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# The challenges of teaching with challenging tasks

## MAV Keynote Presentation

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Mathematics Association of Victoria Conference, 6th and 7th December, 2018

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# (Overcoming)
# The challenges of teaching with challenging tasks

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# Who am I?

Completed my PhD in Primary Mathematics Education in 2017. Began as a lecturer at Monash in 2018 full-time.

Worked in a primary mathematics specialist role for the duration of my PhD (2014-2017).

Passionate about strengthening connections between research and practice.

Passionate about making mathematics more enjoyable to teach and learn.

Regular contributor to teacher practitioner journals, and current editor of the MAV publication *Prime Number*.

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# Overview

1. Overview of challenging tasks
    - What are challenging tasks?
    - What might a lesson involving a challenging task look like?
    - An example of a challenging task

2. (Overcoming) The challenges of teaching with challenging tasks
    - Classroom Management
    - Developing and using prompts
    - Sequencing learning

# What are challenging tasks?

Challenging tasks are demanding and thought-provoking mathematical problems that aim to include all students in the lesson through characteristics such as being simply-posed, possessing a low-floor and high ceiling, and including enabling and extending prompts (Sullivan & Mornane, 2014).

Challenging tasks (Sullivan et al., 2011):

- Must contain at least one enabling and extending prompt developed prior to the delivery of the lesson.
- Must be solvable through multiple methods/ approaches.
- Must be challenging and engaging, taking considerable time to complete (i.e., at least 10 minutes, most likely longer).

# What might a lesson involving a challenging task look like?

*Adapted from Stein et al. (2008)*

**Launch** the task (whole class):

- Early Years: A story hook
- Read the task (note: the ‘story hook’ might be embedded in the task as well)
- Clarify terminology/language
- Indicate expectations

**Explore** the task (individuals or small groups):

- Students work independently.
- Teacher roams, asks key questions, supports students to reason mathematically.
- Students access prompts as needed.

**Discuss/ Summarise** the task (whole class):

- Students present their solutions/ work, and the class discusses approaches.
- Teacher coordinates presentation of work samples and discussion (least to most mathematically sophisticated). Teacher may present additional solutions.

# An example of a challenging task

Summer time is fly time!

Learning Focus: Conceptual Subitising

Year Level: F-1

Story hook: Read Tiny Little Fly (Michael Rosen, Kevin Waldron) and/ or brief discussion about flies as part of Australian summer

Why bother with the ‘story hook’?:

- Stories support the development of mathematical understanding through emotional engagement, promoting visualisation and mental imagery, and providing shared context for students (Averill, 2018).

> *Just thinking about prep children, when we were getting into the length sequence, talking about prior knowledge and context, we found that it was really helpful to read a story and then no matter what prior knowledge the kids had they all had something to talk about and something to go from. So we read the King’s Foot and then they went off and did activities based on that story which really helped them. (Foundation Teacher, EPMC Early Years project).*

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# An example of a challenging task

Summer time is fly time!

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:

- What if there were 6 flies on my wall?

Extending Prompt:

- What if there were 16 flies on my wall?

How might your students approach this task? Do I have the size of the numbers right?

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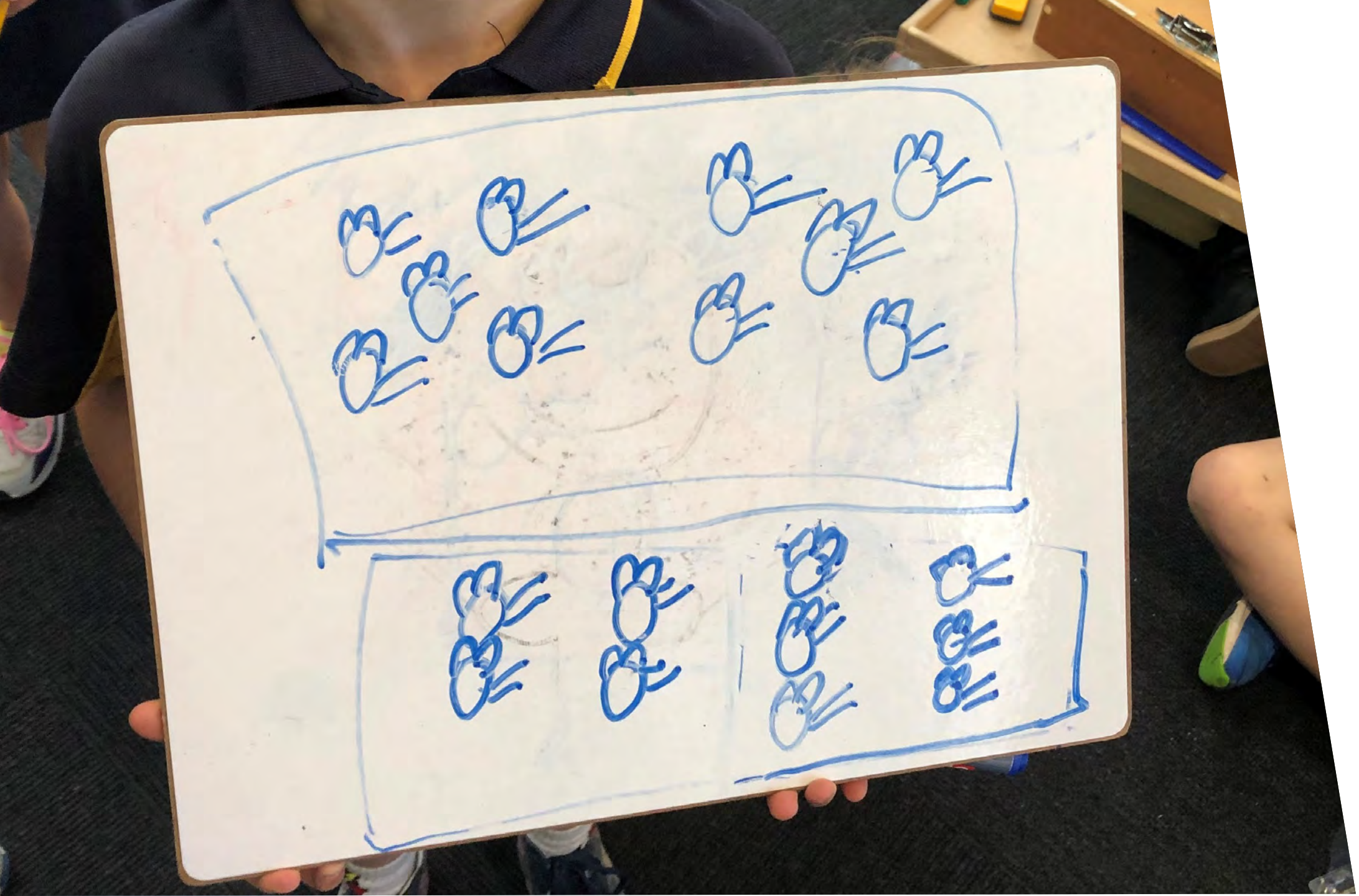

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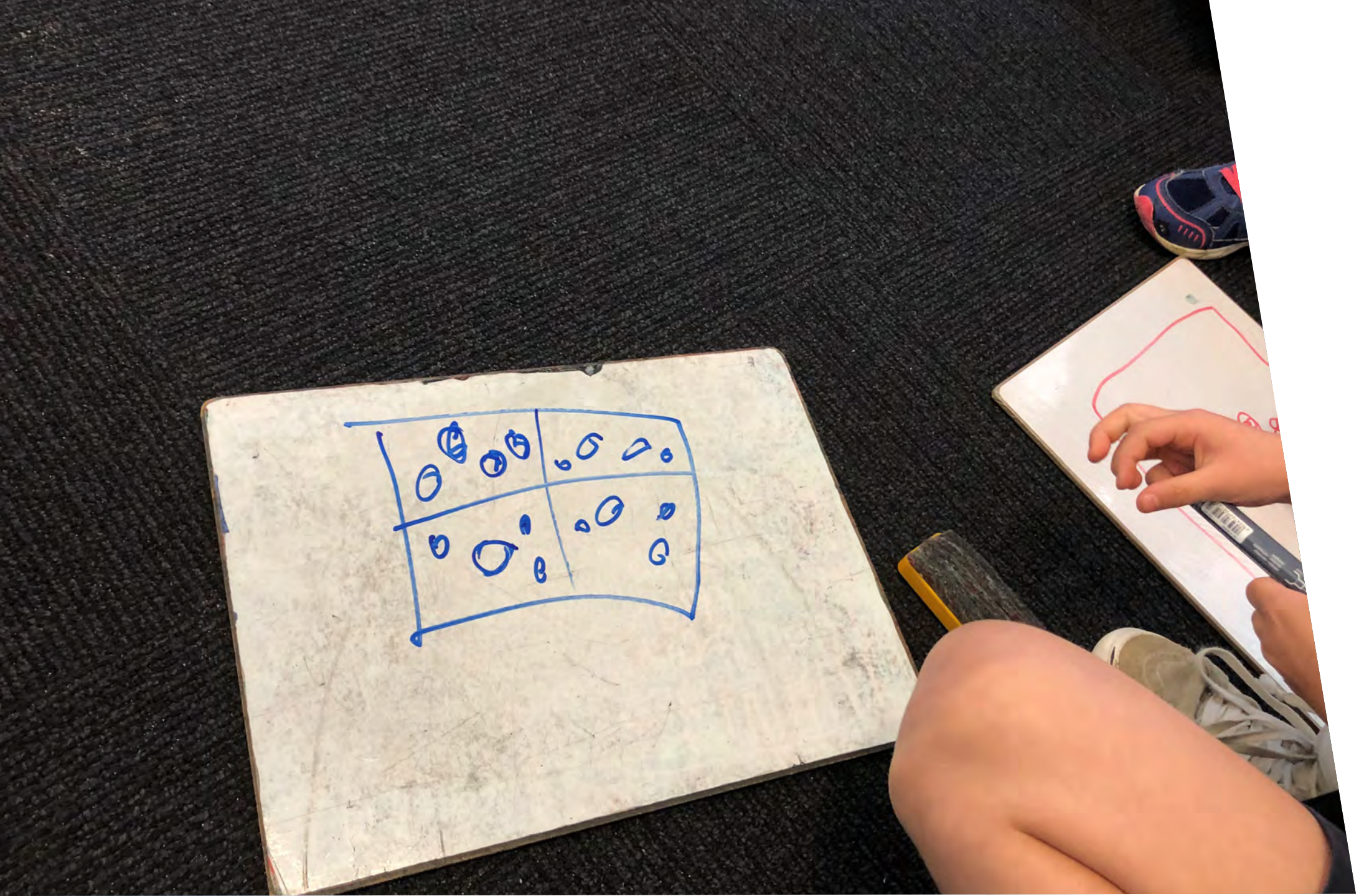

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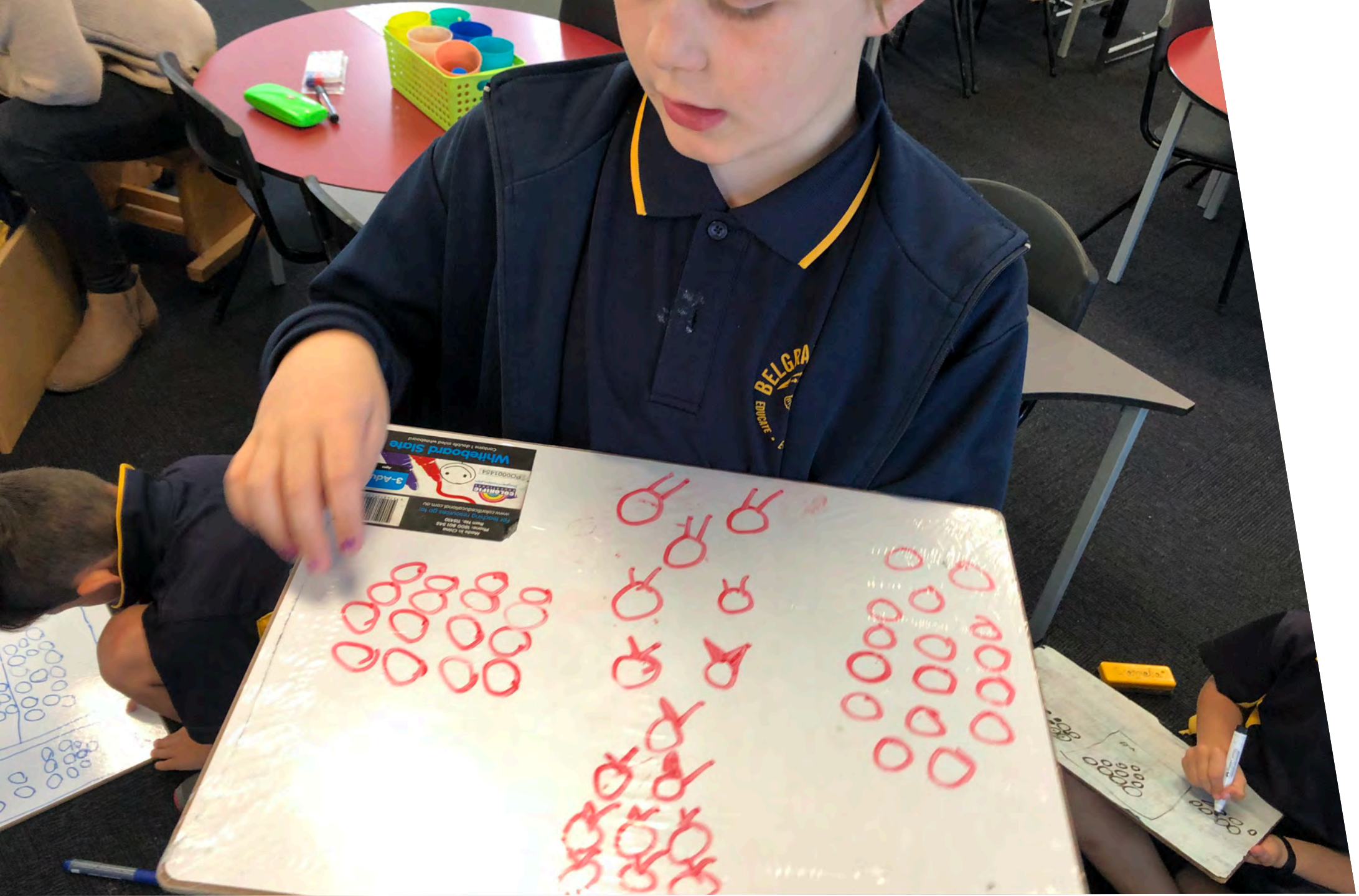


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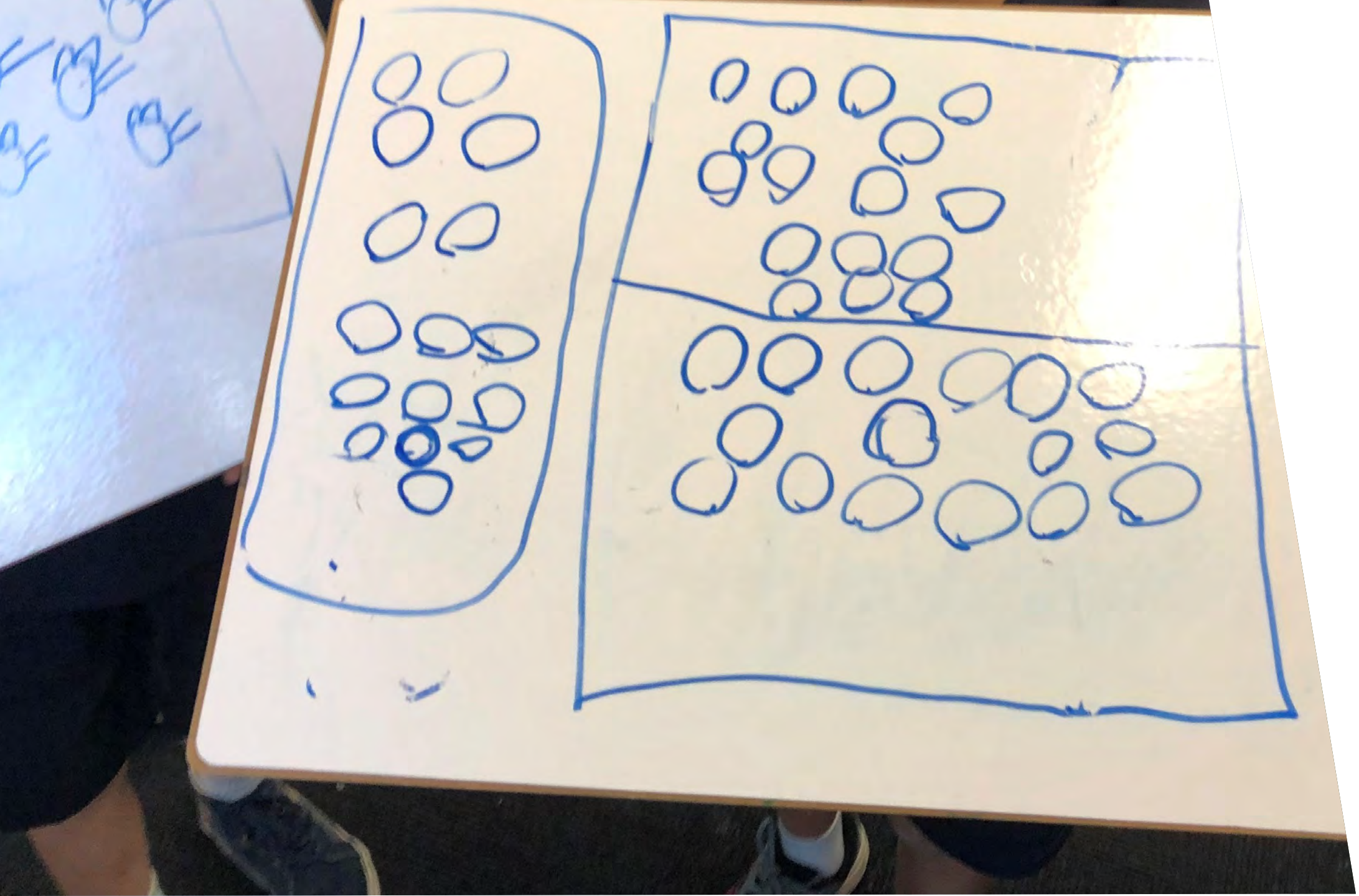

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# An example of a challenging task

*Sourced from Russo & Hopkins (2017a)*

## The Magical Donut Tree (Yr 1-2)

**Lesson Context:**

Kai and Amaya loved donuts, so their mum decided to plant a donut tree.


The tree was magical. Every day, the number of donuts on the tree doubled.

Kai was having his birthday party on Friday, so the family decided to not pick any of the donuts off the tree until then. On Monday, there were 3 donuts on the tree. Your job is to work out how many donuts there were on the tree by Friday.

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# An example of a challenging task

The magic donut tree

Enabling Prompt:

Kai was having his birthday party on Friday, so the family decided to not pick any of the donuts off the tree until then. On Monday, there were **1** donut on the tree. Your job is to work out how many donuts there were on the tree by Friday.

Extending Prompt:

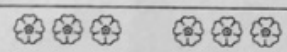
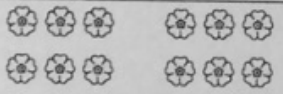
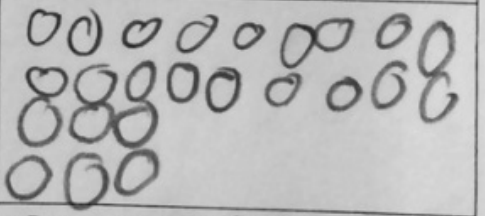
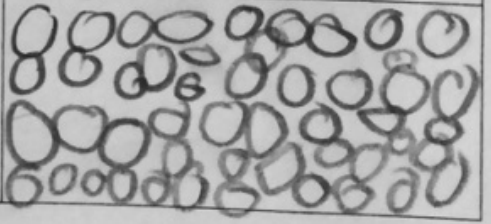
How many donuts would be on the tree if Kai decided to have the party on Saturday instead? How about if he had the party on Sunday? Can you keep the pattern going?

Pictures supporting thinking

Worked from the picture, and then counted:

“There are 12 donuts on Wednesday, so for Thursday, I have to draw 12 donuts, and then draw another 12 donuts”.

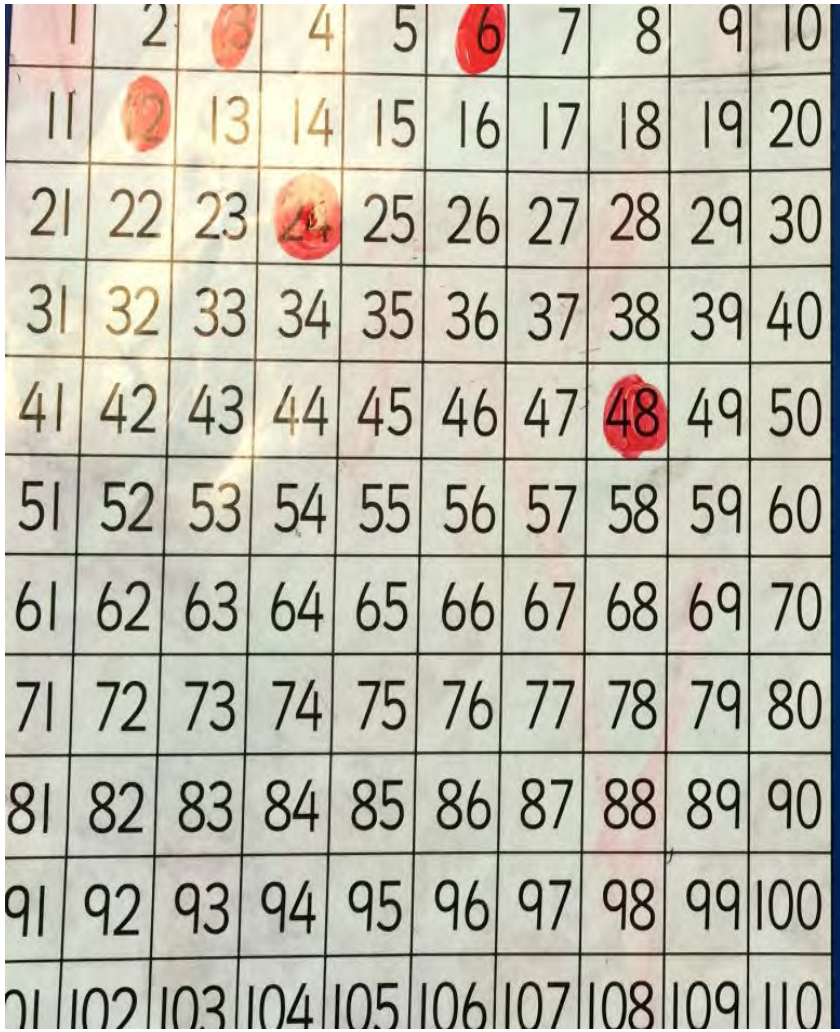
To help you, have a go at completing the following table. Remember, each day the number of donuts doubles.

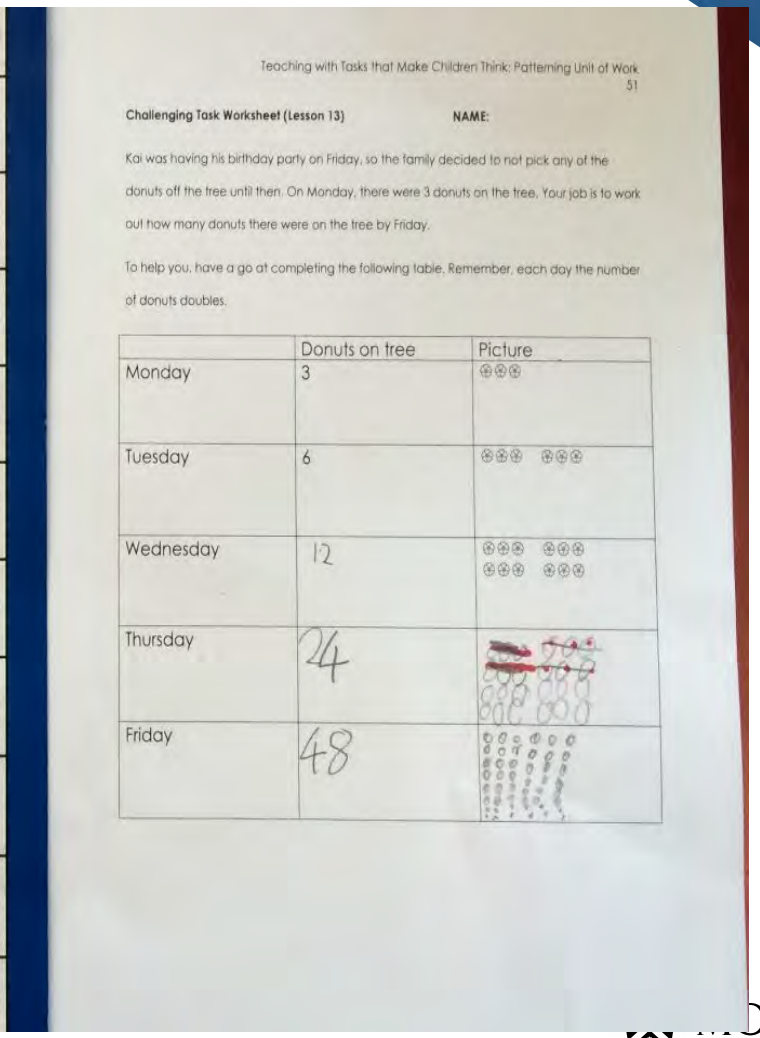
| | Donuts on tree | Picture |
|---|---|---|
| Monday | 3 |  |
| Tuesday | 6 |  |
| Wednesday | 12 |  |
| Thursday | 24 |  |
| Friday | 49 |  |

## Count-on supporting thinking

Use the hundreds chart to count-on, then completed the table.

“There are 12 donuts on Wednesday, so for Thursday, I have to start on 12 and count-on another 12”.



Teaching with Tasks that Make Children Think: Patterning Unit of Work
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**Challenging Task Worksheet (Lesson 13)** **NAME:**

Kai was having his birthday party on Friday, so the family decided to not pick any of the donuts off the tree until then. On Monday, there were 3 donuts on the tree. Your job is to work out how many donuts there were on the tree by Friday.

To help you, have a go at completing the following table. Remember, each day the number of donuts doubles.

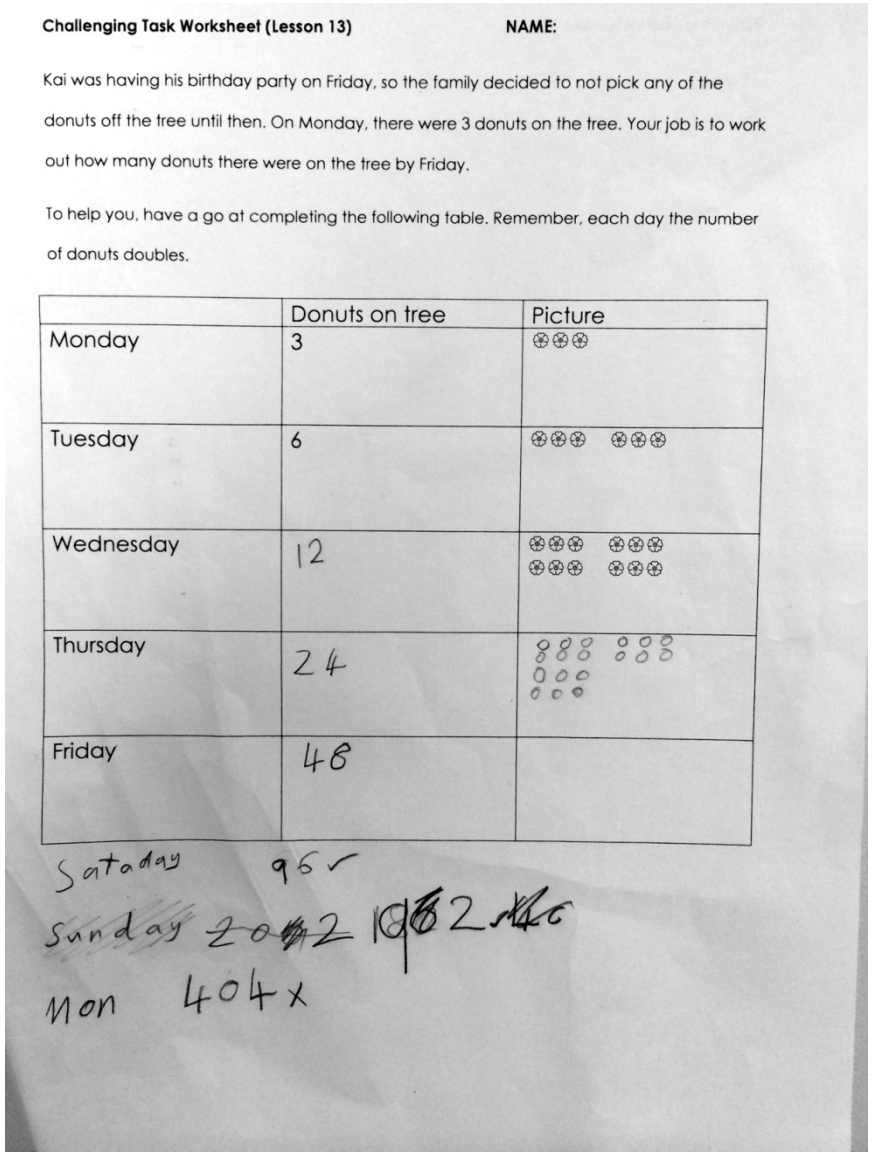
| | Donuts on tree | Picture |
|---|---|---|
| Monday | 3 | |
| Tuesday | 6 | |
| Wednesday | 12 | |
| Thursday | 24 | |
| Friday | 48 | |

## Mental strategies

Used place value partitioning, and then doubled the numbers in the table.

“‘There are 12 donuts on Wednesday, so for Thursday, I have to double 10, and double 2, and then put them together”.

Became increasingly difficult to use this strategy when attempting the extending prompt.



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| Monday | 3 | |
| Tuesday | 6 | |
| Wednesday | 12 | |
| Thursday | 24 | |
| Friday | 48 | |

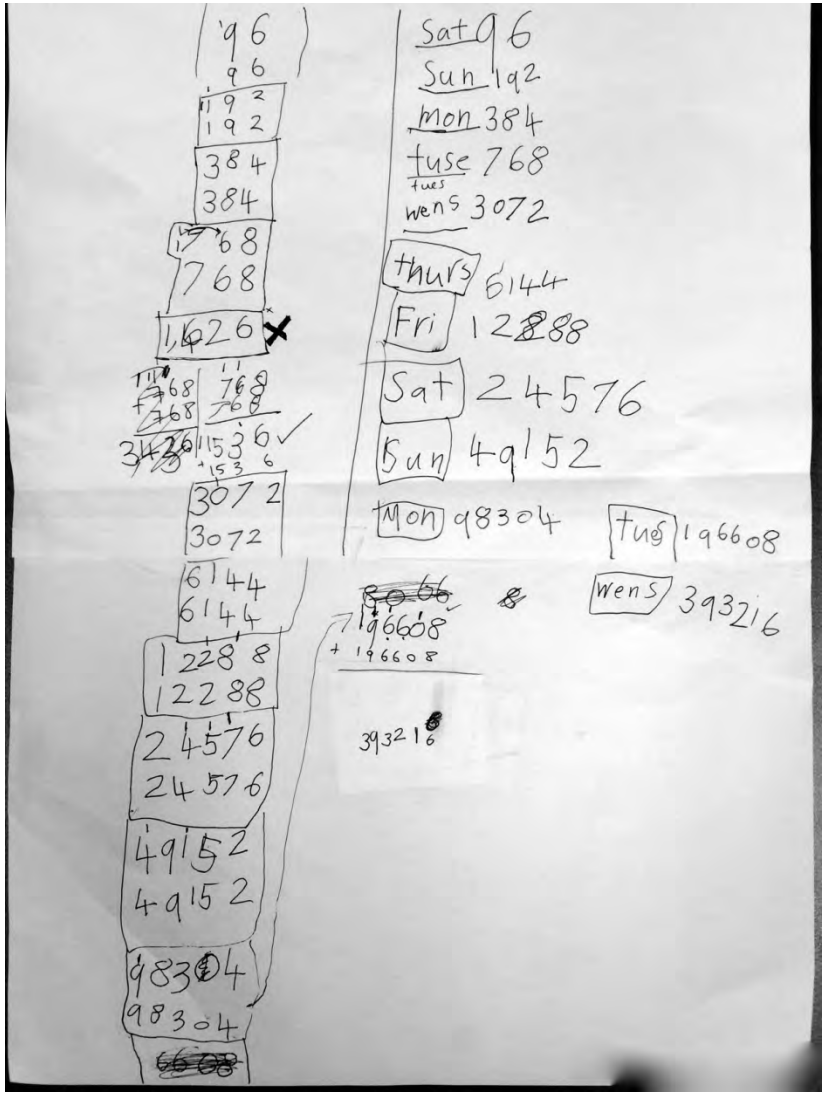
Satoday 96 ✓

Sunday 2042 1962 ✗

Mon 404 ✗

## Algorithm and calculator

The student took the problem home and continued to double numbers initially using the addition algorithm, and then a calculator…

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# (Overcoming) The challenges of teaching with challenging tasks

- Classroom Management
- Developing and using prompts
- Sequencing learning

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# Classroom Management

“These types of tasks are too hard for my kids. They’re not ready for them. They’ll give up.”

“If I try to use these tasks in my classroom, I’ll lose control of my kids!”

- They might and you might (particularly to begin with). During the first week of teaching Challenging Tasks with my Year 1 and 2 students I had:
    - Students crying
    - Students throwing things
    - Students screwing up their work
    - Students refusing to work
    - Students shouting out ‘I don’t get it’
    - Students off-task

# Classroom Management

"These types of tasks are too hard for my kids. They're not ready for them. They'll give up."

"If I try to use these tasks in my classroom, I'll lose control of my kids!"

Quote from an observing teacher (Russo & Hopkins, 2017b. p. 41):

> *Well I think initially when they first started off from the very first lesson they had absolutely no clue about what to do! I was thinking "oh no, they've got no idea". They were wandering around, they just sat there, they didn't have any idea about how to even approach the subject. I don't think they even really knew what you were asking of them… it was like they were in this cloud of mist, and they didn't know where they were.*
>
> *Each day it got better and better, so that by the end, they knew what they had to do. They knew how to use the tools that were there like the counting chart and the abacus… They had some idea as to how they were supposed to tackle the problem. More and more kids switched into what the actual problem was…*

# Classroom Management

"These types of tasks are too hard for my kids. They're not ready for them. They'll give up."

"If I try to use these tasks in my classroom, I'll lose control of my kids!"

- Quotes from students (Yr 1 & 2) about what they valued when reflecting on their own work involving challenging tasks (Russo & Hopkins, 2017c).

  *It was fun as well. Because it was sort of hard for you. I like challenges because I need to use my brain more.*

  *Because it was really difficult and I gave it a go.*

  *Because even though it was really really hard for my brain to figure out, I got it anyway.*

  *I counted in different ways that I have never knew how to count by before. And I think that I learnt a lot more maths stuff at this school. We counted by 2s and we did doubles (at our old school), but we never understood it. And now I understand it.*

  *Because it shows them how I do challenges my way.*

  *Because you can explain – you can learn stuff. And that is how I got really good at maths. I listened to people and they told me strategies. And then you know I might be able to do it that way next time.*

# Classroom Management

"These types of tasks are too hard for my kids. They're not ready for them. They'll give up."

"If I try to use these tasks in my classroom, I'll lose control of my kids!"

<u>Overcoming this challenge:</u>

- If you persist with teaching with challenging tasks**, your students will get there.**
- Have consistently high expectations and build routines (Russo & Hopkins, 2018):

  e.g., ensuring that all potential resources (e.g., bead-frames, hundred charts, enabling prompts) are located in the same place each lesson

  e.g., being very clear about how the lesson is structured (the stages) and sticking to this structure.

# Classroom Management

"I'm not sure I'm ready to teach this way."

Overcoming this challenge:

- If you persist with teaching with challenging tasks, **you will get there.**
- "When is the right time to begin teaching with challenging tasks?":

  *You jump in and you give it a go… You just do it… because if it doesn't work, that's okay, they're still learning. If you think "oh I could've done that better" you can do it again and you just keep going with it. Just as it's okay for them to make mistakes it's okay for us to make a mistake and to acknowledge that "you know what, I didn't do that overly crash hot, I'm going to give that another go".*

  *I think as teachers you can't be afraid. We have this mantra at our school, I think it's ready, fire, aim. Because if you get ready and then you aim sometimes you don't fire, so then you go back to being ready again. But if you just get in there, have a go and do it, "gosh that was amazing" or "no that was terrible, that didn't work, let's try again". (Foundation Teacher, EPMC Early Years project).*

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# (Overcoming) The challenges of teaching with challenging tasks

- Classroom Management
- Developing and using prompts
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# (Overcoming) The challenges of teaching with challenging tasks

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# Developing and using prompts

## What are enabling prompts?

Enabling prompts are designed to reduce the cognitive demand of the task by changing how the problem is represented, helping the student connect the problem to prior learning and/or removing a step in the problem (Sullivan, Mousley & Zevenbergen, 2006)

## What are extending prompts?

Extending prompts expose students to an additional task that requires them to use similar mathematical reasoning, conceptualisations and representations as the main task, with a view of increasing the level of cognitive demand (Sullivan et al., 2006)

# Developing and using prompts

Enabling prompts:

- Can be referred to as the ‘hint sheet’.
- Should be in the same place each lesson (e.g., the teacher’s chair at the front).
- Should be accessed by the student when required, after they’ve spent at least some time grappling with the problem in the “zone of confusion” (Sullivan et al., 2014, p. 11).
- As much as possible, enabling prompts should use visual cues that support the relevant mathematical thinking (e.g., images, tables, diagrams, concept cartoons).

# Developing and using prompts

"My students won't use enabling prompts."

- Initially may be underutilised by students: not used to taking responsibility, perceived stigma.

- Consider praising students for being proactive in accessing the enabling prompt.

- Goal to build a culture where students take responsibility for their own learning, and foster the belief that they can become better mathematicians through effort, calculated risk-taking and resourcefulness.

# Developing and using prompts

"Is anything that makes a problem easier good enough for an enabling prompt?"

- General rule of thumb might be 'good enough'
- However, ideally, the choice of enabling prompt should be influenced by the primary learning objective.
- Getting all students to focus on the same primary learning objective lays the foundation for a meaningful and inclusive whole discussion.
- Prompts should not just make the task easier or harder, but deepen engagement with the particular learning focus.

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# Prompts and Learning Objectives

Summer time is fly time!

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:

- What if there were 6 flies on my wall?

Extending Prompt:

- What if there were 16 flies on my wall?

# Prompts and Learning Objectives

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Where is the maths?

Learning objectives:

- Conceptual subitising
- Exploring part-whole relationships focused around the quantity 10

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# Prompts and Learning Objectives

What is the primary learning objective?

- Conceptual subitising

- Exploring part-whole relationships focused around the quantity 10

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# Prompts and Learning Objectives

What is the primary learning objective?

- **Conceptual subitising**

  Enabling Prompt: Reducing the size of the numbers

  What if there were 6 flies on my wall?

- Exploring part-whole relationships focused around the quantity 10

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# Prompts and Learning Objectives

What is the primary learning objective?

- Conceptual subitising

  Enabling Prompt: Reducing the size of the numbers

  What if there were 6 flies on my wall?

- **<u>Exploring part-whole relationships focused around the quantity 10</u>**

  Enabling Prompt: Changing the representation

  Pretend these 10 counters are the flies. Show me what the pattern might have looked like.

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# Prompts and Learning Objectives

Why it matters…

- the learning focus helps direct the mathematical discussion, for example, the teacher's choice of work samples, and the features emphasised
- it helps shape where the teacher will go next with the learning

Learning Objectives and possible follow-up tasks

- Conceptual subitising

  Delicious Donuts Task

- Exploring part-whole relationships focused around the quantity 10

  Tower Task

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# Conceptual subitising: Follow-up task

Delicious donuts!

I ordered two donuts. One had 19 sprinkles on it and the other had 7. I knew the first donut had 19 sprinkles almost straight away. But I had to count the 7 sprinkle donut.

Draw what the donuts might have looked like.

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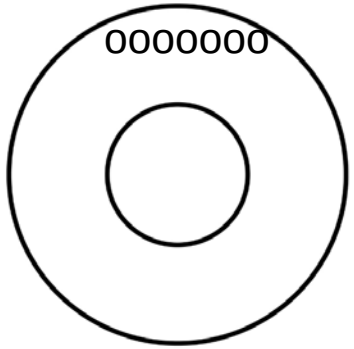
# Conceptual subitising: Follow-up task

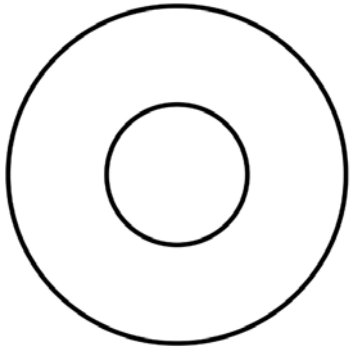
Delicious donuts!

Enabling Prompt

Did you have to count the sprinkles?




Put some sprinkles on this donut so you *just know* how many there are straight away



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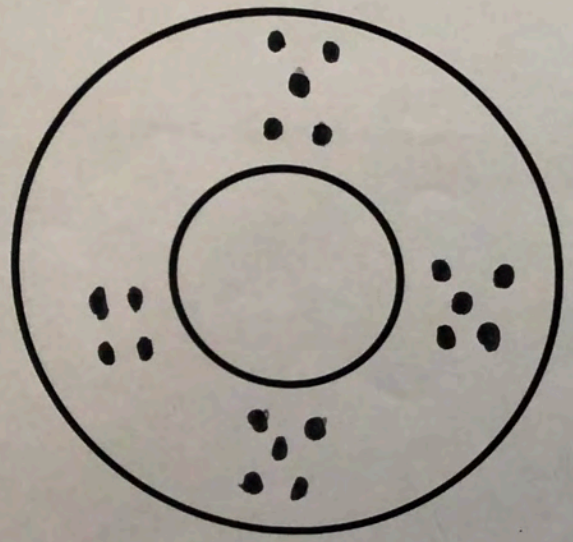

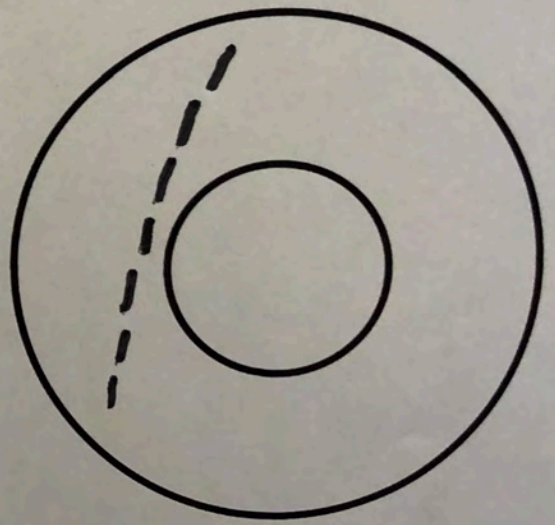

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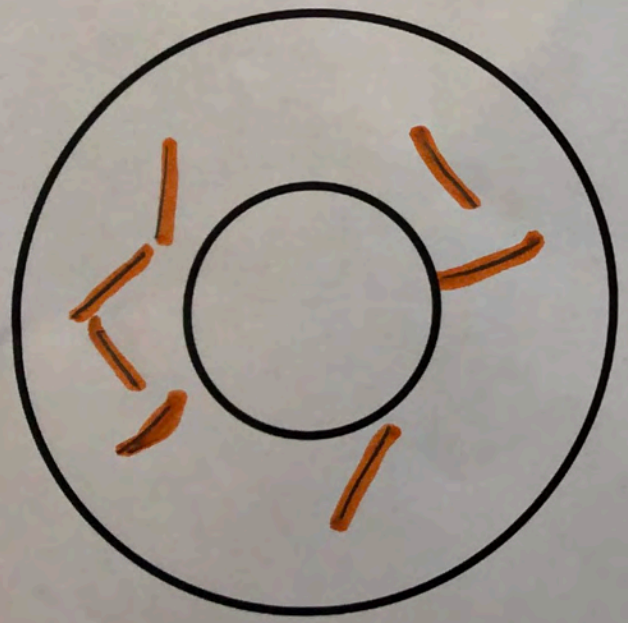

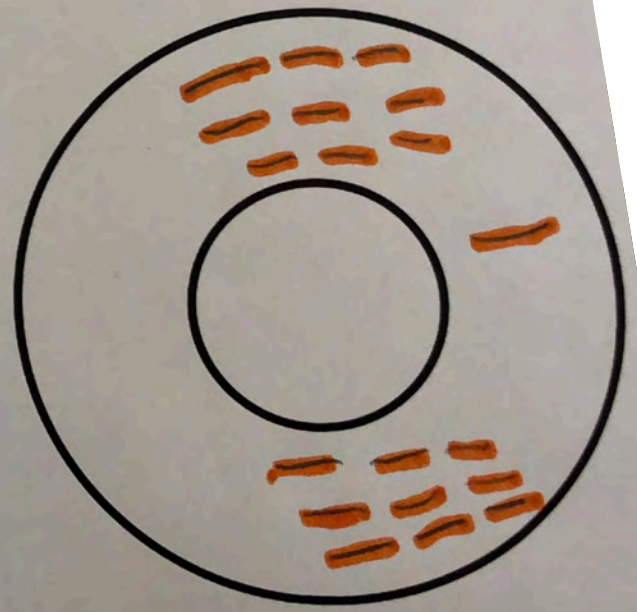

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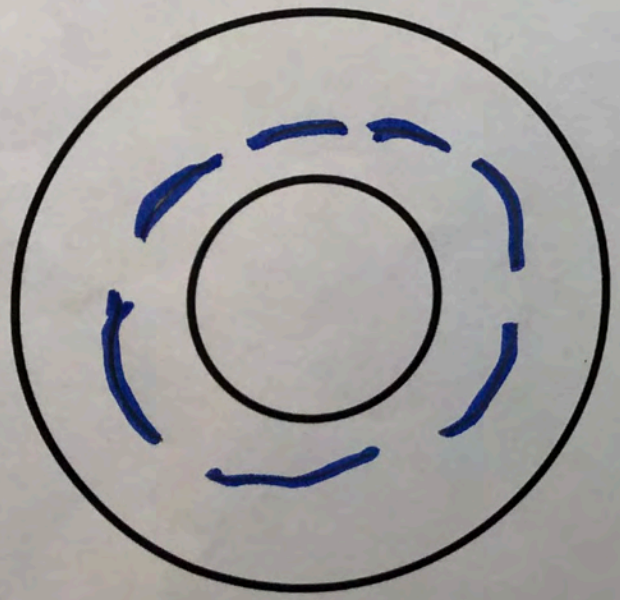

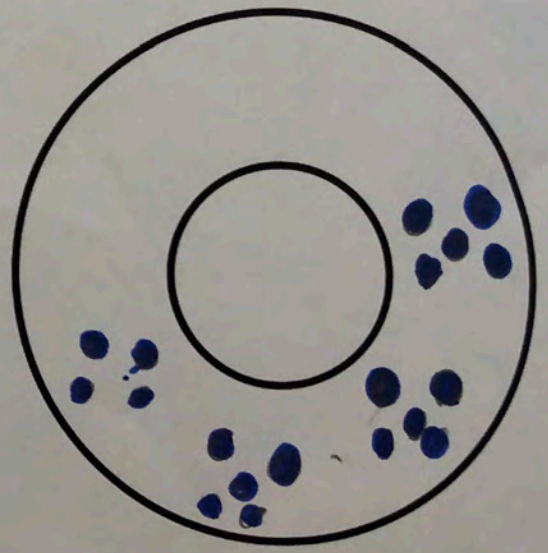

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# Conceptual subitising: Follow-up task

Delicious donuts!

Extending Prompt:

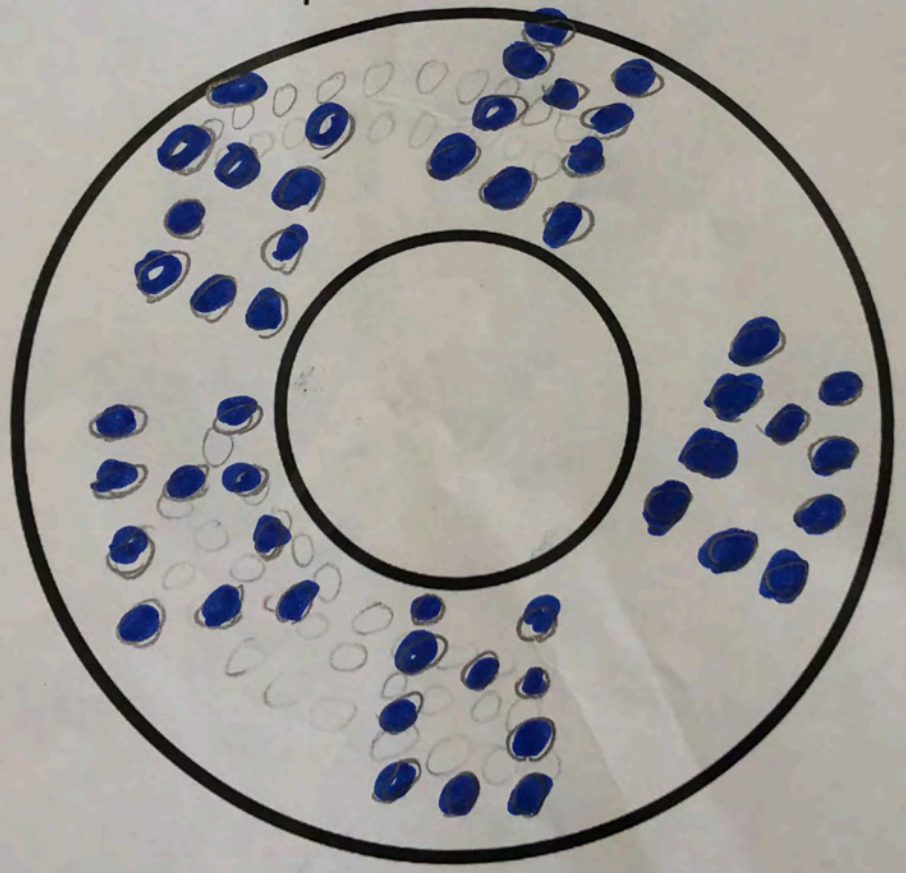
- What are the most sprinkles that might be on a donut so that you could tell how many there are almost straight away? Draw a picture of this donut.

# Delicious Donuts

*Extending prompt*

***Super challenge***

*What are the most* sprinkles that might be on a donut so that you could tell how many the *are almost straight away?* Draw a picture of this donut.



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# Delicious Donuts

*Extending prompt*

***Super challenge***

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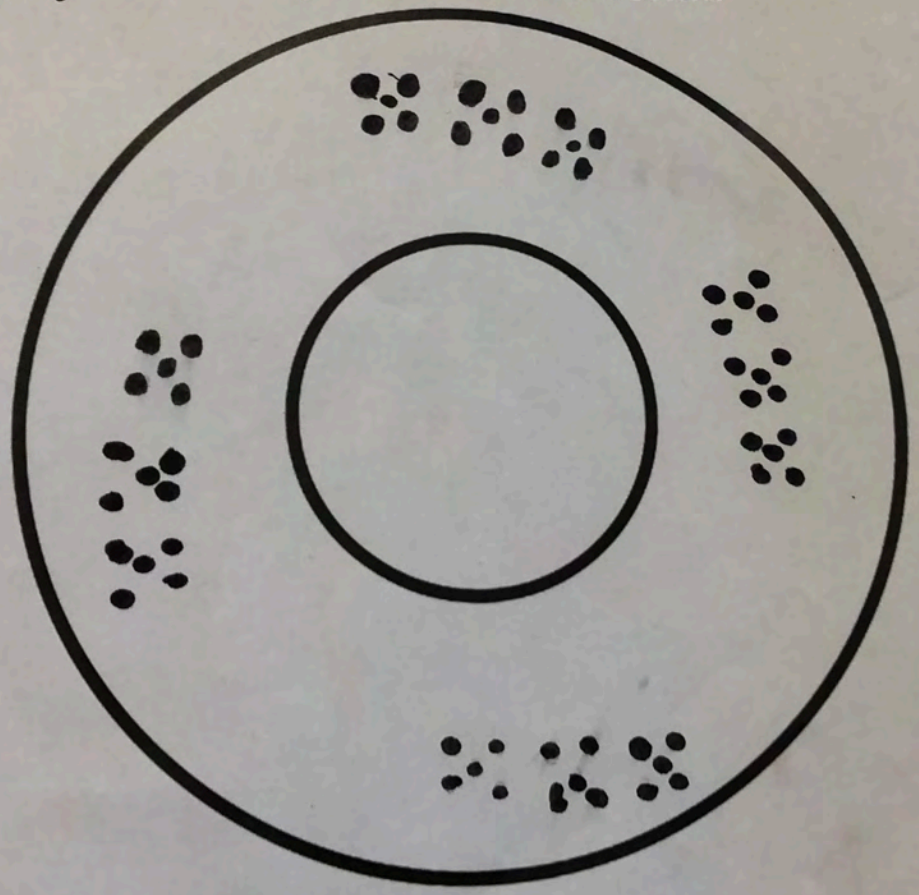

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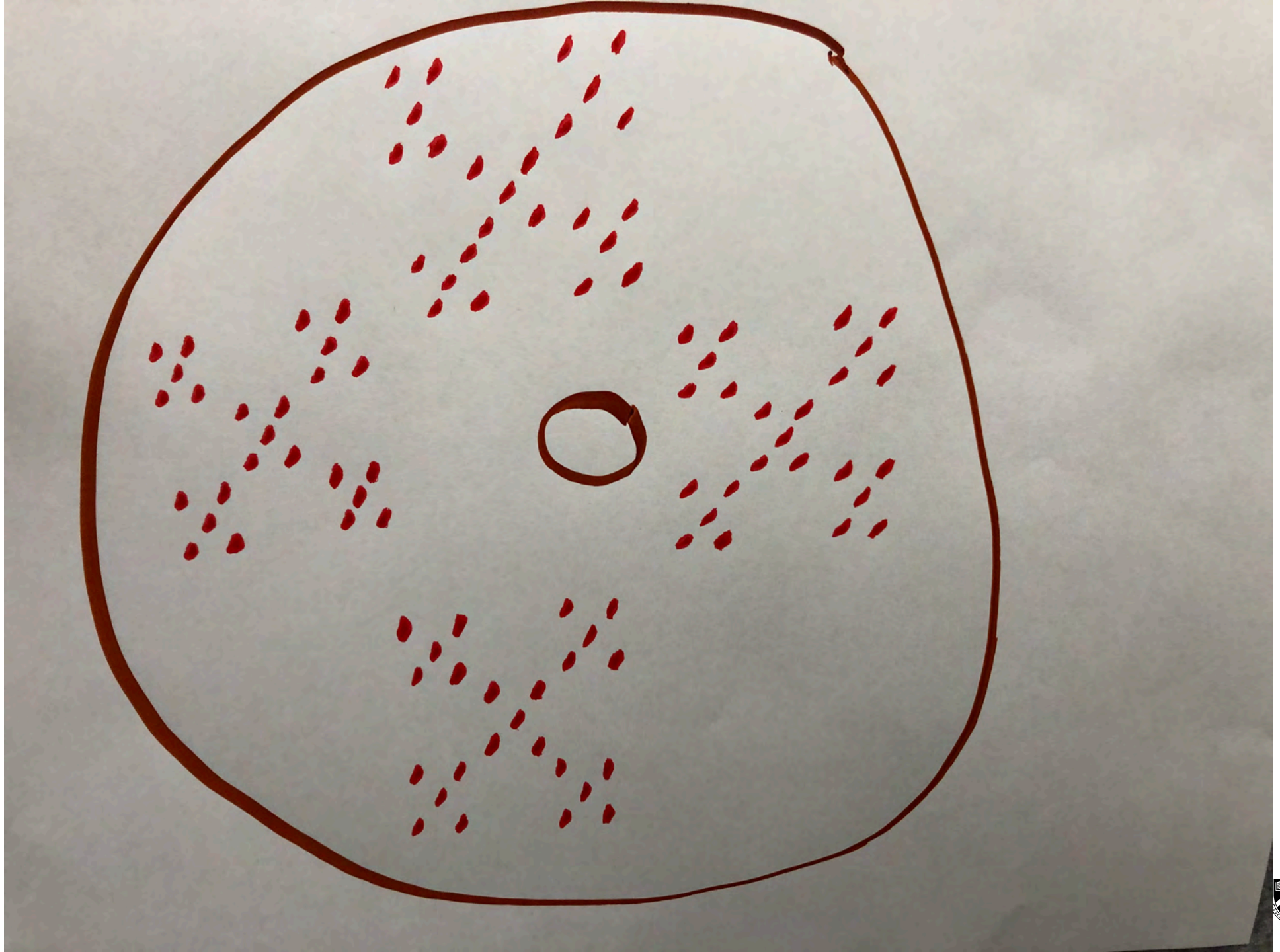

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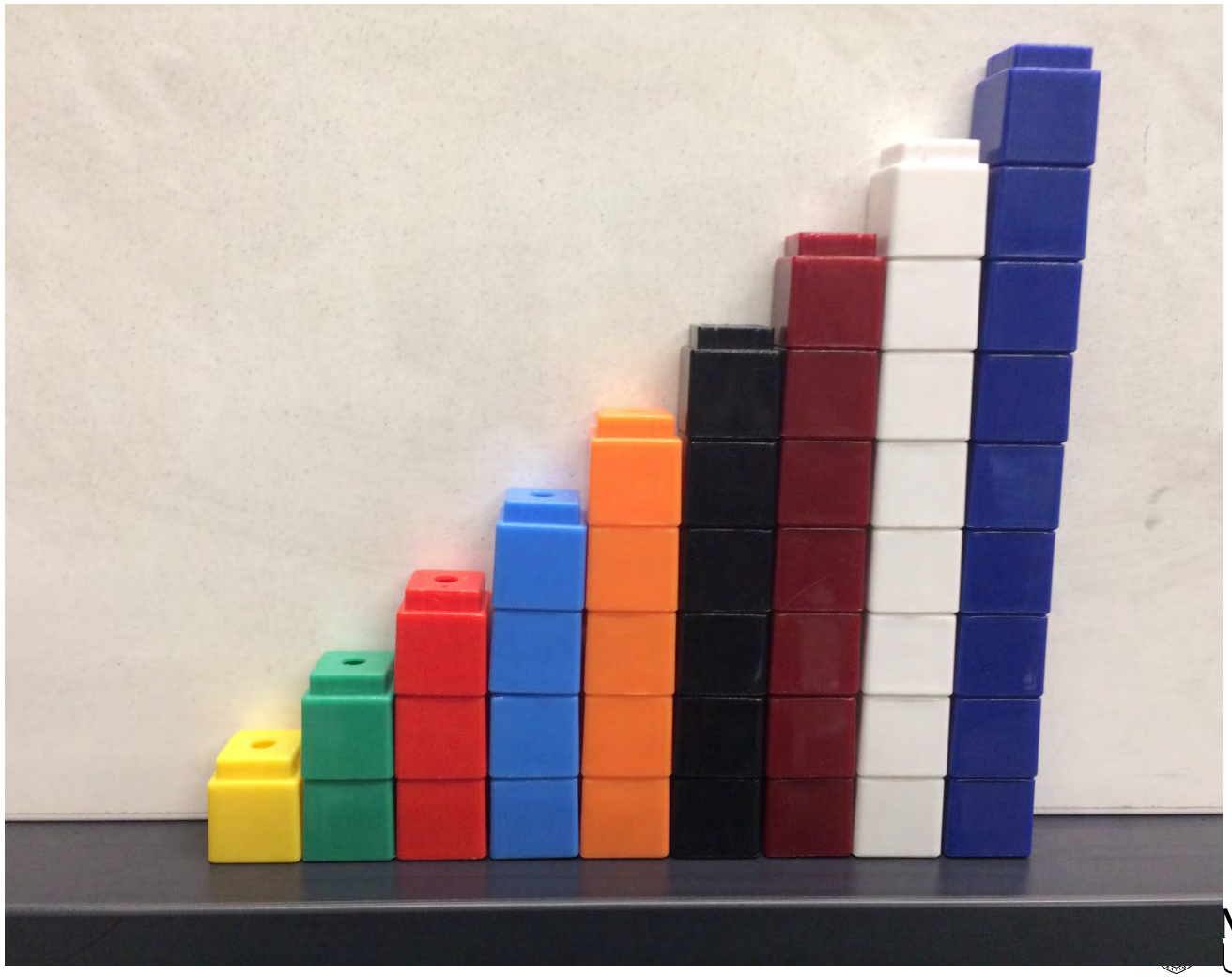
# Exploring part-whole relationships focused around the quantity 10

*Sourced from Hopkins & Russo (2017); Inspired by Sullivan (2017)*

**Tower Task**

Can you create a tower that is exactly 10 blocks tall from these smaller towers? Record your solution.



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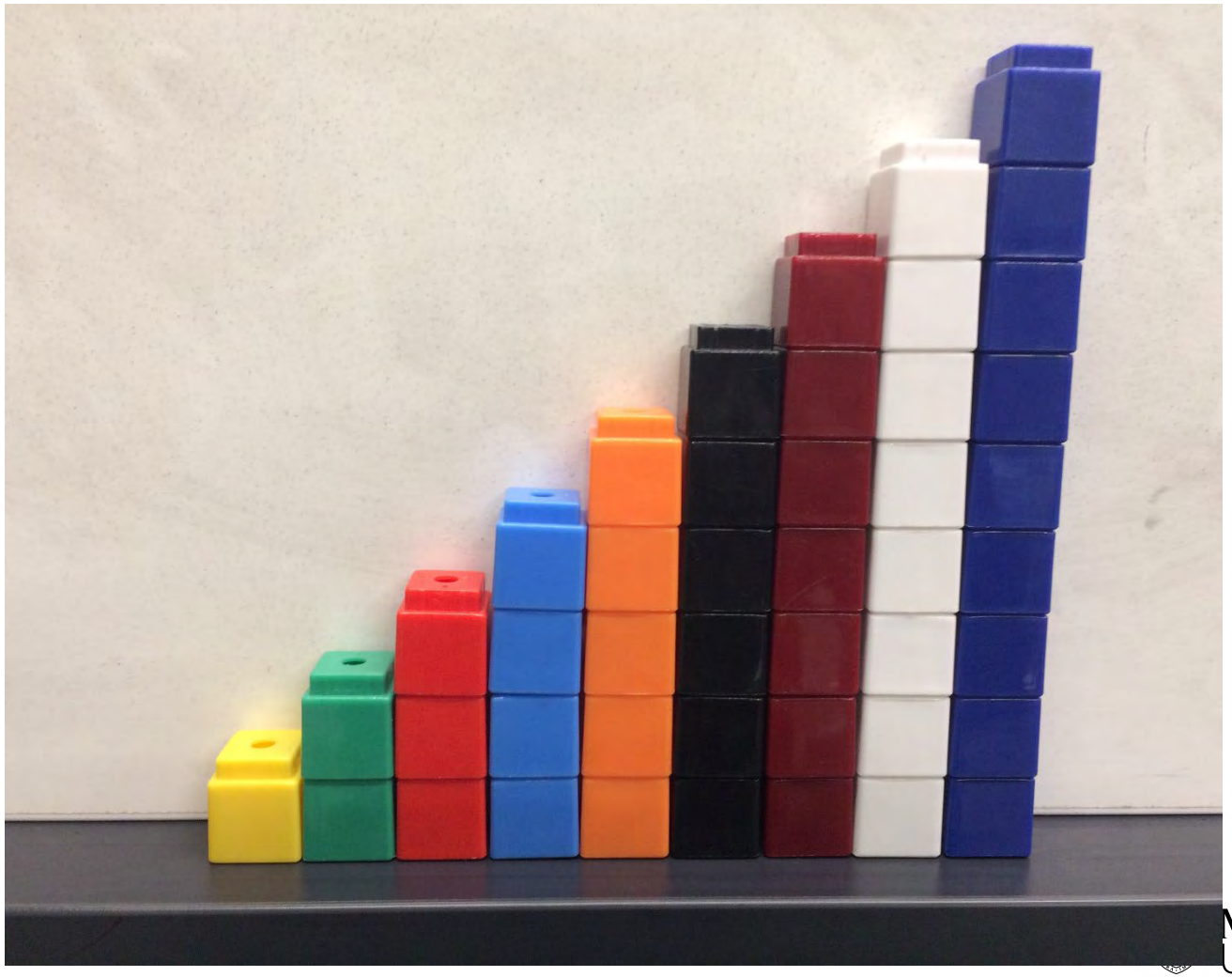
# Tower Task

Enabling Prompt

- To help you, create the towers like the ones in this picture *(removing a step in the problem; focus on concrete representations).*

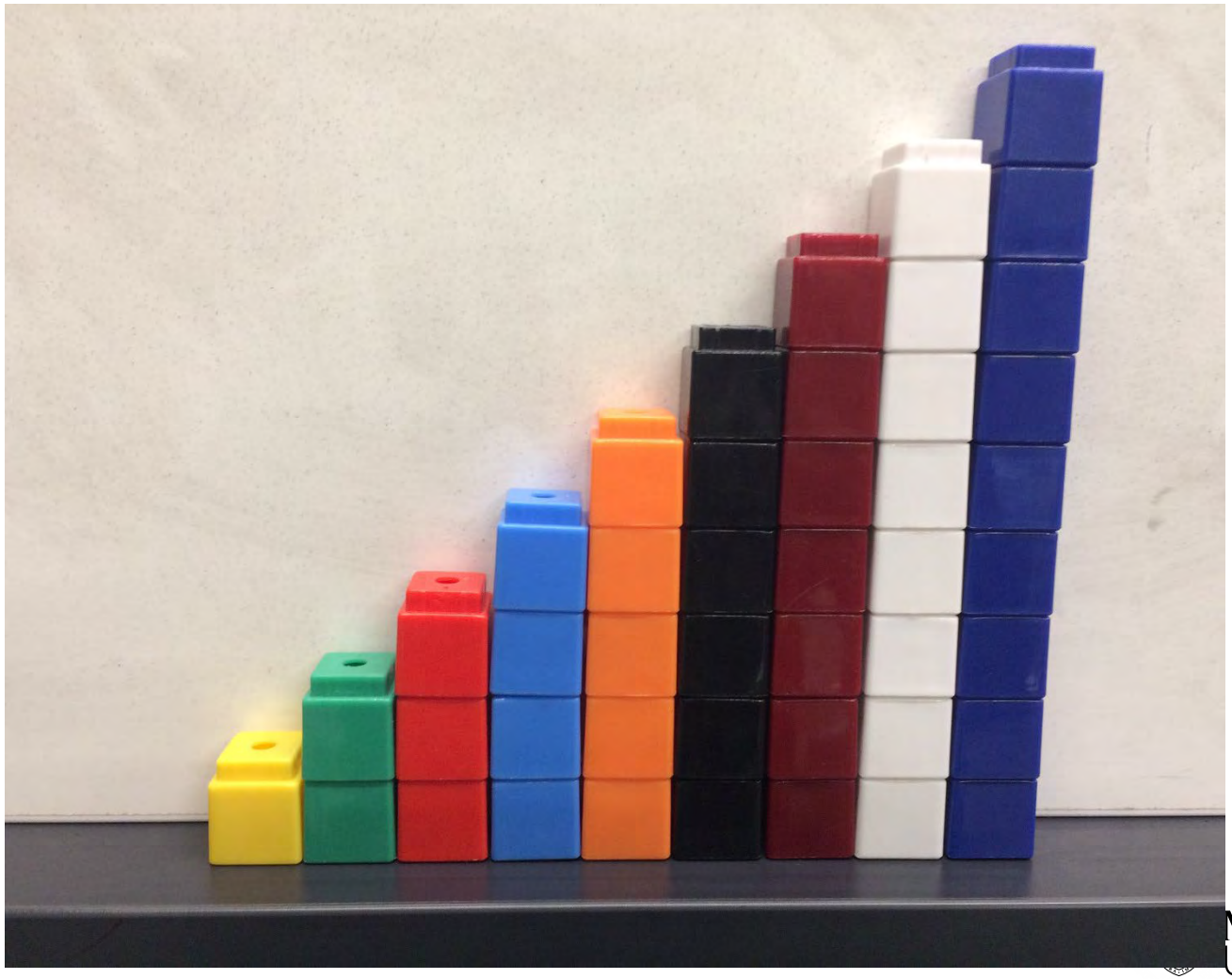
- Can you create a tower that is exactly 5 blocks tall from these smaller towers? Record your solution *(reducing the size of the numbers; reducing the number of possibilities).*



# Tower Task

Extending Prompt

- There are exactly nine solutions. Can you find them all? (*encouraging students to be systematic in their strategy and recording*).



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# (Overcoming) The challenges of teaching with challenging tasks

- Classroom Management
- Developing and using prompts
- **Sequencing learning**

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# Sequences of tasks

"I've taught a couple of challenging tasks, but where to next? What's the big picture?"

"How often should I be teaching with challenging tasks?"

- Although units of work have been developed with one or more challenging tasks as the centrepiece for each lesson, often challenging tasks are presented as pairs (or sometimes triplets) of tasks or lessons.

- Recently, Peter Sullivan, Sharyn Livy, Ann Downton (Monash University), Janette Bobis (Sydney University) and myself have been exploring the idea of embedding challenging tasks in an interconnected sequence of learning.

- A sequence is comprised of progressively more complex learning suggestions. Under each learning suggestion, several challenging tasks might be explored.

# Characteristics of sequences…

The sequences are proposed to:

- be structured similarly, especially identifying relevant curriculum foci and learning goals;
- represent one to two weeks of classroom mathematics lessons;
- facilitate movement from concrete to pictorial to symbolic/mental images;

- be challenging for students in that they will not initially know how to solve the problems;
- allow students time to make choices on the type of answer and/or approaches to solution; and
- be explicitly differentiable through a “low floor high ceiling” nature or enabling and extending prompts.

# Example of a sequence

Length Sequence…

# Length

Peter Sullivan, Janette Bobis, Ann Downton, Sally Hughes, Sharyn Livy, Melody McCormick, James Russo

# Summing up

1. Overview of challenging tasks
    - What are challenging tasks?
    - What might a lesson involving a challenging task look like?
    - An example of a challenging task

2. (Overcoming) The challenges of teaching with challenging tasks
    - Classroom Management
    - Developing and using prompts
    - Sequencing learning

# (Overcoming) The challenges of teaching with challenging tasks

**Classroom Management**

“These types of tasks are too hard for my kids. They’re not ready for them. They’ll give up.”

“If I try to use these tasks in my classroom, I’ll lose control of my kids!”

“I’m not sure I’m ready to teach this way.”

- If the teacher persists with teaching with challenging tasks, students will learn to persevere
- Routine and consistent (high) expectations important
- If the teacher finds the process daunting, there is an opportunity for the teacher to model ‘giving it a go’, demonstrating how mistakes can be viewed as learning opportunities rather than failure.

# (Overcoming) The challenges of teaching with challenging tasks

**Developing and using prompts**

“My students won’t use enabling prompts.”

“Is anything that makes a problem easier good enough for an enabling prompt?”

- Prompts should be in the same place in the classroom every lesson
- Importance of visual cues so students can access prompts independently
- Develop a culture of ‘self-help’; students decide when to get prompts
- Praise students who seek out prompts (initially)
- **Choice of prompt should be shaped by the primary learning objective**

# (Overcoming) The challenges of teaching with challenging tasks

**Sequencing learning**

“I’ve taught a couple of challenging tasks, but where to next? What’s the big picture?”

“How often should I be teaching with challenging tasks?”

- Challenging tasks often developed in lesson pairs or triplets
- Recent focus on developing sequences of learning incorporating challenging tasks
- **Stay tuned, more to come…**

# Questions and discussion

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