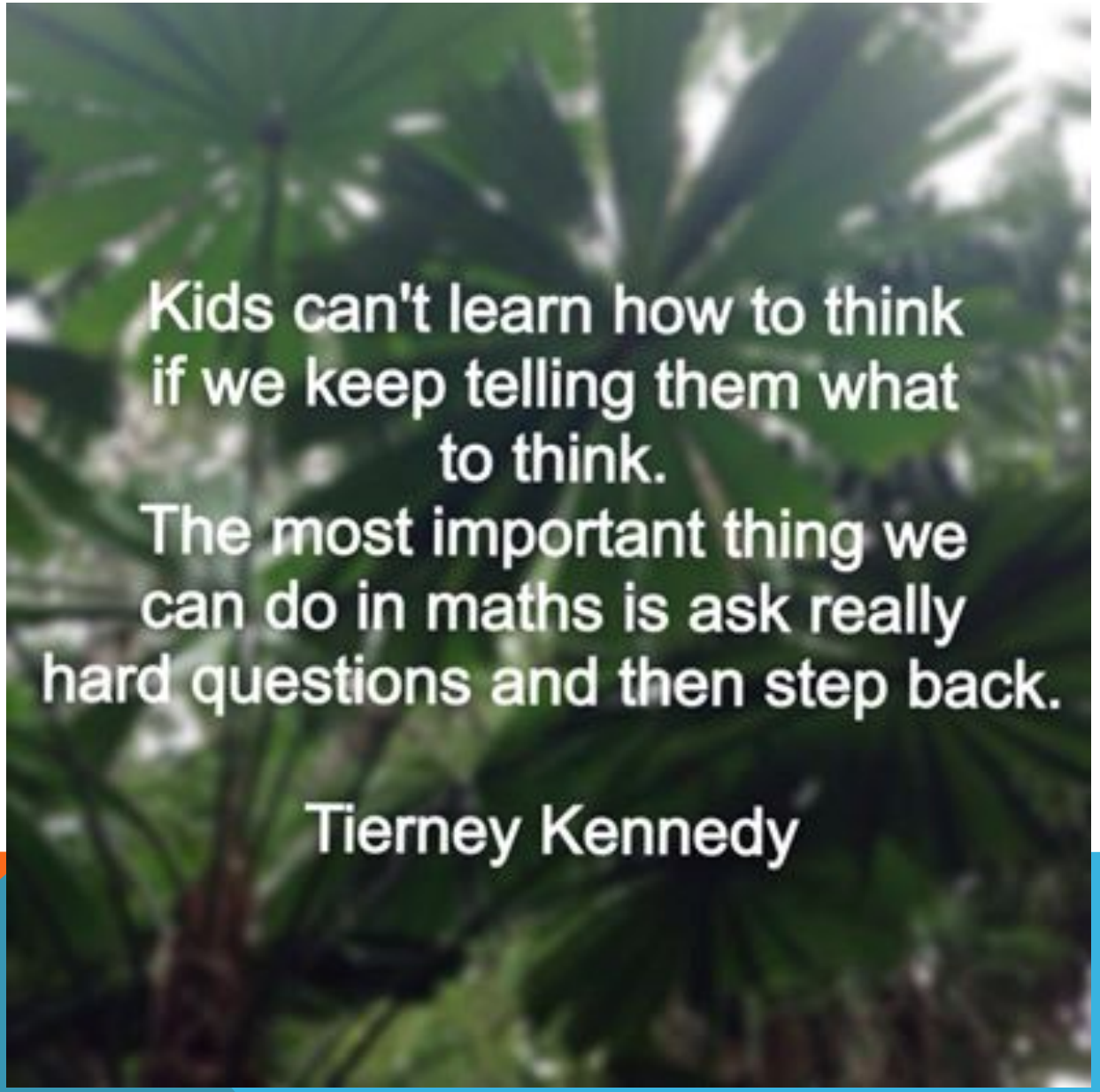
HOW

TASKS



Reasoning increases disposition as it is sense making and it is relatable, therefore worth persevering.


Too often
we give children
answers to
remember
rather than
problems to
solve.
Roger Lewin


Kids can't learn how to think
if we keep telling them what
to think.
The most important thing we
can do in maths is ask really
hard questions and then step back.
Tierney Kennedy

RESOURCES

https://www.youcubed.org/

https://www.youcubed.org/week-of-inspirational-math/

https://www.resolve.edu.au/

www.nrich.org.uk

www.nzmaths.co.nz

www.topdrawer.aamt.edu.au

https://www.tabletalkmath.com/resources.html

https://www.education.com/game/multiply-by-3-matching/

http://mathisvisual.com/

http://www.stmath.com/productive-struggle-math-rigor?utm_campaign=Creative%20and%20Rigorous%20Problem%20Solving%20KD%20%7C%20Oct-Dec%202017&utm_source=facebook&utm_medium=social

http://www.primas-project.eu/en/index.do

http://www.primas-project.eu/servlet/supportBinaryFiles?referenceId=4&supportId=1362

http://www.mathlearningcenter.org/bridges/grade

http://www.mathlearningcenter.org/

Subscribe to

www.backtofrontmaths.com.au

www.maths300.esa.edu.au

http://profpete.com.au/resource/

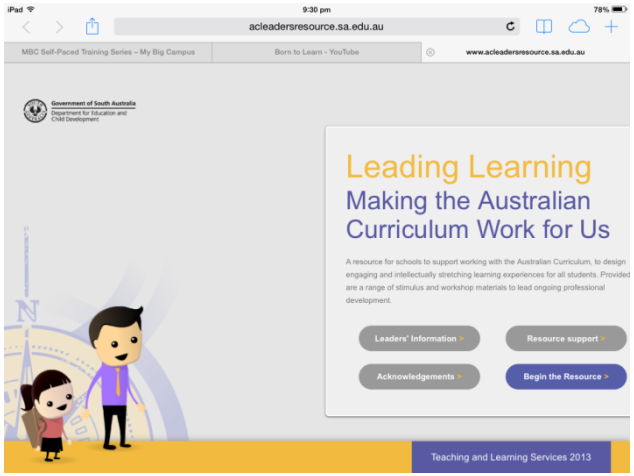
www.mathsmentality.com.au

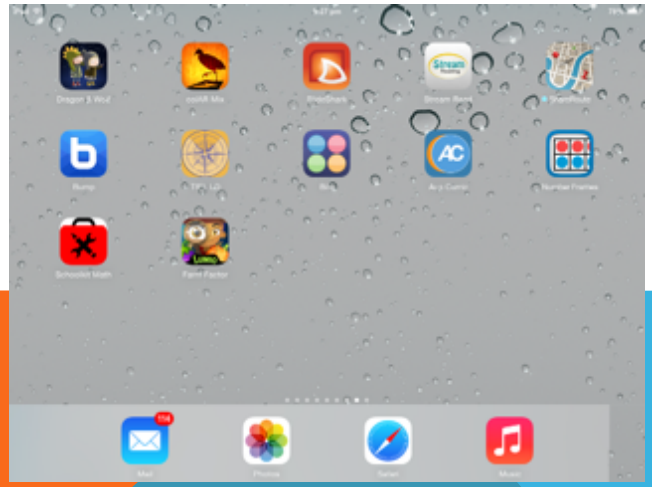
http://www.fireflyeducation.com.au/imaths/

MTSonline – www.schoolcentre.com.au (great value $22 year)

App
Bedtime Maths
for parents

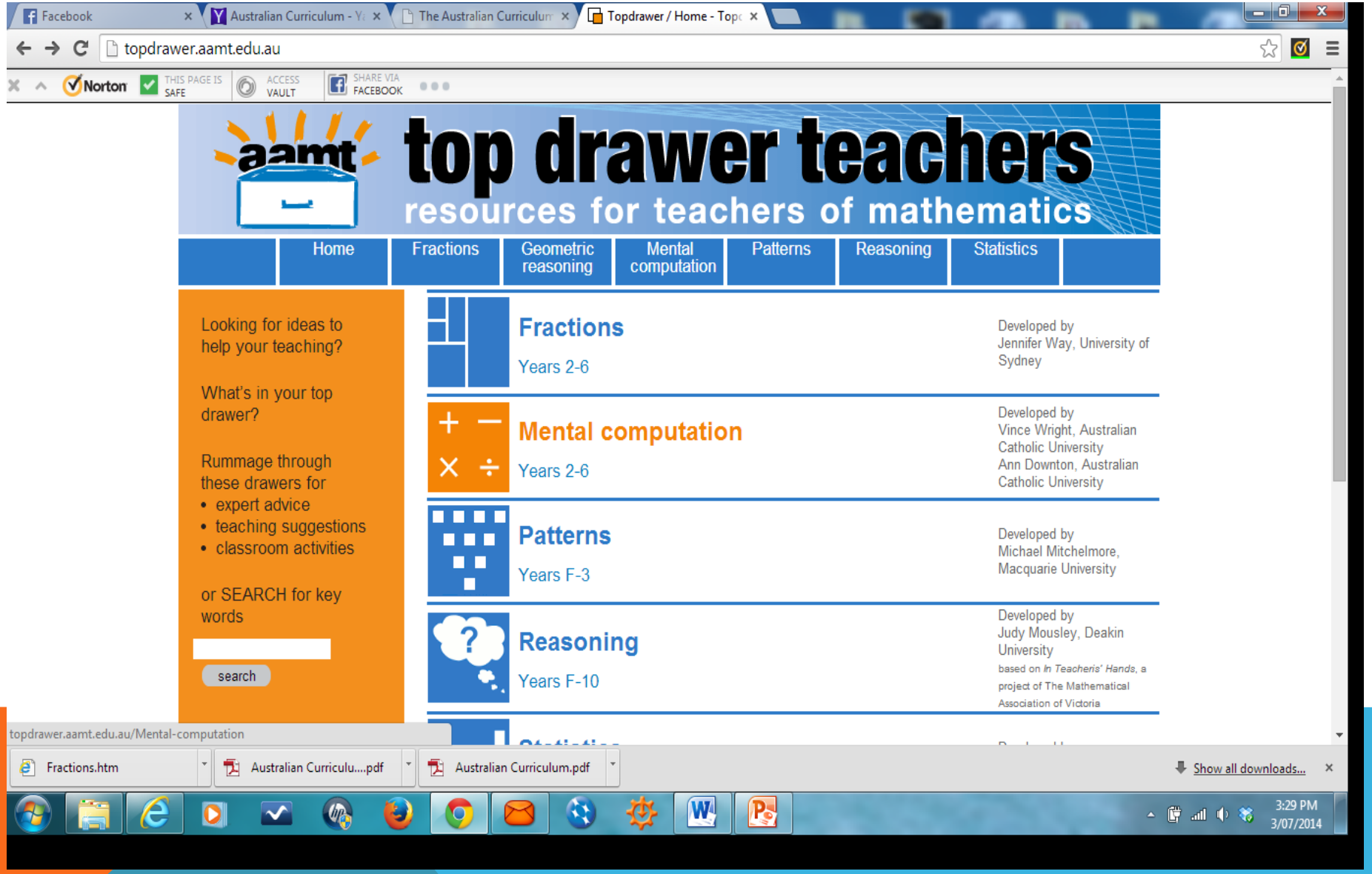
http://www.acleadersresource.sa.edu.au/index.php?page=bringing_it_to_life





Bringing it to Life – download app

TfEL LD app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Years 2-6
Developed by Jennifer Way, University of Sydney
Mental computation
Years 2-6
Developed by Vince Wright, Australian Catholic University
Ann Downton, Australian Catholic University
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Years F-3
Developed by Michael Mitchelmore, Macquarie University
Reasoning
Years F-10
Developed by Judy Mousley, Deakin University
based on In Teacheris' Hands, a project of The Mathematical Association of Victoria
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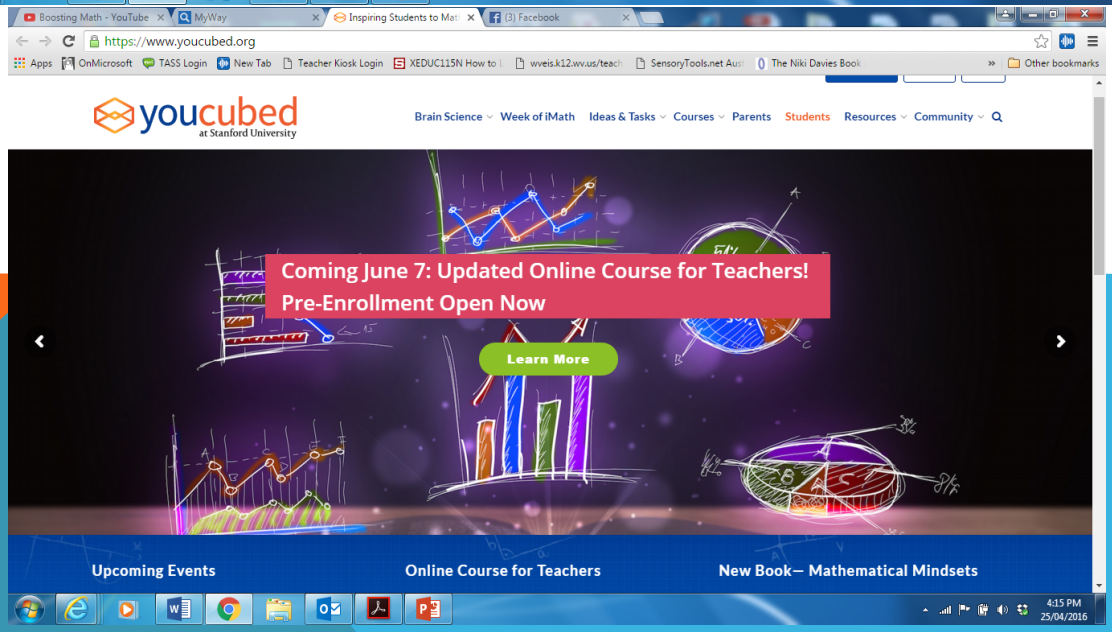
New Book— Mathematical Mindsets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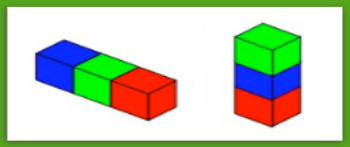
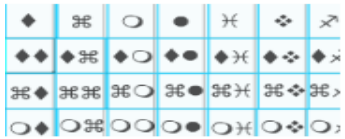


Cubes
This feature brings together tasks which make use of interlocking cubes.

Past features

Collections
- Stage 1 and 2 Curriculum
- Other Resources
- Primary Professional Development

Current



Reasoning

Reasoning is fundamental to knowing and doing mathematics but when do we reason and what does reasoning 'look like'? The article below helps to answer those questions and draws together tasks which offer opportunities for learners to reason for different purposes and in different ways.

Mathematical Reasoning – Moving Beyond 'because ...'
Stage: 1 and 2
In this article for primary teachers we consider in depth when we might reason which helps us understand what reasoning 'looks like'.

Eggs in Baskets Stage: 1 ★★
There are three baskets, a brown one, a red one and a pink one, holding a total of 10 eggs. Can you use the information given to find out how many eggs are in each basket?

Hundred Square live Stage: 1 ★★
A hundred square has been printed on both sides of a piece of paper. What is on the back of 100? 58? 23? 19?

That Number Square! live
Stage: 1 and 2 ★
How quickly can you put back the numbers on the hundred square? What's the smartest way to do it?

Coded Hundred Square Stage: 2 ★
This 100 square jigsaw is written in code.

Related
- Reasoning and Convincing at KS1
- Reasoning and Convincing at KS2
- Improving Reasoning: Analysing Alternative Approaches

Trending

New EYFS activity
Number Book

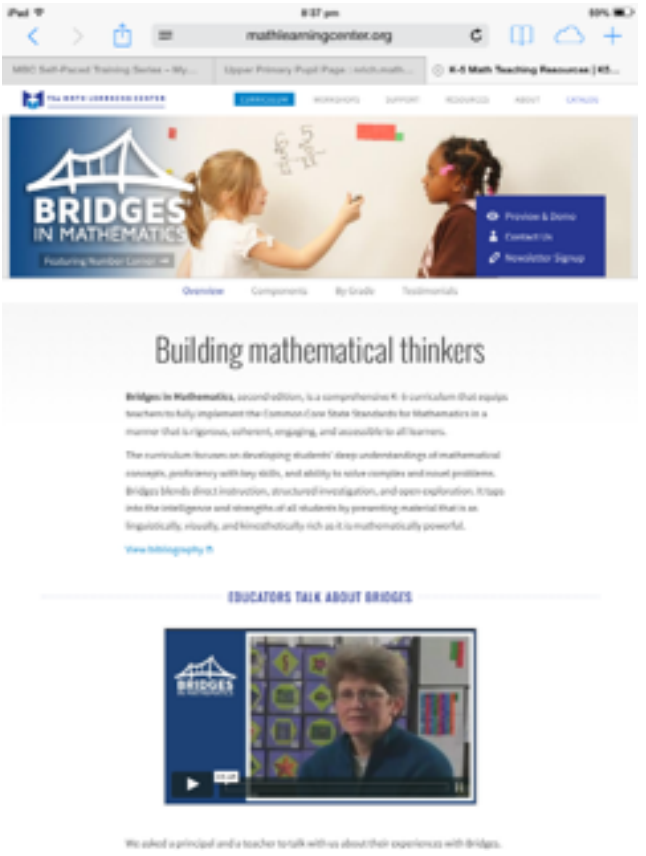
New game!
Reasoned Rounding

Book now
NQT Inspiration Day 10 July 2014

Open for solutions!
Primary Live Problems

Recently solved
Student Solutions

http://www.mathlearningcenter.org/



http://www.mathlearningcenter.org/bridges/overview

PLANNING

1. Learner Objectives

a. Content (What will students be learning?)

b. Process (How will students be learning?)

c. Rationale (Why are students learning this content?)

2. Assessment

a. What processes will be used to check for student understanding in class?

b. What processes will be used to check for student understanding at the end of the lesson/unit?

3. Instructional Strategies

a. What special resources, questioning techniques, or motivational techniques will be used?

4. Observer Focus

a. What is the major focus of data collection?

Project that addresses a recommendation of my thesis

Mathematics *by* Inquiry

Mathematics by Inquiry is a bold new national program to promote innovative approaches to mathematics teaching in Australian schools. It is managed by the Australian Academy of Science in partnership with the Australian Association of Mathematics Teachers, and is funded by the Australian Government.

The project will develop classroom materials with an inquiry-based approach to mathematics, for every year of school from foundation to year 10. The materials will emphasise distinctive aspects of mathematics, including generalisation and proof as key elements of mathematical reasoning. They will emphasise mathematics as both a dynamic human endeavour and as an enabling science which underpins scientific and technological advancement. Many of the materials will be based on relevant real-world examples and contexts, and all will enable students to deal with complex situations using a variety of mathematical methods.

The classroom materials will be seamlessly integrated with a set of professional resources that support individual teacher learning, classroom practice and a whole-of-school culture of inquiry approaches to mathematics. These resources will support the Australian mathematics curriculum and be applicable across a range of different school settings. They will build teachers' knowledge and capacity with contemporary practices in mathematics teaching and learning, with a particular focus on problem solving and mathematical reasoning.

Mathematics by Inquiry will engage with and draw from the work of leading teachers, principals and academics from around the country. The project team will work closely with educational jurisdictions, teachers' associations, teacher educators and principals to ensure that the materials and inquiry approach become a central aspect of every Australian mathematics classroom.

Key facts

Partners: The Australian Academy of Science and the Australian Association of Mathematics Teachers

Funding and duration: $6.4 million from 1 November 2015 to 30 June 2018

Key personnel:

- **Executive Director**: Dr Steve Thornton
- **Director of classroom materials**: Emeritus Professor Kaye Stacey
- **Director of professional resources**: Professor Peter Sullivan
- **Director of communications and dissemination**: Mr Will Morony
- Other project staff to be employed

What Mathematics by Inquiry will provide for teachers, schools and students:

- a **framework** for Mathematics by Inquiry, informing all aspects of resource development and dissemination
- exemplary Mathematics by Inquiry **experiences** at every level from foundation to year 10
- **special topics**, each being a substantial teaching resource highlighting aspects of mathematical reasoning such as modelling or proof, capitalising on emerging technologies and mathematically able software
- **professional resources**, each highlighting an aspect of Mathematics by Inquiry such as assessing higher order thinking, supporting student inquiry and mathematical inquiry in STEM contexts
- **dissemination** via Scootle and the AAMT Dimensions portal, supported by 240 champions recruited and trained from across Australia.

Contact details

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Ian Potter House
Gordon Street
Canberra ACT 2601

mbi@science.org.au
(+61) 2 6201 9400

Australian Academy of Science

aamt

https://www.resolve.edu.au/explore-resources?f%5B0%5D=type%3Aresource

http://www.aamt.edu.au/Library/Projects/Maths-by-Inquiry/(language)/eng-AU

mbi-fact-sheet-2015.pdf 46.15 kB