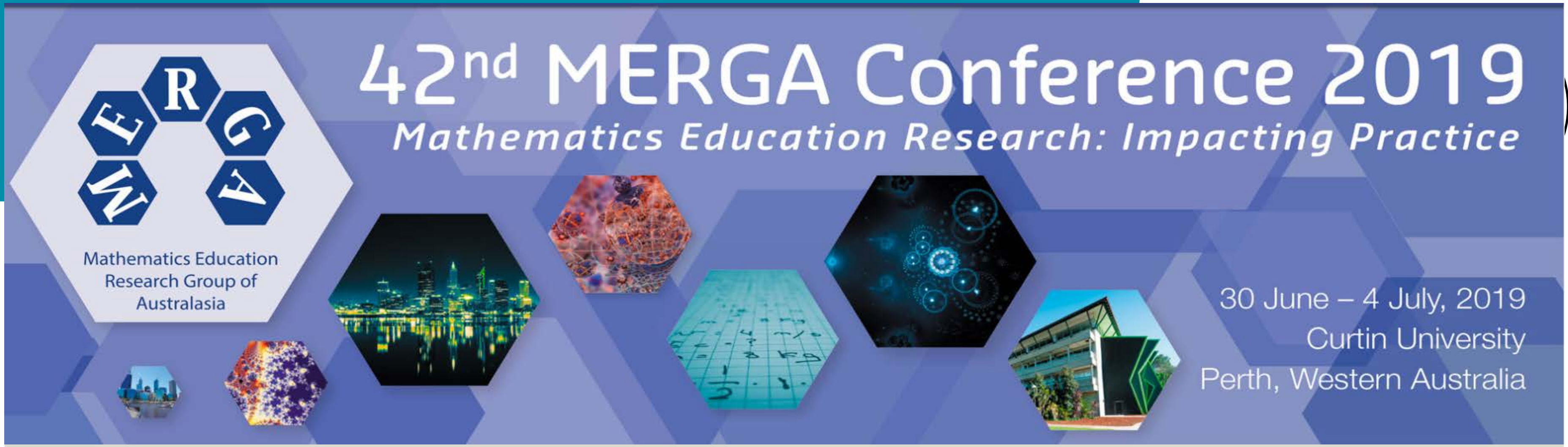

Interdisciplinary Mathematics and Science (IMS) Learning in the Primary School

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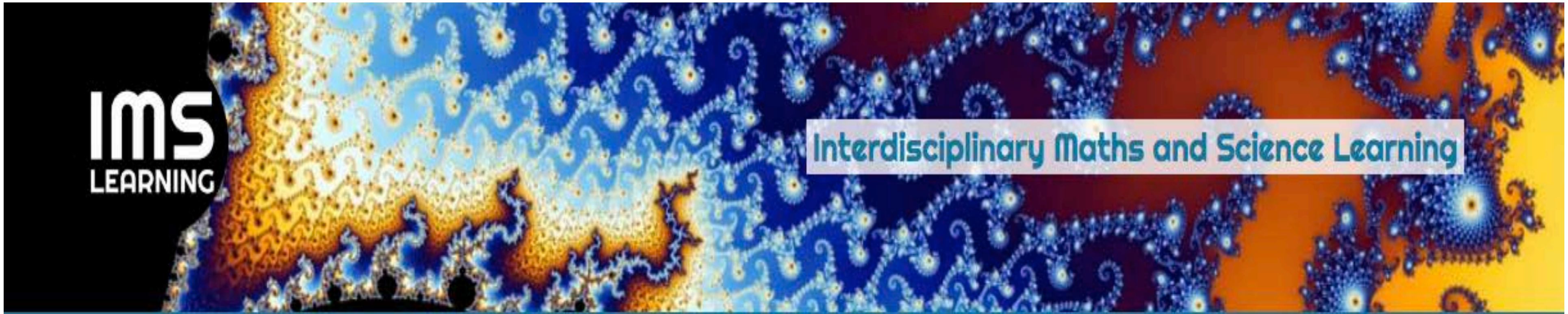
*Macquarie University, Sydney, Australia
Deakin University, Melbourne, Australia

MACQUARIE University

DEAKIN UNIVERSITY



Home Overview Profiles Findings Login

ENRICHING MATHS AND SCIENCE LEARNING: AN INTERDISCIPLINARY APPROACH

This is an international, longitudinal project which aims to investigate the effectiveness of an innovative interdisciplinary learning approach in mathematics and science. Through collaborating primary schools in Australia and the United States of America (USA), it will investigate how students' invention and transformation of representational systems can connect to support deeper reasoning and learning. The project will form the bases for new curricular designs that leverage students' representational practices across science, technology, engineering and mathematics (STEM) disciplines to promote more robust and generative knowledge.

"

Science and Maths are like colours

You mix them together and you get something else that's really good, but it's sort of still the same.

Year 1 student

https://imslearning.org/

Enriching Mathematics and Science learning: An Interdisciplinary approach

- To investigate ways in which mathematics and science can be productively linked to deepen student learning in each area.

- To explore how, over three years, students grow in their competence to inquire in both mathematics and science, in a range of topics.

- To identify effective ways to develop shared learning communities in primary schools across Australia and the USA.

Australian Research Council Discovery Project #180102333 2018-2020

Research Team

Deakin University
Russell Tytler (science education)
Lihua Xu
Peta White
Vaughan Prain

Macquarie University
Joanne Mulligan (mathematics education)

Vanderbilt USA
Rich Lehrer
Leona Schauble (science and mathematics education

Rationale

STEM approaches are now widely advocated (Bybee, 2013; Vasquez, 2015)

Disciplinary learning is compromised, especially in mathematics (Honey, Pearson, & Schweingruber, 2014)

Integrated STEM activities can often default to an 'epistemic stew' (Lehrer, 2016)

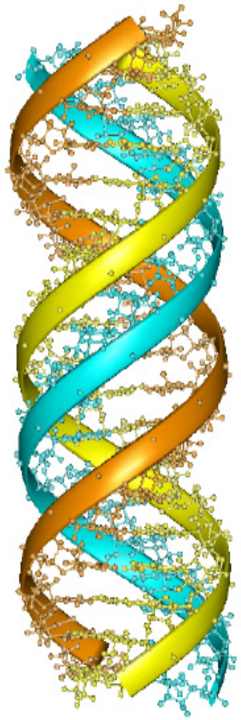
Inter-disciplinary models of practice and knowledge must be built on student acquisition and

Application of deep, developmental disciplinary knowledge

Purpose of the Project

Engage in experiences with concepts that are synergistic—mutual gain to support deeper learning in both

- Focus on learning outcomes, including assessment of concepts
- Teachers and students as co-researchers
- Refine guided inquiry teaching and learning approaches
- Facilitate student modelling and representation construction
- Teacher led strategies of modelling – invent, evaluate, refine, extend with meaningful, interesting tasks
- Focus on data modelling
- Longitudinal tracking of students modelling and learning
- Produce exemplary learning sequences



“Design learning with epistemological practices in mind” (Lehrer, 2018).

Provide opportunities for children to see commonalities and distinctions in how knowledge is generated and revised in disciplines.

Conceptual systems elaborated by interdisciplinary engagement.

Position children to experience epistemic distinctions important to disciplined knowing.

Method

Four primary schools (Melbourne and Geelong) Grades 1-2; 4-5; 5-6 (2 to 6 classes per grade)

Case study teachers and 12 students per grade

Design research method: longitudinal (3 years)

Development and reiteration of learning sequences for selected topics:

- Armspan
- Motion
- Ecology
- Water Use
- Fast plants
- Astronomy

How do student’s structure their data?

Explore how students’ graphical representation might enhance mathematical and scientific reasoning from student-led investigations

Identify common features in collecting, organising, interpreting, and representing data: making inferences

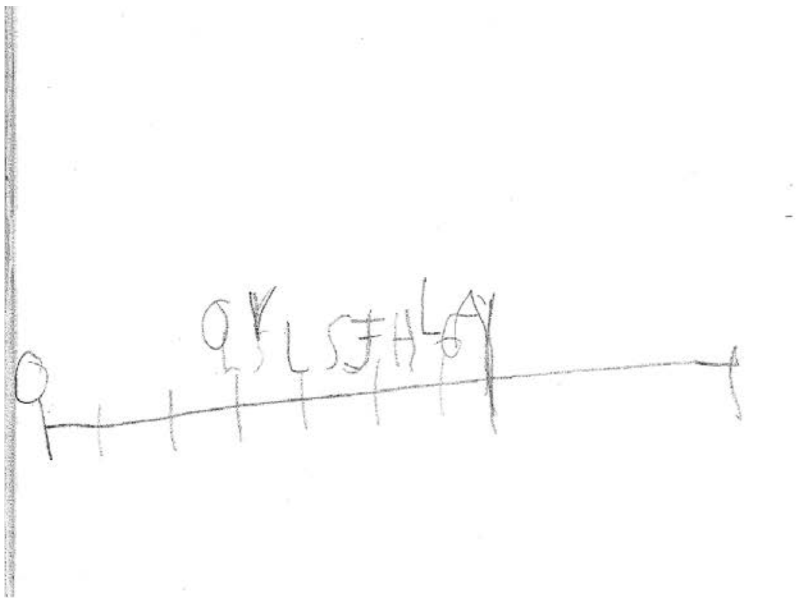
How do students ‘structure’ their data?

What are the mathematical ideas that lead to representational competence?

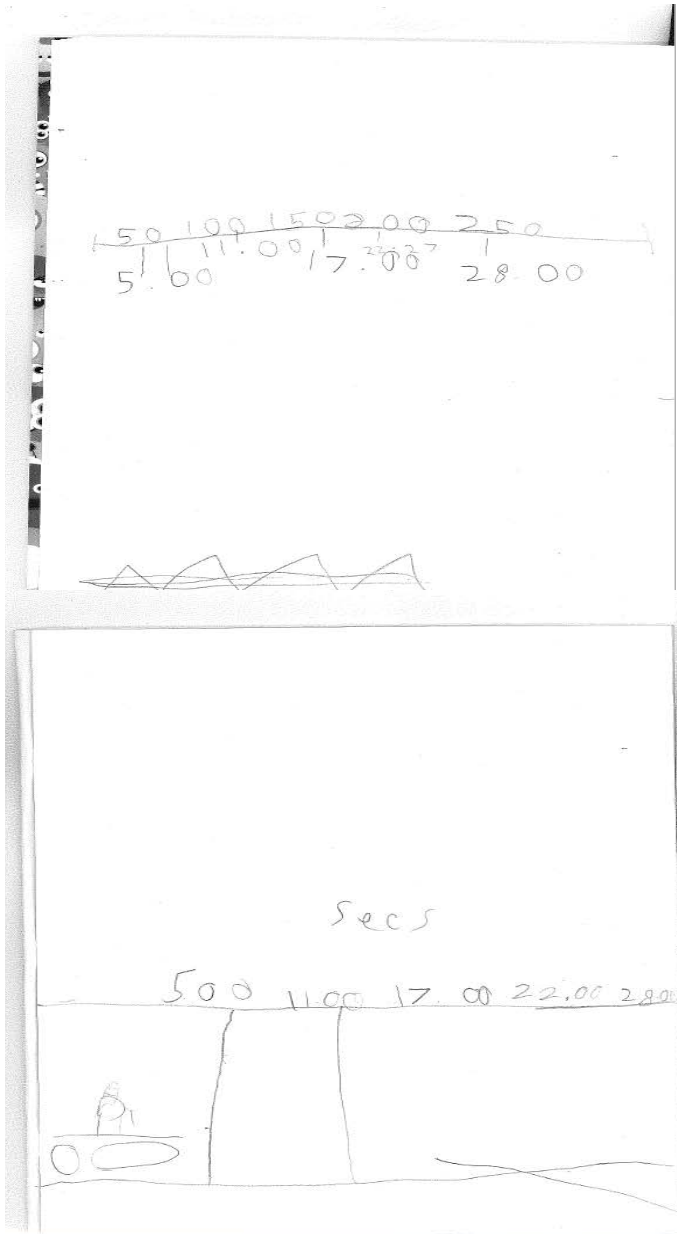
IMS ‘big’ ideas

Big idea	Illustration
Maths and science interact to support deeper learning in each	The back and forth nature of the interplay between mathematics and science. The invention and refinement of the mathematics to explore authentic questions The sharpening of the science ideas made possible by the more focused mathematization
Exploration of constructs that are common to maths and science	Constructing measure Data variation and ways of representing data Sampling Spatial reasoning
Constructing representations, modeling to reason and learn	e.g. modeling data and inventing displays, measures of centre … Modeling of earth and sun relations to explain shadow movement Inventing measures of water use, and data displays
Guided inquiry pedagogy foregrounding children’s questions	e.g. children’s decisions around sampling, and measuring living things Questions about patterns of plant growth, and conditions that shape the growth. Teacher use of children’s inventions, ideas to move thinking forward • Display and discussion of children’s representations • Gallery walks

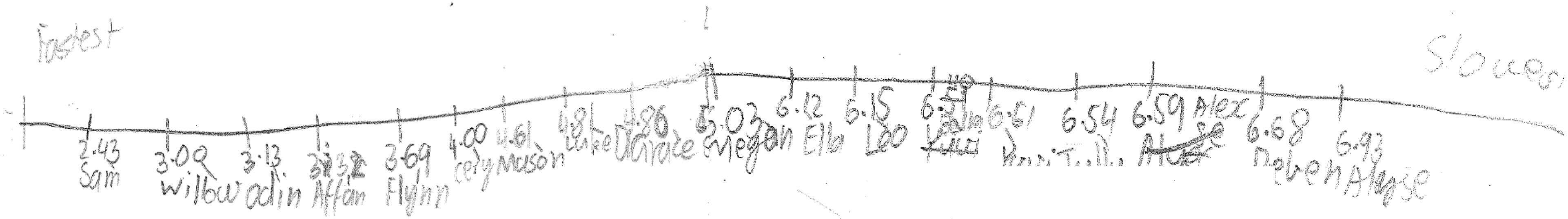
Motion



Number of steps in 6 seconds

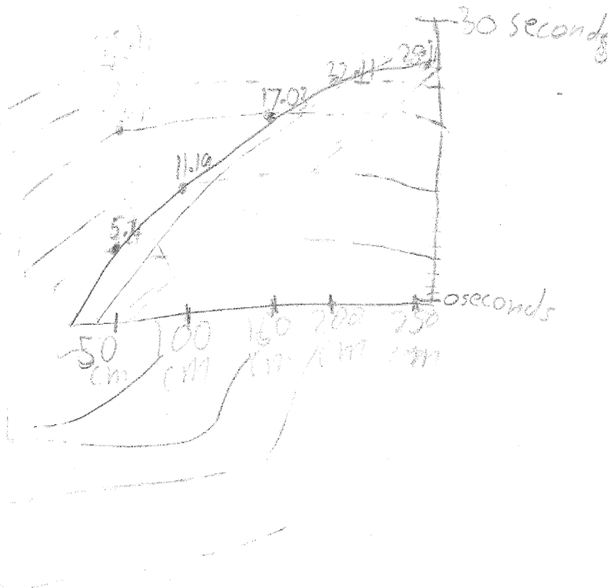


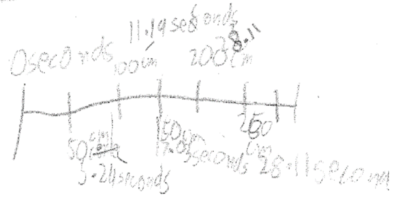
Video of constant motion



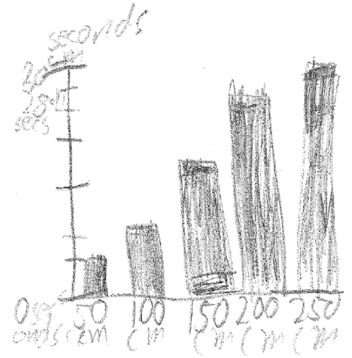
Conset speeds

50cm = 5.24 seconds
100cm = 11.19 seconds
150cm = 17.03 seconds
200cm = 23.11 seconds
250cm = 28.11 seconds

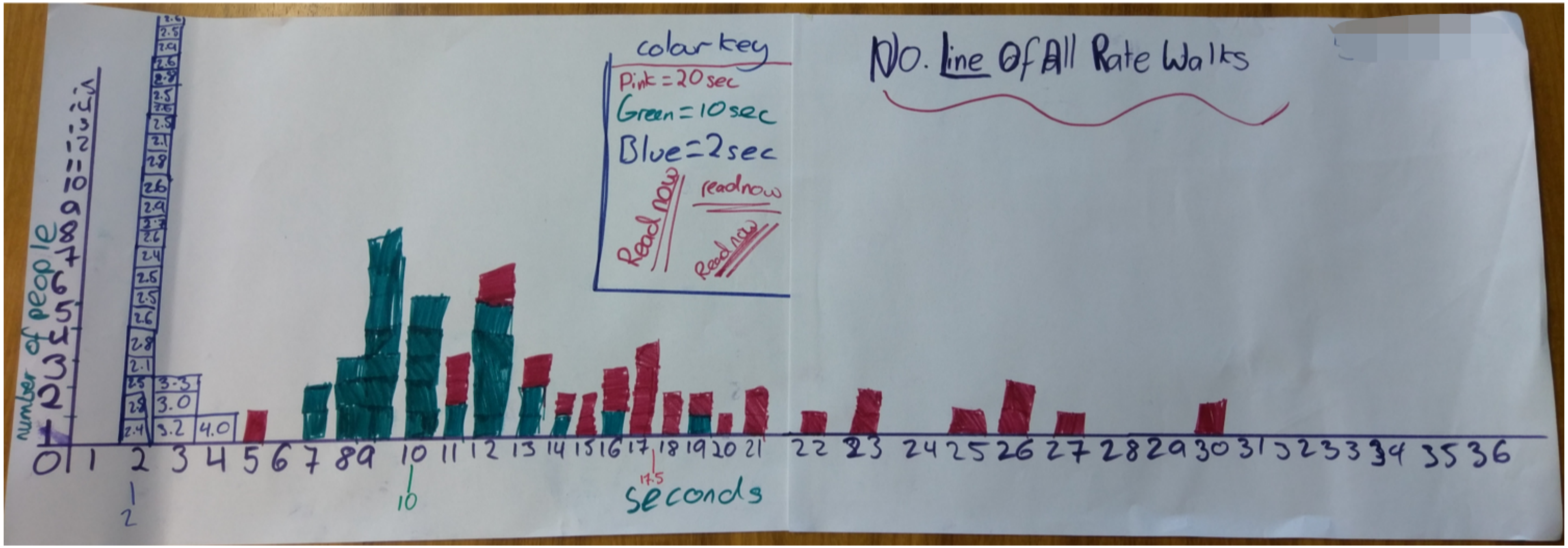




50 cm	100 secs	150 secs	200 secs	250 secs
5	11	17	23	28
		03		11



Comparing rate walks



Fast Plant Growth

Day 3. Seed Germination (March 14)

Day 7. Plant Growth (March 18)

Day 10. Plant Growth (March 21)

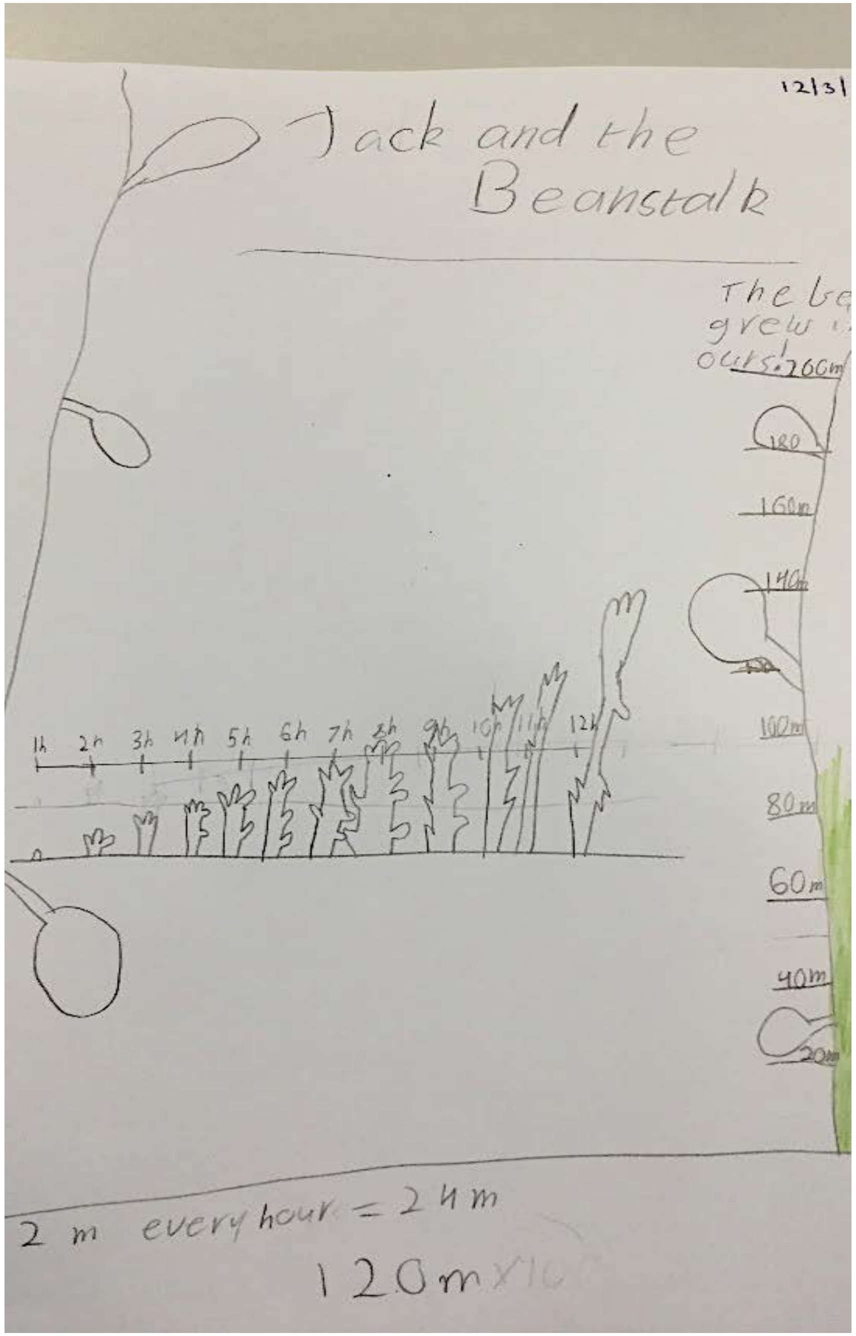
Fast Plant Growth

Sequence Overview: how data can be gathered, represented, and evaluated to effectively display the life cycle of a plant. Science ideas and processes explored within this sequence:

- Germination
- Growth and growth variation
- Life cycle including seed and flower anatomy
- Environmental influences on plant growth
- Modelling data
- Communicating results

Mathematical ideas and processes explored within this sequence:

- Data collection and organisation including estimate and measure rate of growth over time, understand idea of rate of growth and intervals of time vs individual measures
- Data display including graphing (line graphs)
- Data analysis and evaluation
- Variations in data
- Modelling



Jack and the Beanstalk
180
160m
140m
100m
80m
60m
40m
20m
1h 2h 3h 4h 5h 6h 7h 8h 9h 10h 11h 12h
2 m every hour = 24 m
120m

K-W-L 19/2

nk I Know!

1. Adapting is getting used to the envirom
around you.

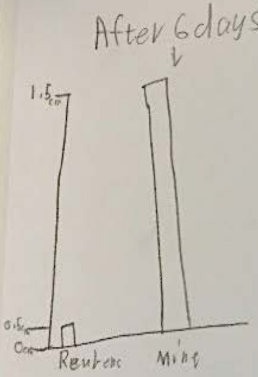
Animals adapt for pr
and the weather in t
invironment.

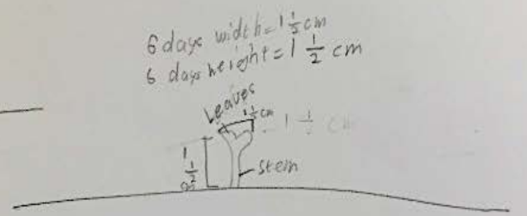
Want to Know!

1. How do plants adapt?

2. Why do plants adapt?

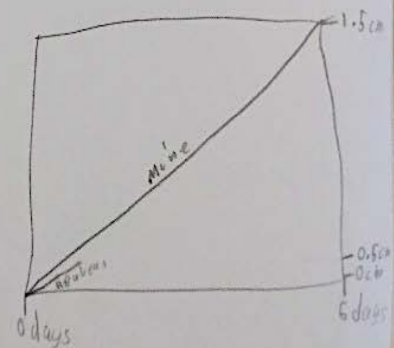
Fast Seeds





Mine
0 days - 7 days
1.5cm

Reubens
0 days - 7 days
0.5cm



Investigating Water Use

Investigating Water Use

Sequence Overview

- To extend the Primary Connections "Water Works" unit, through an in-depth focus on data collection, informal to formal measures, and data displays with analysis and interpretation of findings.
- Collect data about their water use at home and then learn the importance of generating formal measures to compare results of informal measures. The data is analysed as class data with possible exploration of number lines, median, mean, and or mode measures.

Investigating Water Use

Science ideas and processes explored within this sequence:

- Water conservation and personal use of water
- Water use around the home.
- Invention of processes including measure for water use.
- Problem posing and problem solving
- The need for standard units of measure: estimating and using appropriate units.

Mathematical ideas and processes explored within this sequence:

- Relationship between number of units and size of unit
- Data modeling – how different displays bring out different features of the data
- Data modeling – measures of centre (mode, median), range, outliers, informal discussion of measures of spread.

Examples of children's thinking and representations

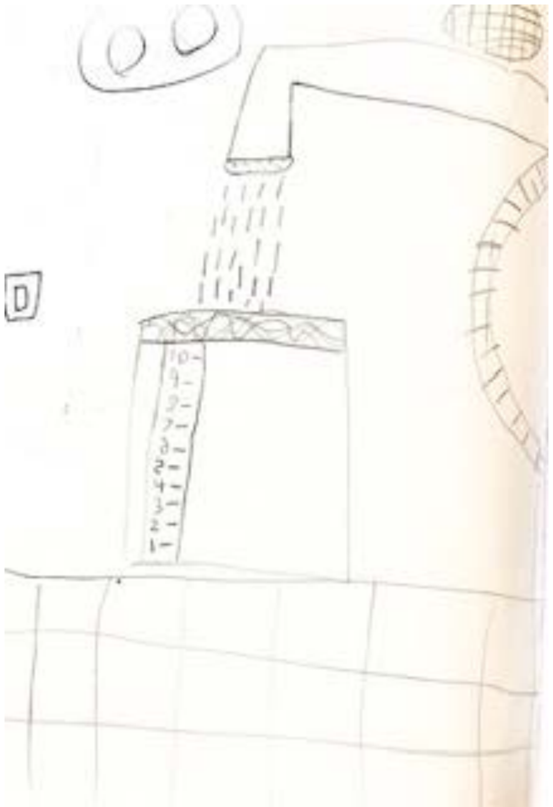
"We can compare with a bar graph how much water they used"

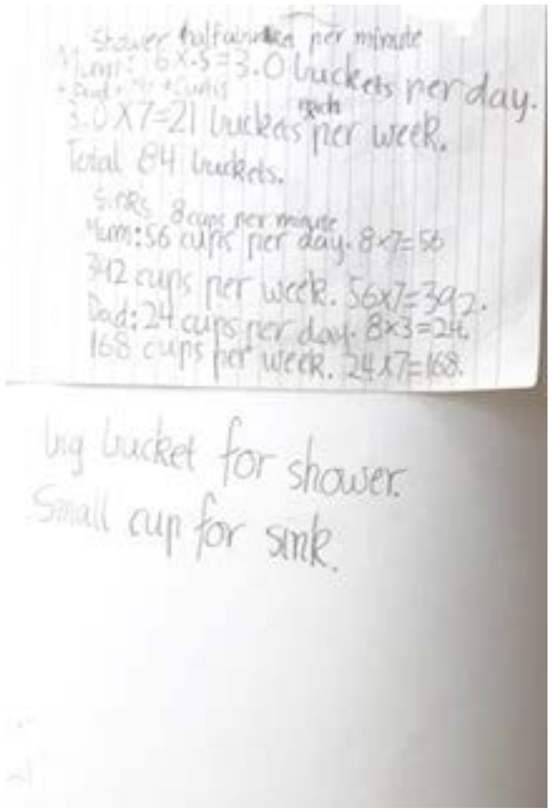
"litres are what we measure water in"

"It's 0.5" referring to 500ml bottle

"Different taps and showers use different amounts of water… that's why we can't just time"

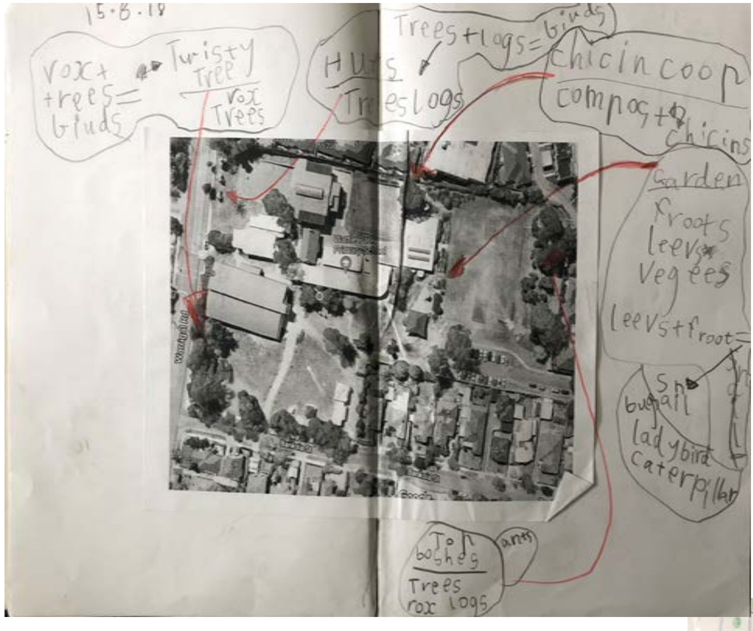
"We can time how long people are in the shower then check with a bucket how much water is used in that time?"

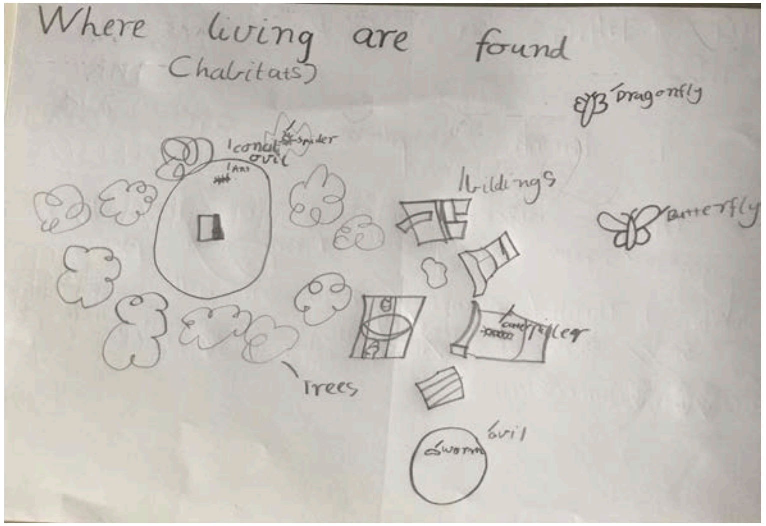




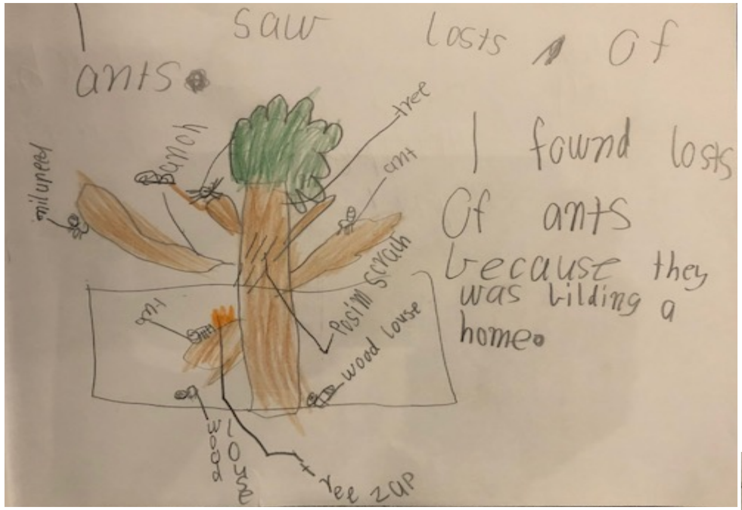
Ecology

Where are living things?
Birdseye view mapping and scaffolding Googlemap

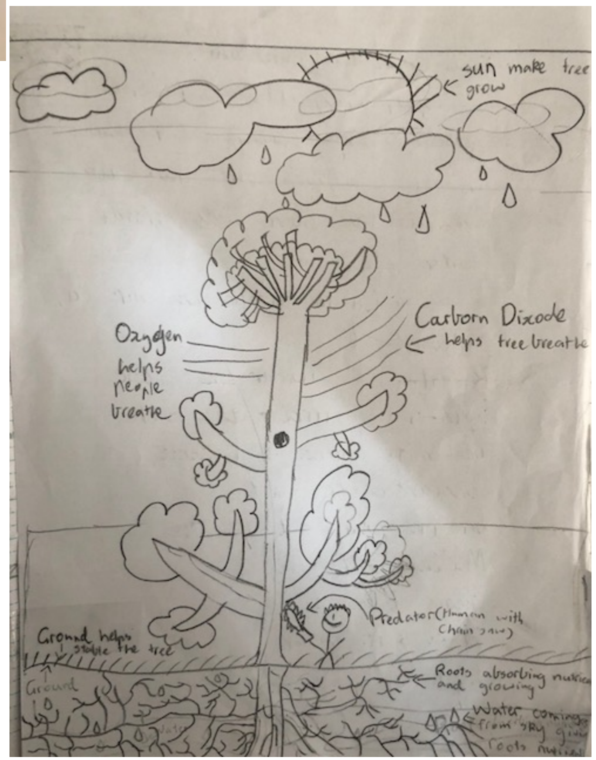




Plan views

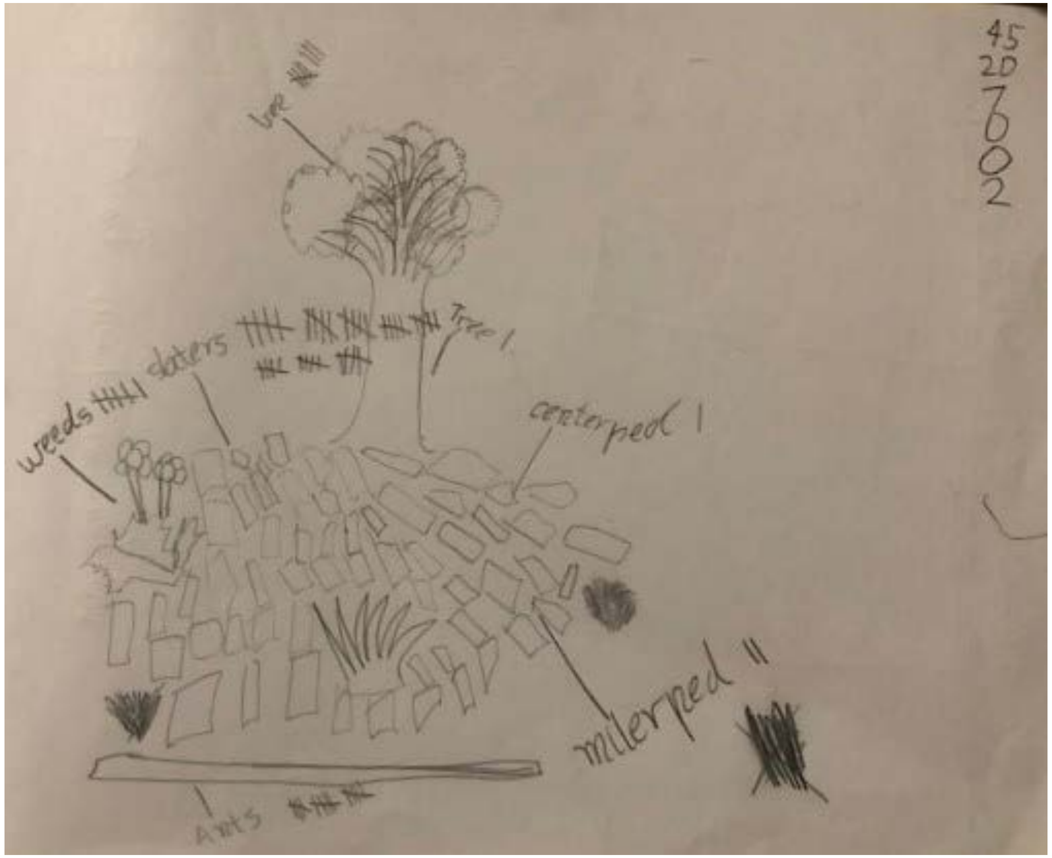

I saw losts of ants.
I fownd losts Of ants because they was bilding a home.
tree
ant
wood louse
tree zap

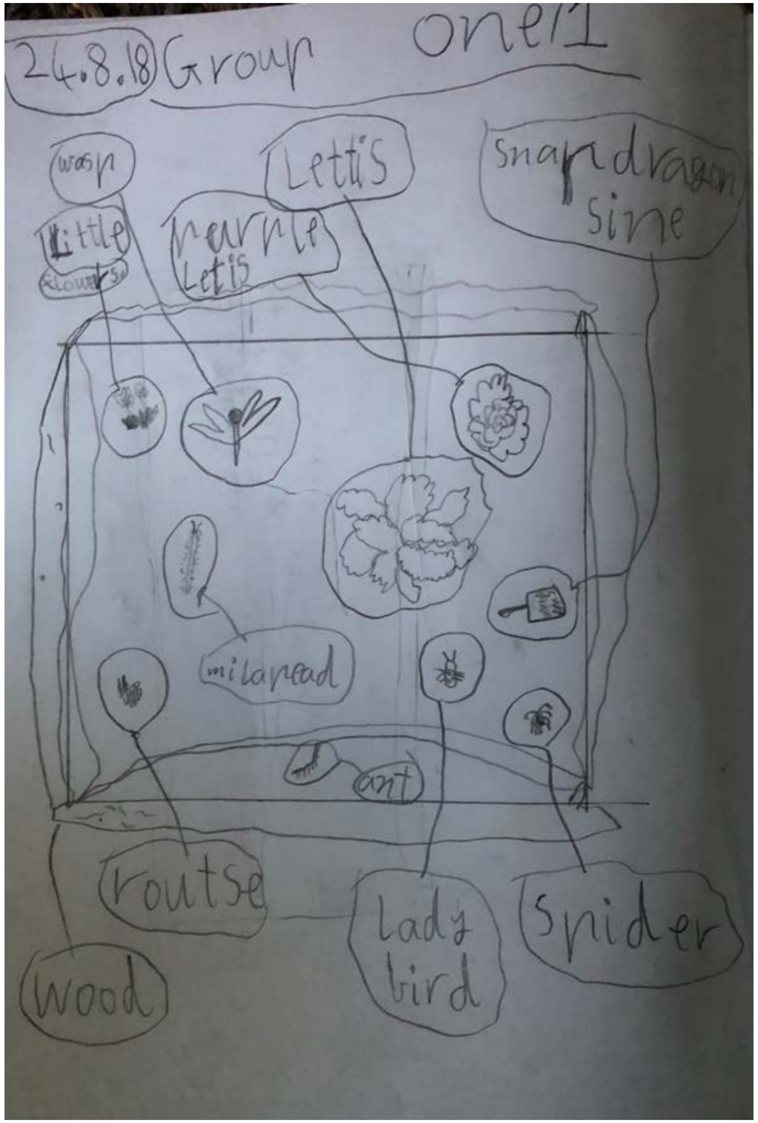

MiLPid
ants
Flowers


sun make tree grow
Carborn Dixode helps tree breathe
Oxygen helps people breathe
Predator
Ground helps stable the tree
Roots absorbing
Water coming from sky

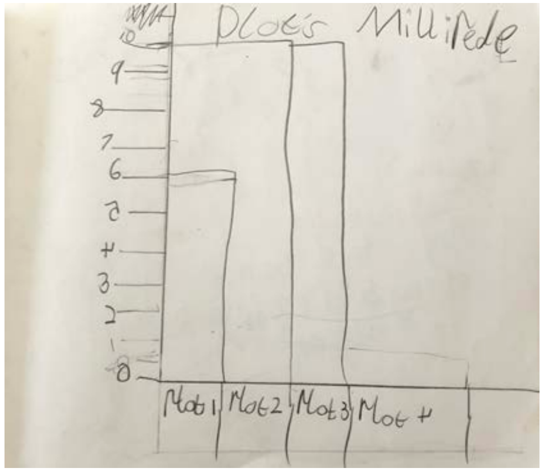
Mapping the plots (Year 4 student)

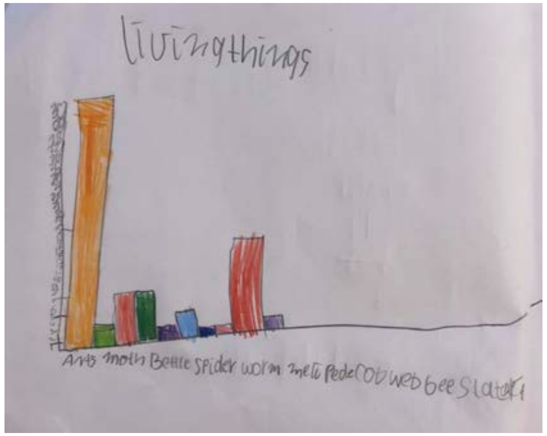
Birdseye view: Plot representations

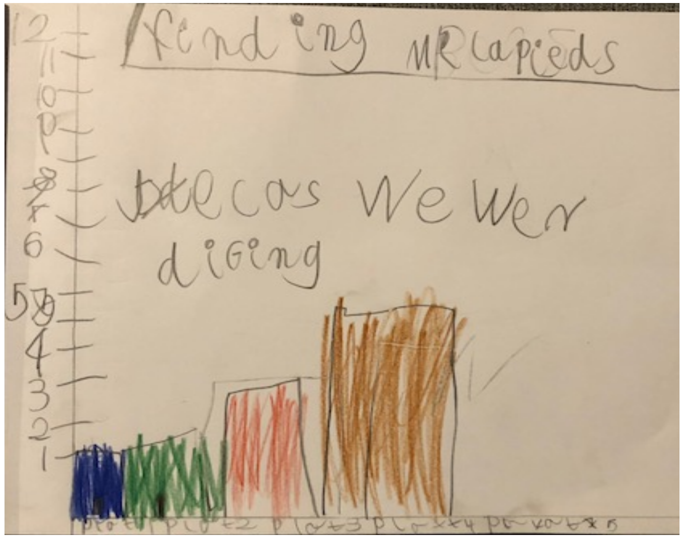


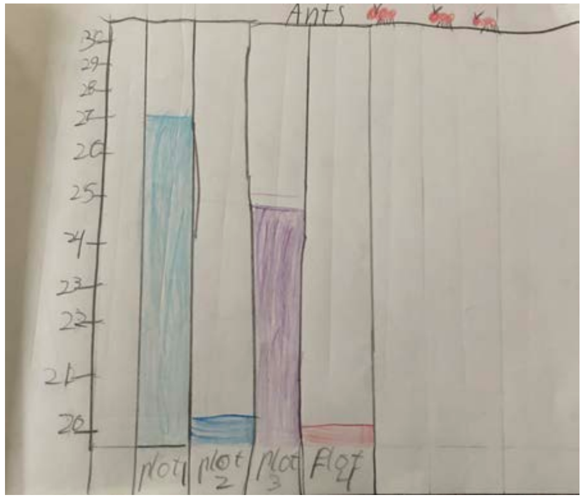


Graphs: Representations



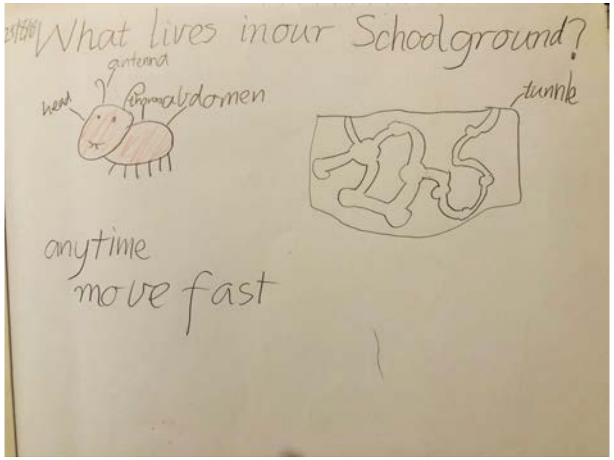


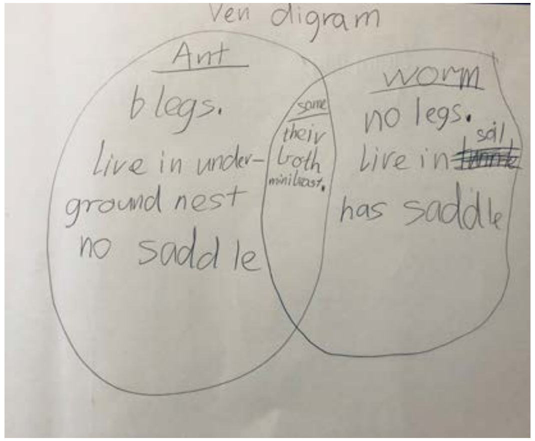


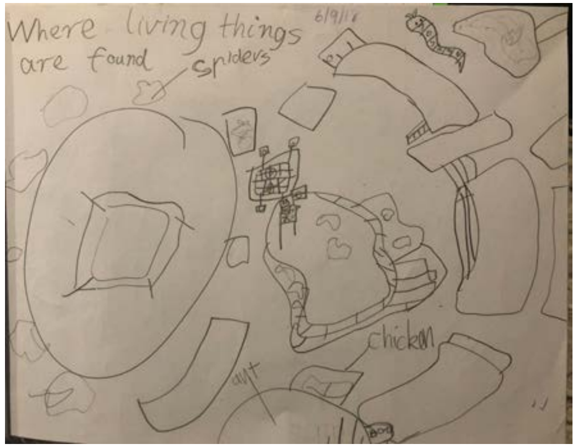


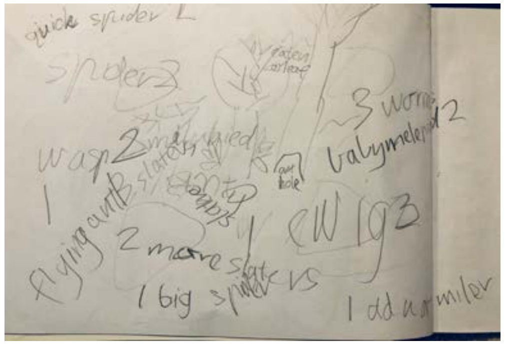
Making inferences and connections

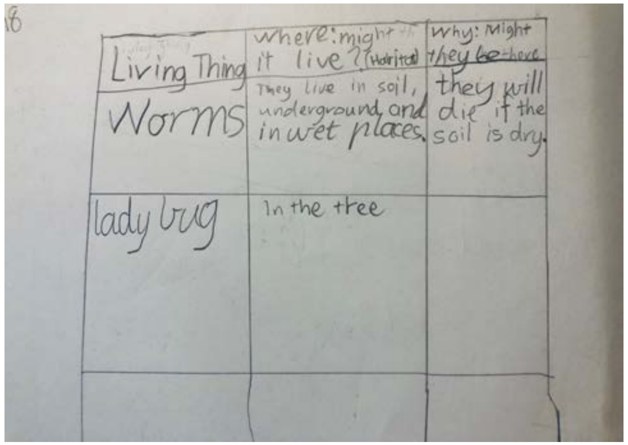
- Sequence over a series of weeks
- Needs, habitat and structures

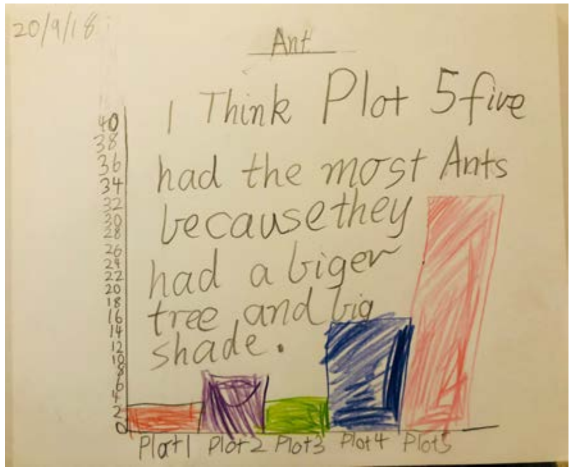


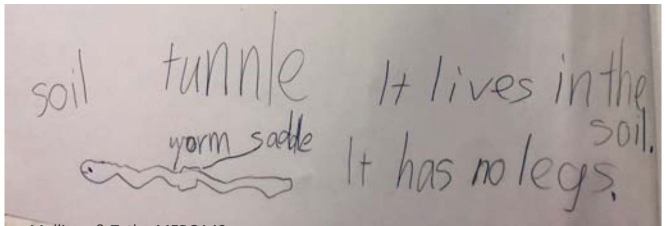






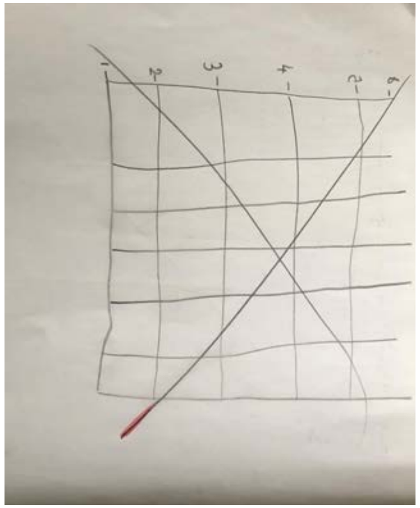


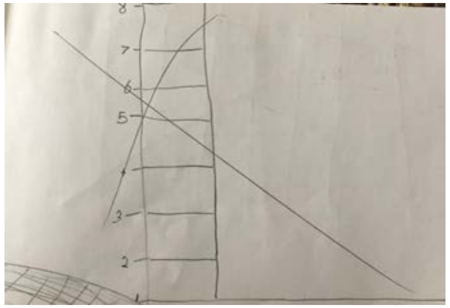


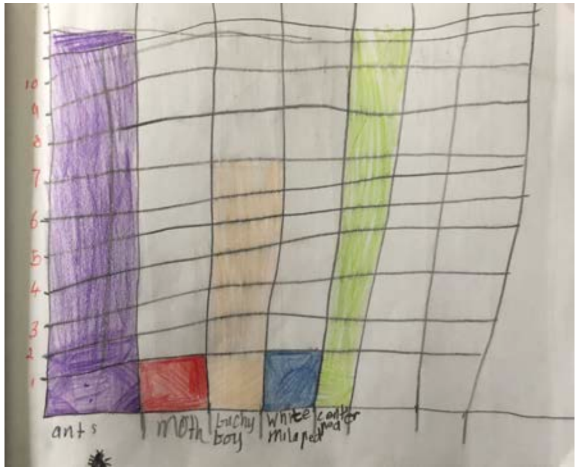


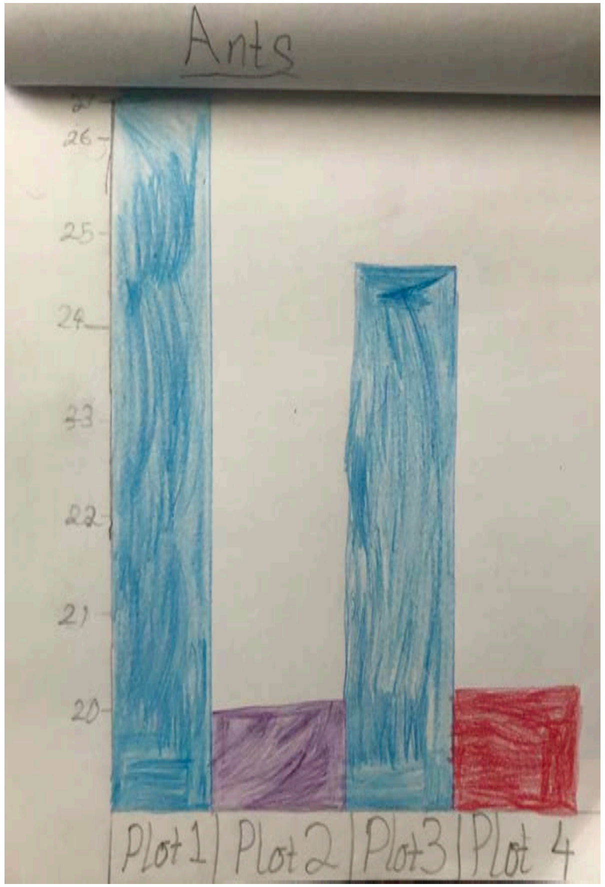
Development of graphs

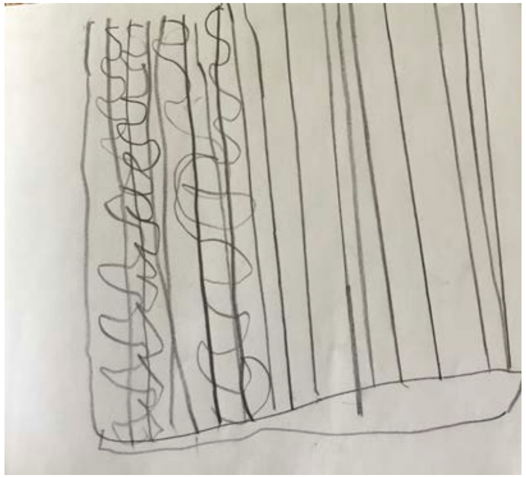
Student Example



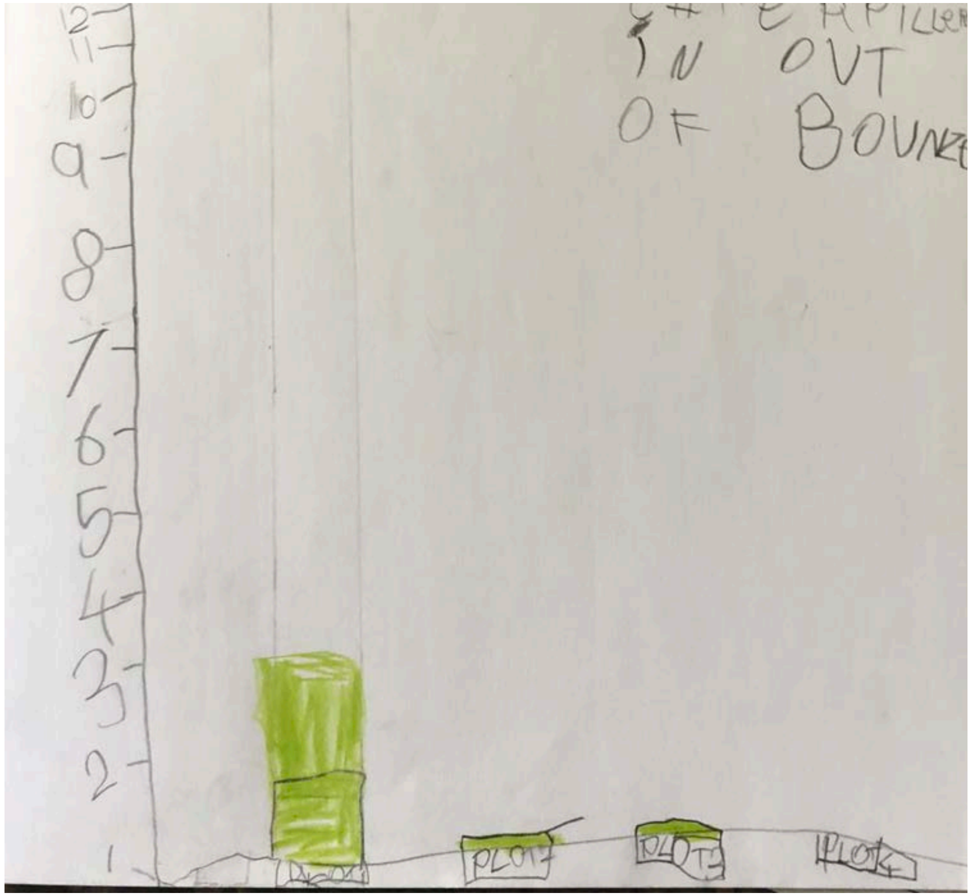









Plot 1
Plot 2
Plot 3
Plot 4


12
11
10
9
8
7
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1
IN OUT
OF

Astronomy

Learning outcomes

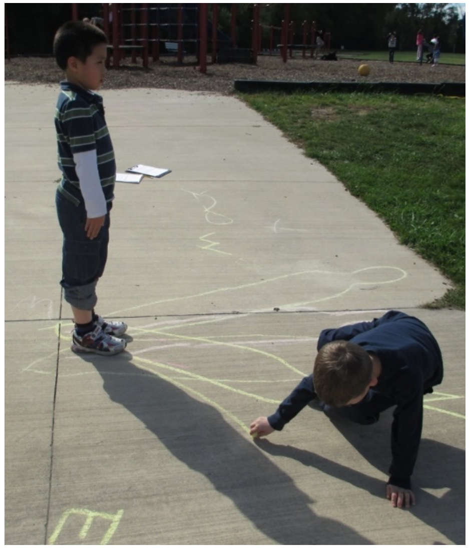
1. To develop an understanding about Astronomy, day/night and the earth's rotation through a shadow investigation
2. To develop an understanding of the ways science and mathematics use modelling processes to understand natural systems and mathematical patterns
3. Focus on measuring, time, spatial recognition, directionality, data recording and analysis

The sequence will focus on spatial relations of the sun and earth, coordinating an earth centred and space centred perspective.

Tracing shadows over the day

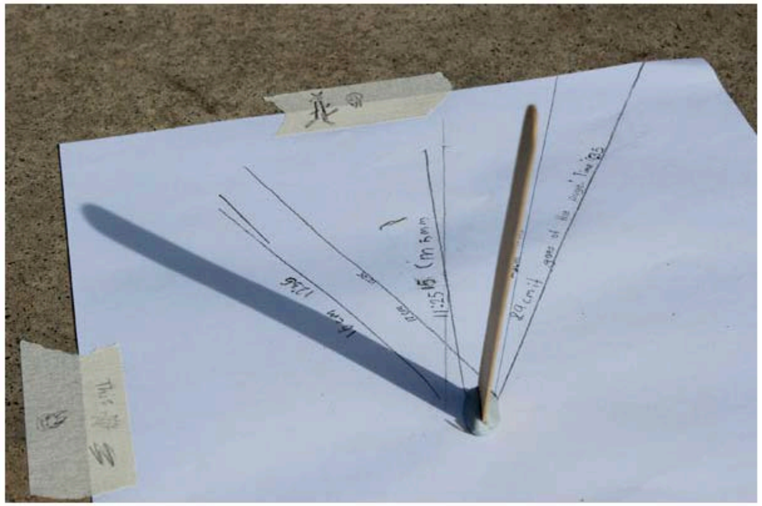
Grade 1:

- Children work in pairs to trace their shadow 4-5 times over the today
- Informally measure length with a tape
- The teacher discusses the relation of the shadow to the suns' position
- Children construct a report of the size and position of shadows



Grade 4:

- Shadow stick activity – more formal measurements
- Children report, linking the shadow patterns with position of sun during the day.



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