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Mathematics: a spirit of inquiry

MAV Conference 2019

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Always, sometimes, never

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- Are the statements always true, sometimes true or never true?
- How do you know?

I use inquiry in my teaching.

If you add a number to 5, your answer will be bigger than 5

- Can you find examples or counter-examples for each one?
- For the “sometimes” cards can you explain when they are true? Or rewrite them so that they are always true or never true?

Inquiry

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Was seen

- As another subject of the curriculum

Is now seen

- As a way of being, what ever they're learning or doing
- It's how we position ourselves, and our students as learners

Inquiry as a stance

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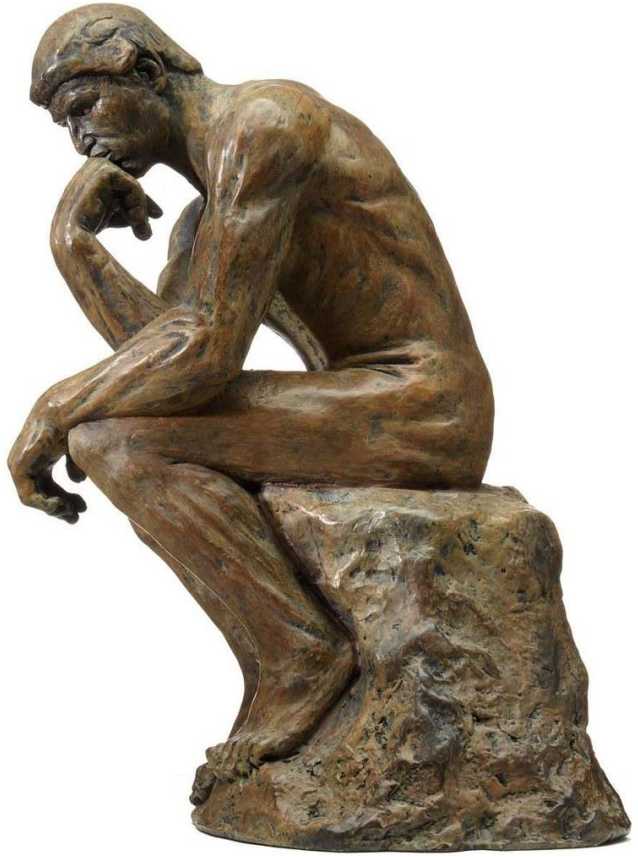
- Inquiry is a belief about learning
- A philosophy
- We enact curriculum as inquiry
- Inquiry is exploring the tensions significant to the learner
- Involves going beyond our current understandings
- Begins with current understandings
- Requires support of a collaborative community



Inquiry

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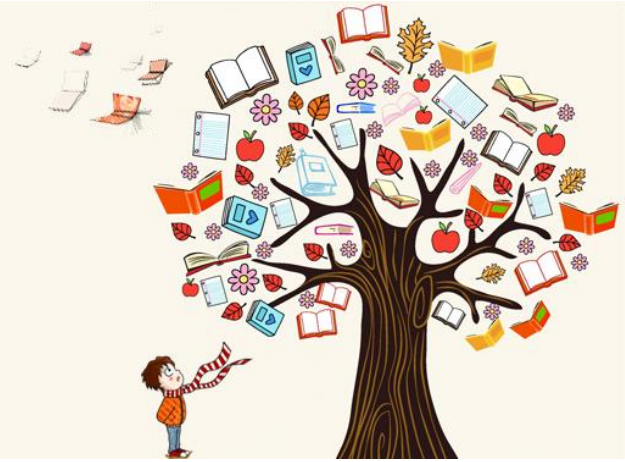
Is not

about filling heads with soon to be forgotten facts

It is

about instilling a passion and hunger for learning



Think, Pair, Share

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- Think of something you have learned recently
- Write down the steps you took or the process that led you to your new understanding
- Share with the person sitting next to you
- What are the similarities between your partners experience and yours
- Could you plot the

process as a framework?

Inquiry is natural to learning

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- Outside of school contexts inquiry is the way **children** and **adults** learn
- Engaging with life : **curiosity** leads the need to know and leads to new knowledge
- From curiosity to knowledge and more in depth investigation
- **Explorations and investigations** support the construction of new understandings and in asking new and more complex questions

Inquiry is based on connections

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- Inquiry begins in the learner's own experience and current understandings
- Without points of connection learning is difficult and easily forgotten
- Inquiry starts by immersing students in engagements so they may find connections to their experiences
- The teachers job is to observe and listen for current understandings

Time Differences

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The time is now 11.45.

The workshop ends at 20 past 1.

What time will lunch be?

Work with a partner to find an answer in 2 different ways.

Discuss: How does this problem create a connection with you?

Inquiry is conceptual

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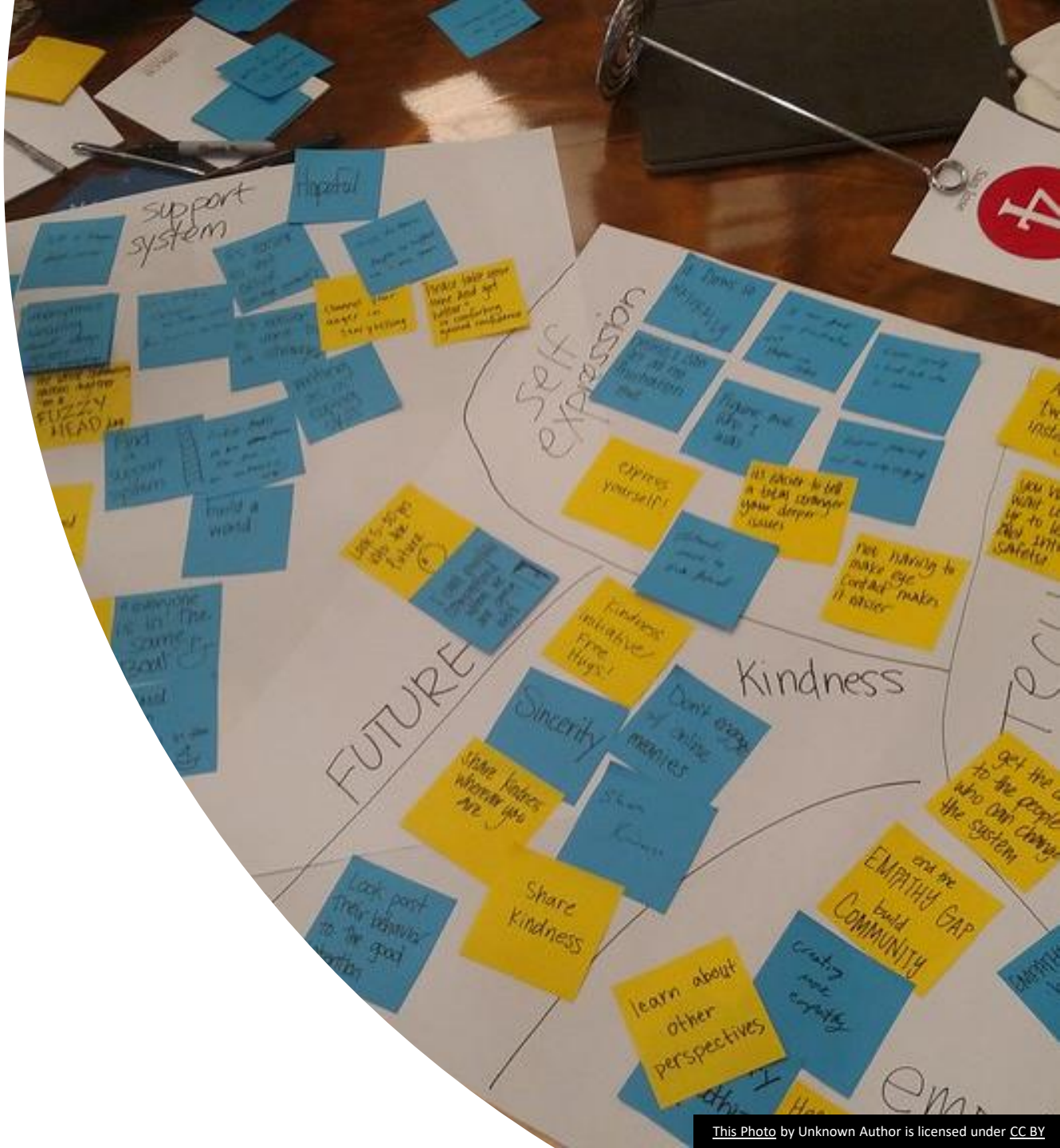
Why is 5 five?

Inquiry is conceptual

- The emphasis is on the big ideas behind the topics
- Knowledge becomes a tool to explore the conceptual understandings that underlie that knowledge



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Discuss: What are the big mathematical ideas behind this question?

Inquiry is problem posing and problem solving

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- The distinction between problem posing and problem solving distinguishes between guided inquiry, personal inquiry and collaborative inquiry
- Guided inquiry: teacher poses problems; students are problem solvers
- Students actively engage in reasoning to develop own understanding of that strategy

Types of Inquiry

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Project oriented

Project

- Design and make a vegetable garden

Question

- How do we attract more native birds and animals to our school?

Philosophical/ethical

- What makes me who I am?
- Does the past make sense?

Issues/problem-oriented

- What can we do about the schools waste?
- How can I manage to go to the bathroom, collect lunch and visit MAVShop during my lunch break?

The learning environment

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The role of the teacher is to create a learning environment (or experiences) that has the most potential for anomaly or tension for the learners (Dewey 1938)

The emotional environment

A collaborative community*

Learning is visible

A space that honours the aesthetics

A flexible space

A space that helps teach

An intellectually challenging space

A place of possibilities

Research based

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- Schools often focus on cooperation; inquiry goes beyond cooperation
- Inquiry requires collaborators to think together; to challenge our thinking
- Dialogue is how we transform ourselves as human beings(Freire 1978)
- The most conducive space for learning is defined by what can be learned with the collaborative support of others (Vygotsky 1978)
- The most effective learning occurs within communities of practice where members work together toward understanding (Lave and Wenger 1991)

Enacting Inquiry in the Classroom

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- Frameworks provide a bridge between theory and practice
- Frameworks ensure consistency of practice
- Links a set of beliefs about the learning process

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models for structured inquiry

Kathy Short

1. Building from the known
browsing, talking, listening

2. Taking the time to find questions for Inquiry
wondering & wandering
observing & exploring

3. Gaining new perspectives
inquiry groups
In-depth researching
tools for Inquiry

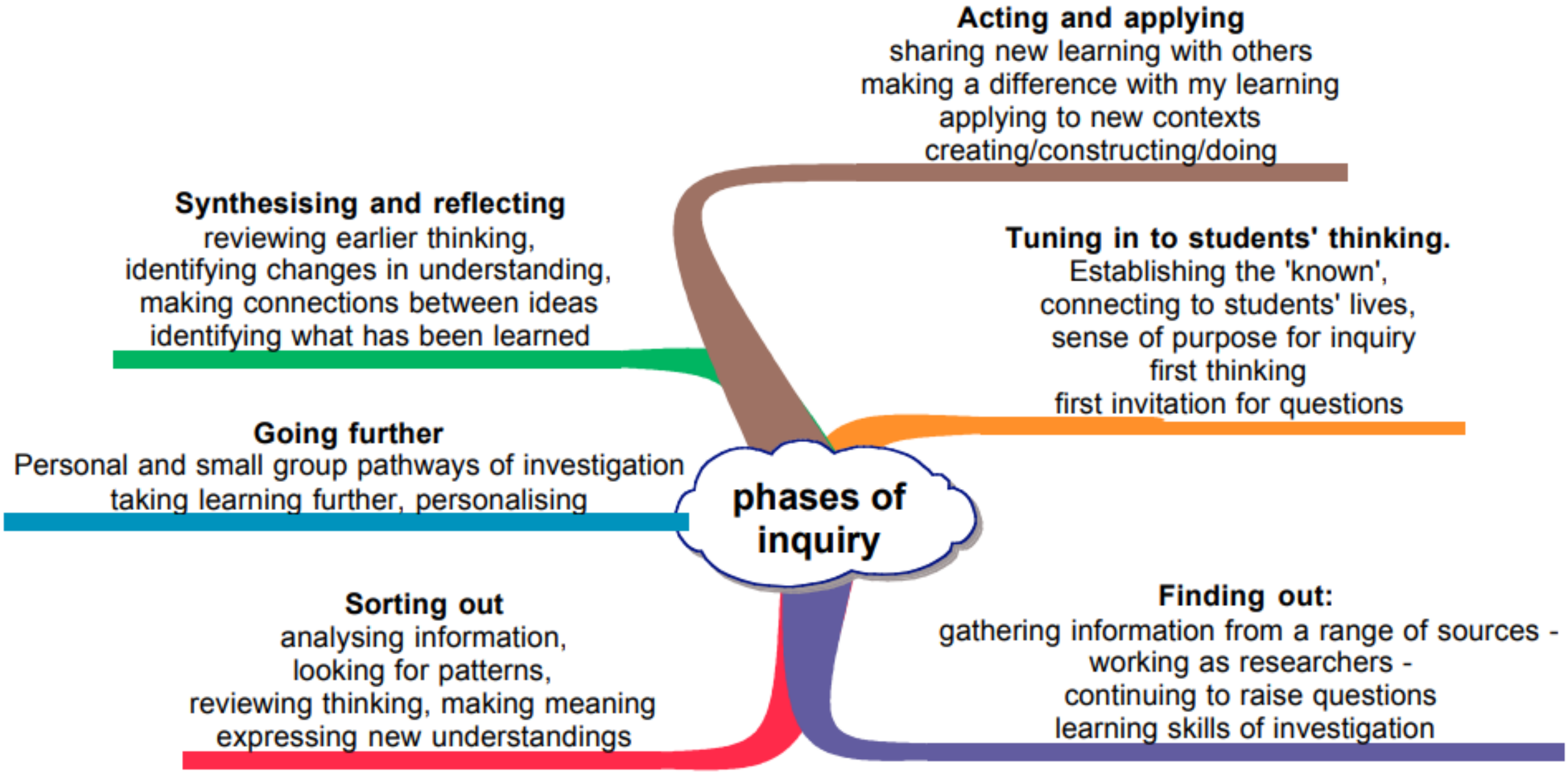
4. Attending to Difference
revision on inquiry
learning logs

5. Sharing What Was Learned
inquiry presentations

6. Planning New Inquiries
group reflection

7. Taking thoughtful new action
invitation for action

The Inquiry Cycle



Kath Murdoch

Structuring the lesson Peter Sullivan et al

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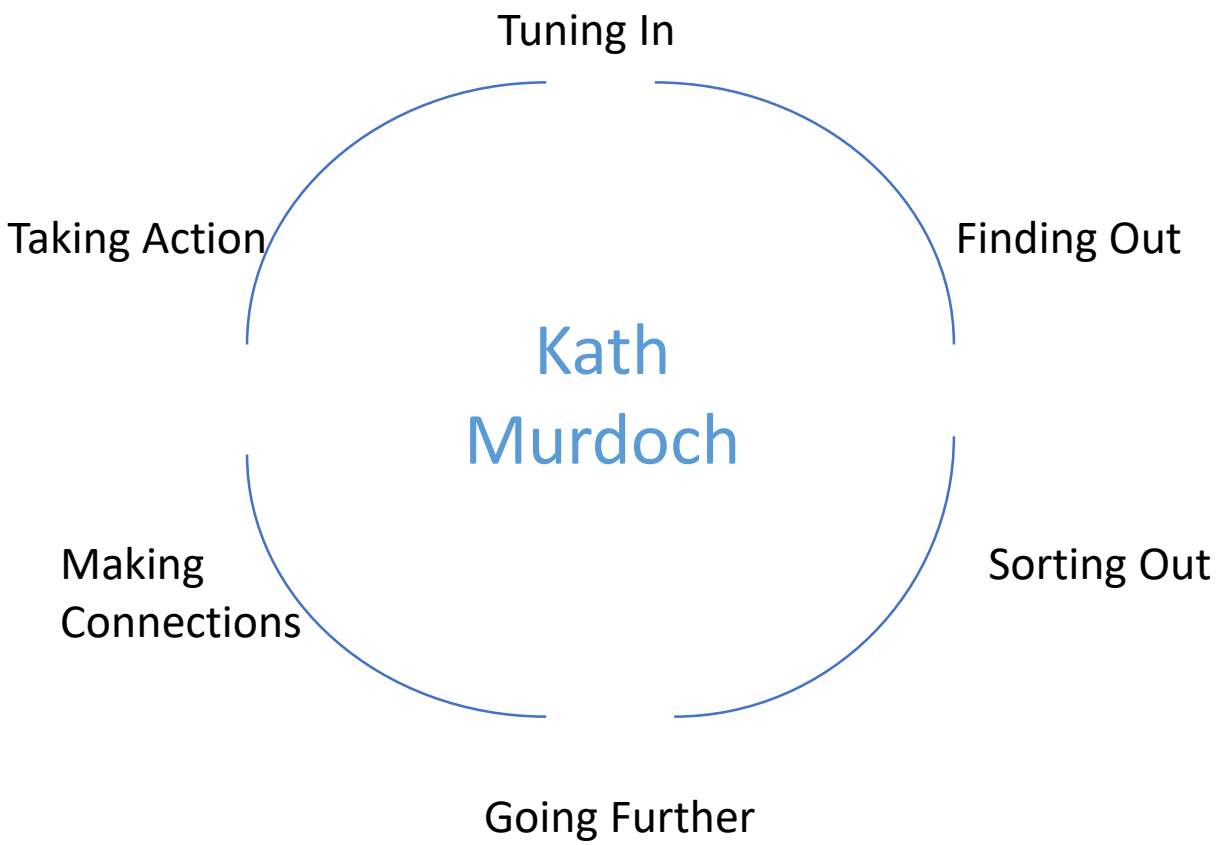
Launch: Warm up, Learning Focus, Introduction, Key Mathematical Language

Explore: Learning task, Enabling and Extending Prompts

Summarise: Supplementary Tasks, Possible Student Solutions



Kath Murdoch Inquiry Process Model	Scientific Inquiry Process and Skills	Technology Design Process and Skills	Bloom's Taxonomy	Solo Taxonomy	5 E's
Tuning In	Question Predict	Explore & define task	Creating	Uni-Structural	Engage
Finding Out/ Sorting out	Plan Investigations	Research existing ideas / solutions	Remembering Evaluating Understanding	Multi-structural Relational	Explore
Going Further	Conduct Investigations	Test/ make solutions	Analysing Understanding	Relational	Explore
Making / Drawing Conclusions	Process and analyse data	Re-do Test/ make	Evaluating Understanding	Relational Multi-structural	Explain
Taking Action	Communicate	Communicate	Creating	Extended Abstract	Elaborate
Reflection	Ongoing	Evaluate	Reflect	Extended Abstract	Evaluate

Water Tanks

- All new houses built in Victoria must have a water tank
- You can add water tanks to existing houses as well
- How do you decide what size tank is needed? What data do you need to make your decision?

Water Tanks

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1) What size tank would you recommend for this house?
2) Why?

Water Tanks

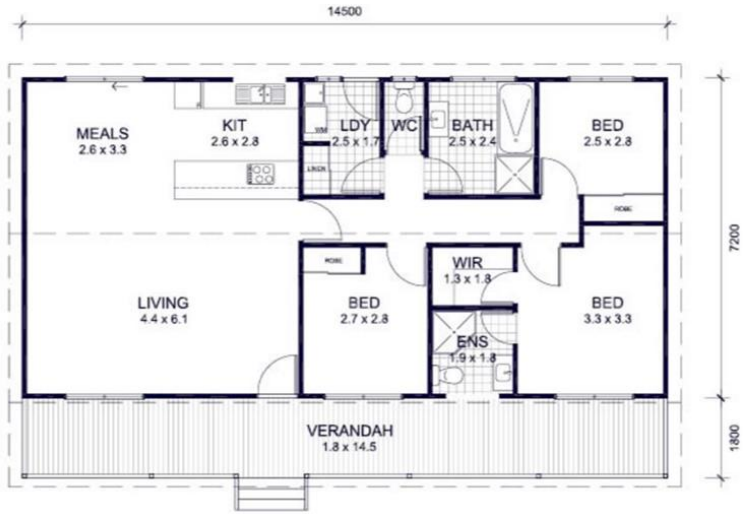
- **Assume:**
- The roof is the size of the house plus the verandah

  (Note that the measurements are provided in a mix of mm and m.)
- Family of four
- House in Melbourne
- Tank water used only for flushing toilets and watering garden

Water Tanks

- **Possible considerations:**
- Annual rainfall
- Area of roof from which water will be collected
- Use of water – number of residents, size of home, number of bathrooms, frequency of laundry, garden, pool, etc.
- Amount of water to have ‘ahead’ (Rule of thumb is four weeks’ supply, in case there is no rain in that time)
- Use of tank water vs. ‘city’ water

Water Tanks



What will be your problem solving strategy?

How will you work together as a group to solve this prob.e….

What assumptions will you make?

What information do you need?

What measurement knowledge will you need and use?

What calculations do you need to do?

Water Tanks

- How much water the family will need per day for flushing toilets and watering the garden?
  - Water use for household needs – See http://www.bushmantanks.com.au/information/calculators
  - Complete these calculations using your own assumptions about toilet use (full/half flushes, number of flushes, etc.) and watering the garden (size, length of time to water, etc.)

Water Tanks

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- How much rain (in cm^3 and L) would be collected for each square metre of the roof, per mm of rain?
- Consider these relationships:
  - mm, cm, and m
  - cm^2 and m^2
  - cm^3 and mL
  - cm^3 and L

Water Tanks

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- What is the area of the roof in m^2?
- How much water will be harvested from this roof in one year of average Melbourne rainfall?

Inquiry and mathematics

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- It is the way you teach, not what you teach
- It is the way students think and engage in the learning, not what is being done to them

Blocks in my pocket

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I have some blocks in my pocket. I noticed that when I shared the blocks into two equal groups that there was one left over. When I shared them into three equal groups, there were two left over.

How many blocks might I have in my pocket?

Do the task. Record your working and your thinking as you go.

Dianne Siemon et al *Teaching Mathematics* 2015

Blocks in my pocket

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Enabling Prompt: –

- Have paper plates and small blocks or counters for students to use.
- Ensure the students understand the concepts of sharing and remainders. Ask a student to take a handful of blocks and share them evenly with a few friends. Discuss how the results may be recorded.
- Break the task into two smaller steps: sharing with 2 groups and then sharing with 3 groups.

Dianne Siemon et al *Teaching Mathematics* 2015

Blocks in my pocket

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Extending Prompt: –

- How many solutions are there? And How do you know?

Summary/Reflection

A conclusion should include

- Possible Student Solutions to the Learning Task
- A summary of the main points
- A final check for understanding
- A reminder of why the topic is important
- Where the topic leads to

Supplementary Tasks

Dianne Siemon et al *Teaching Mathematics* 2015

Blocks in my pocket

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I have some blocks in my pocket. I noticed that when I shared the blocks into two equal groups that there was one left over. When I shared them into three equal groups, there were two left over.

How many blocks might I have in my pocket?

1. Now that you have worked on the task, consider how you might plan to use this in the classroom.

2. What introduction would you use to ensure students understand the task?

Dianne Siemon et al *Teaching Mathematics* 2015

Connection

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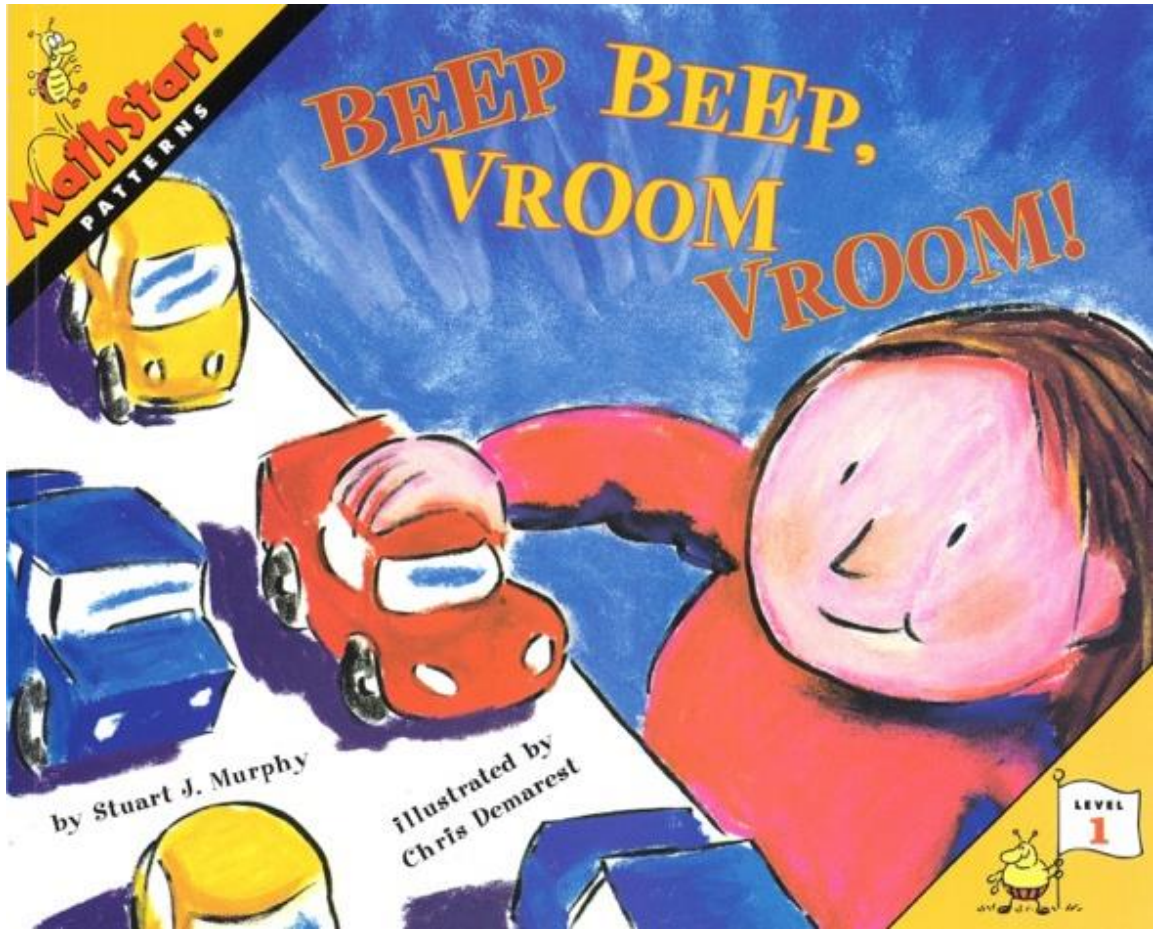
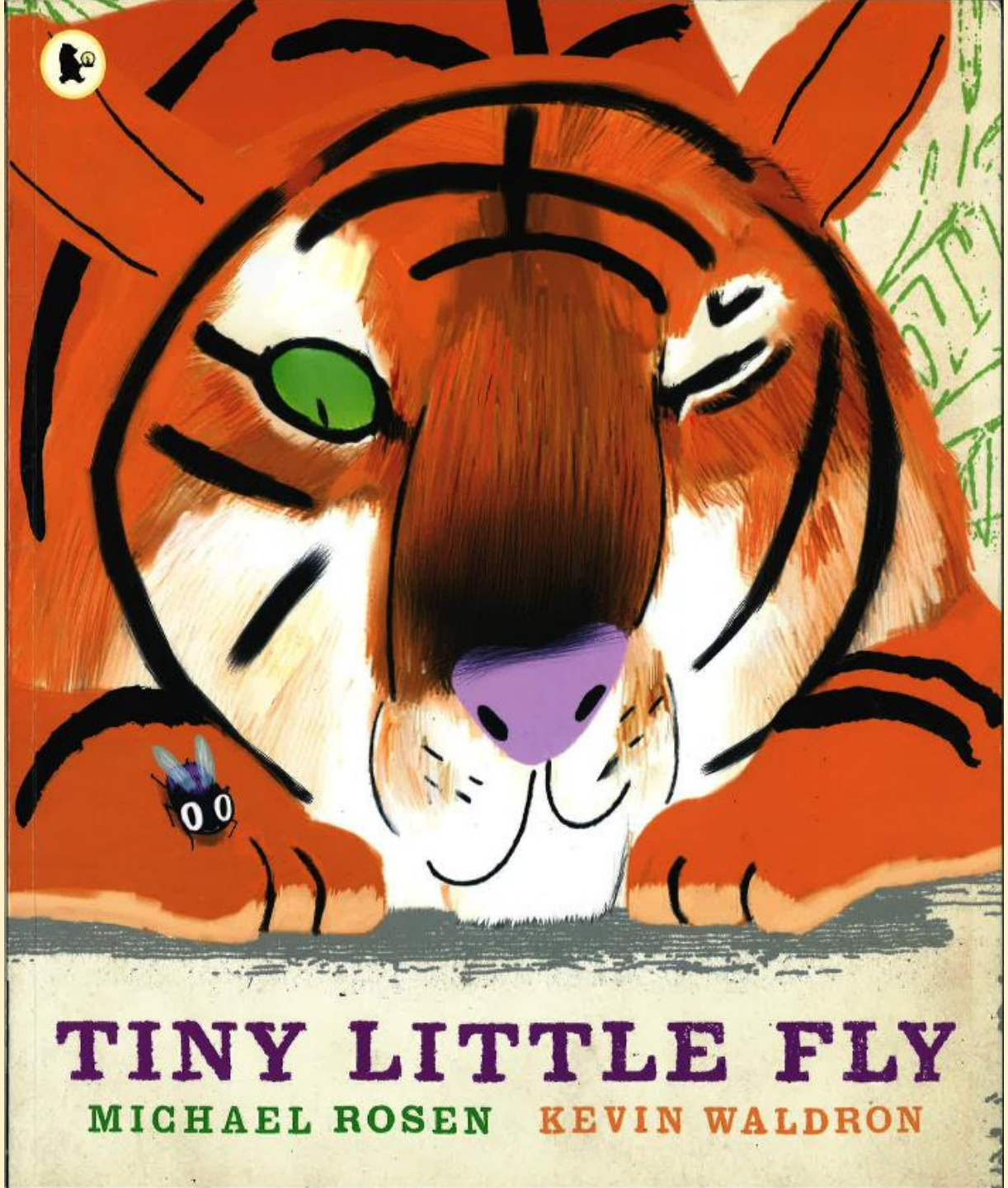
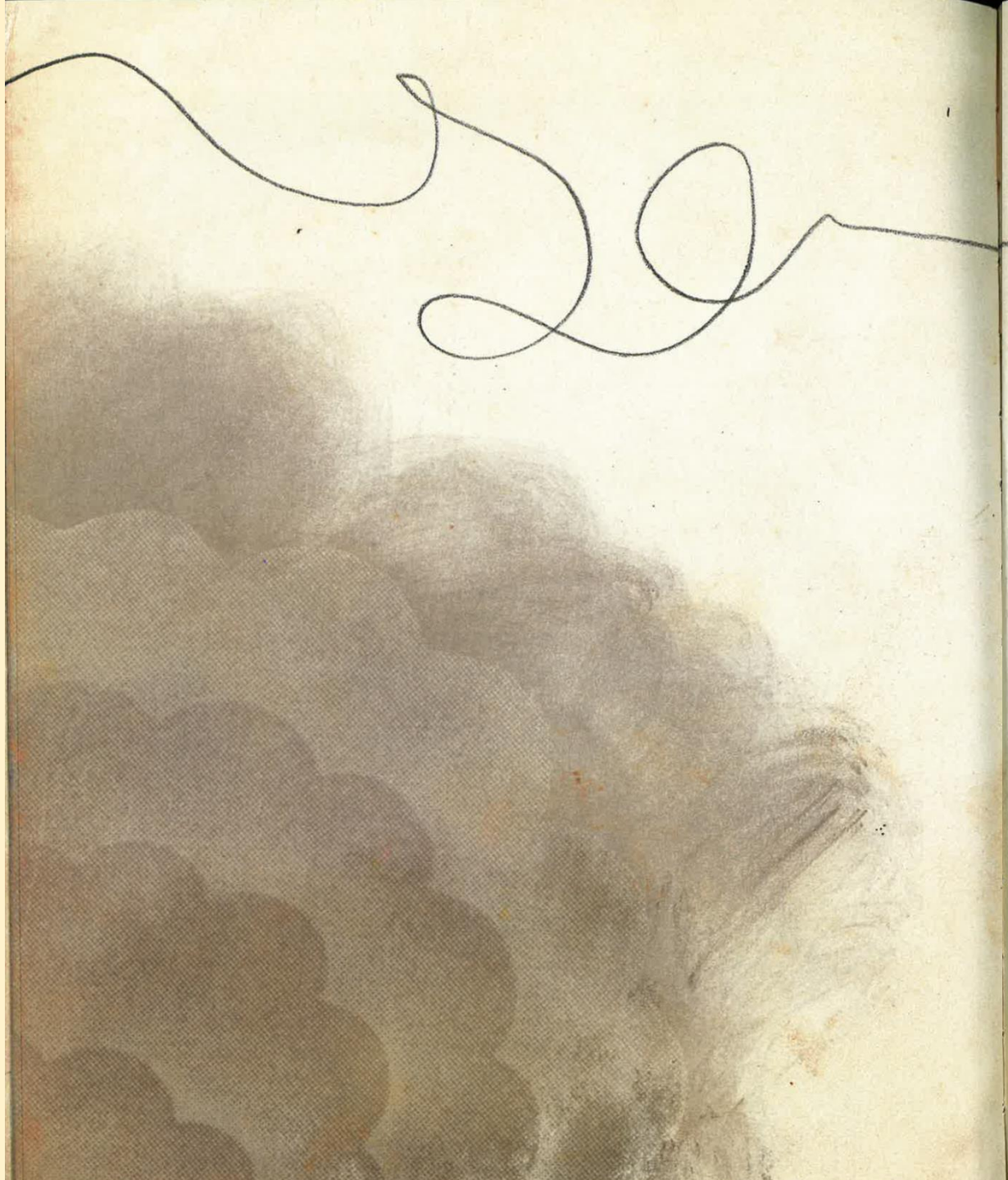
- Provocation
- Stories support the development of mathematical understanding through **emotional engagement**, promoting visualisation and mental imagery, and providing **shared context** for students (Averill, 2018).
- Example: *Beep, beep, vroom, vroom!*




TINY LITTLE FLY
MICHAEL ROSEN
KEVIN WALDRON

Tiny Little Fly,
Winks one eye...



More tiny flies!

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I saw 10 flies on my bedroom wall, and I knew how many there were straight away without counting them.

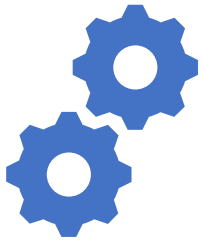
Can you draw what the 10 flies on the wall might have looked like?
Now draw them a different way.
Which picture do you think makes it easier to know there were 10 flies on my wall?

Enabling Prompt: for those stuck in the ‘zone of confusion’

- What if there were 6 flies on my wall?

Extending Prompt: For those who finish quickly

- What if there were 16 flies on my wall?



- Tension is the driving force that compels learners forward (Dewey,1938)
- Disrupts our understanding about life
- Drives us to reach toward new insights

Wondering Observing and Exploring

Action

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- Do what?
- What do we do with new understandings?
- What difference does it make to our broader understanding?
- What are our new questions?
- If action is not addressed, knowledge becomes siloed (is that a word?), artificial, school knowledge and not connected to the real world.

Reflection

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I USED TO THINK…, BUT NOW I THINK…

A routine for reflecting on how and why our thinking has changed

Use these sentence starters:

I used to think……

But now I think……..

Lastly, a reminder

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- Inquiry is not a set of instructional practices but a theoretical shift
- A stance of inquiry influences who learners become as human beings
- Inquiry transforms education from learning *about* to learning to *be* (Short 2009)