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Enhancing Learning Through Interdisciplinary Maths and Science

DEAKIN UNIVERSITY

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Enhancing Learning through Interdisciplinary Mathematics and Science

This workshop will engage teachers in interdisciplinary activity around the mathematics of measurement, variation and data modeling and the science of flight, using the design of paper helicopters as the context. This primary school sequence was developed within an Australian Research Council project exploring approaches to interdisciplinary mathematics and science where engagement with concepts in each subject are mutually reinforcing. The approach draws on a guided inquiry approach where students construct/invent, evaluate and refine representations drawing on hands-on activities, reflecting key knowledge building processes in each discipline. We will explore the activities, and unpack the pedagogy, for the learning potential that is opened up, and present a detailed unpacking of a. the learning that occurred in the sequence when we ran it in six Grade 2 classes; b. the challenges for teachers in aligning this investigative work with the science and mathematics curricula, and c. the potential of the activities, and the approach, for interdisciplinary work at different year levels. We will introduce participants to the resources available on the project website (https://imslearning.org/), for science/mathematics sequences from Grades 1 through 6.

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Wurundjeri Tribe
By Jacqueline Suttin, Valerie Felix, and Nicholas Gomes

https://www.haikudeck.com/wurundjeri-tribe-travel-and-lifestyle-presentation-LPCIUHsayB#slide4

Learning goals and disciplinary focus

Concepts in mathematics, related to science:

Measurement variation; representation and interpretation of measurement; data modelling and graphing; motion; body maths

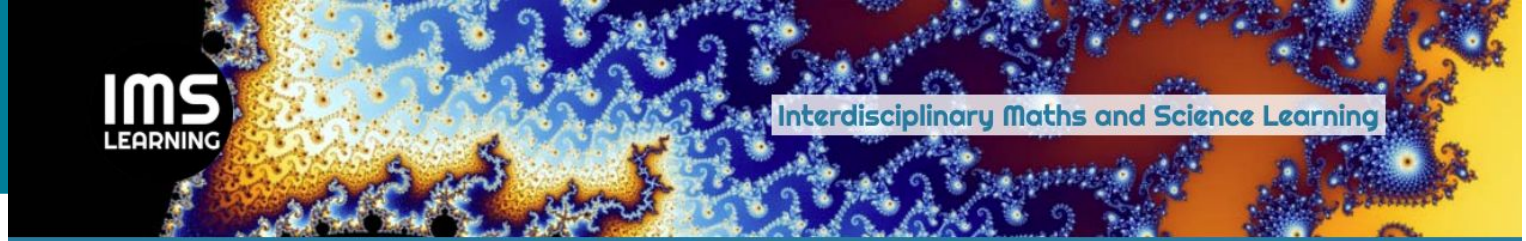
Learning goals:

To explore opportunities for pedagogical connections between mathematics and science to engage students and enhance their learning experience.

Session outline and intent

1. Introduction to how mathematics and science might be productively linked: opportunities and challenges
2. Representation construction & modelling – the IMS project
3. Group activities:
    a. Paper Helicopter Flight
4. Reporting back and debriefing

https://imslearning.org/



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ENRICHING MATHS AND SCIENCE LEARNING: AN INTERDISCIPLINARY APPROACH

This international, longitudinal project 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.

> **I was guessing, I didn't really know... now I know and understand**
>
> Year 2 student

Tytler, R., Prain, V., Mulligan, J., White, P.J., Xu,, L., Lehrer, R., Schauble, L., Kirk, M., Speldewinde, C., & Neilsen, C. (2018). Enriching Maths and Science learning: An interdisciplinary approach.

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Background to the IMS pedagogy

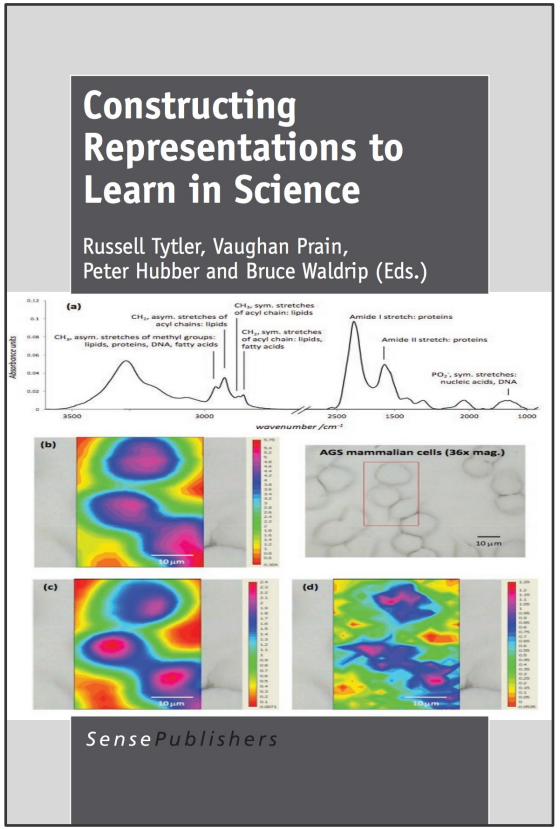
Learning as induction into the multi modal discursive practices of science and mathematics (Latour, Peirce, Lemke)

Model based reasoning, socio semiotic perspectives (Lehrer & Schauble, Lemke)

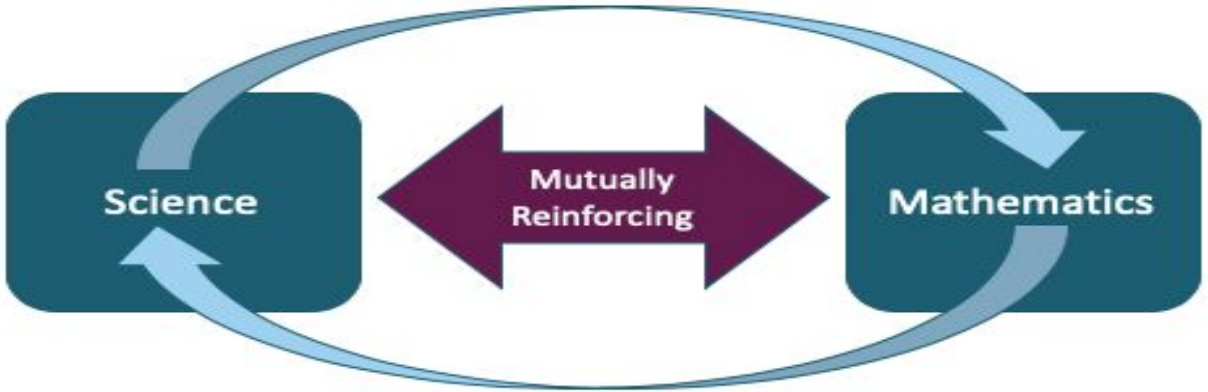
Pedagogy: guided inquiry where children generate data/observations and **invent, compare, assess and revise**, and coordinate representations.

Maths and science interact productively, each raising questions that advances the other. There is a focus on constructs that are common to both.

Representational tools are crucial resources for speculating, reasoning, contesting and justifying explanations, knowledge building, and communicating.



Productively linking mathematics and science



The key principles are that

a) the mathematics and science concepts and practices are mutually reinforcing,

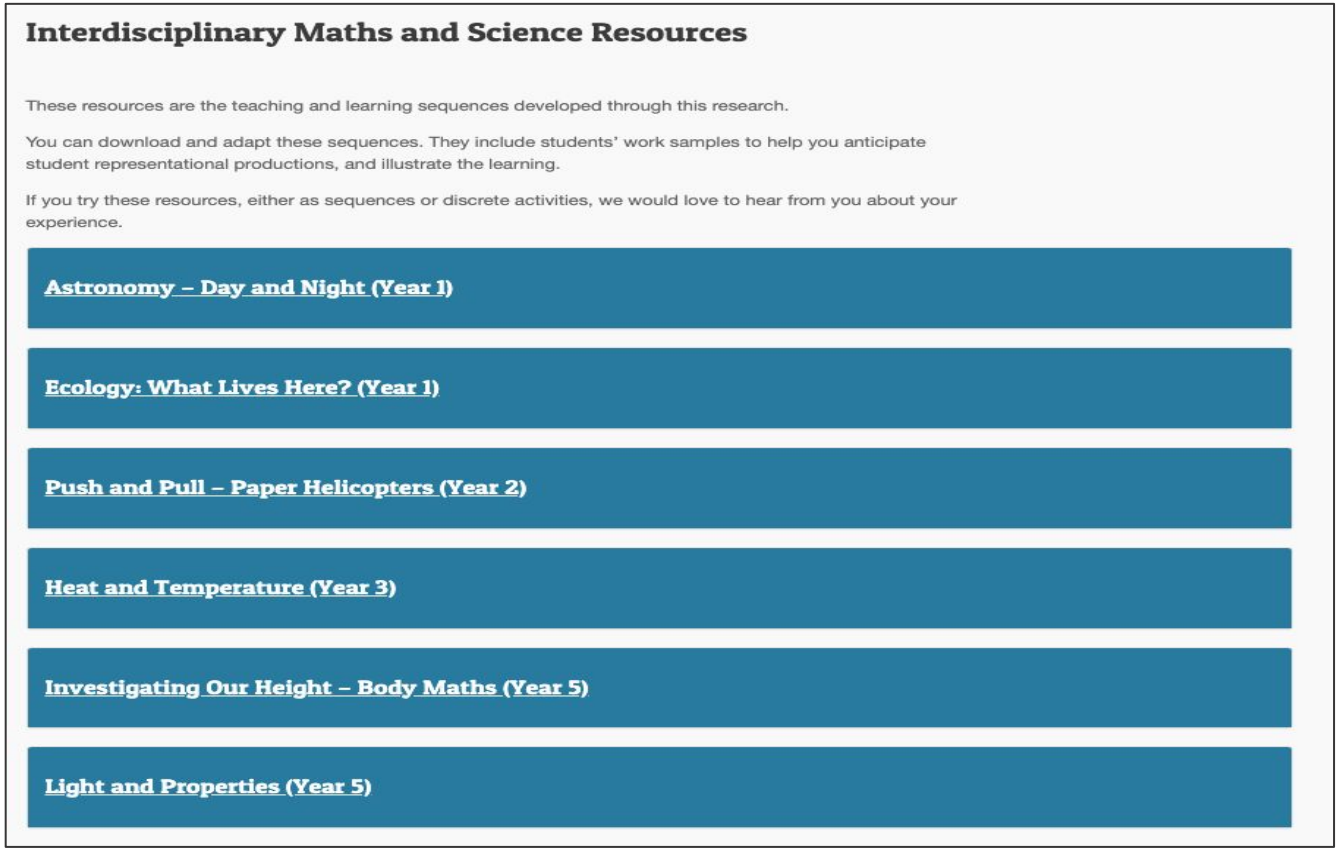
b) the interdisciplinary tasks lead to fresh learning in each subject, and not simply application of known procedures and concepts, and

c) that the reasoning and learning in each subject reflects disciplinary knowledge building practices, involving the invention and guided refinement of representational systems.

The IMS topics

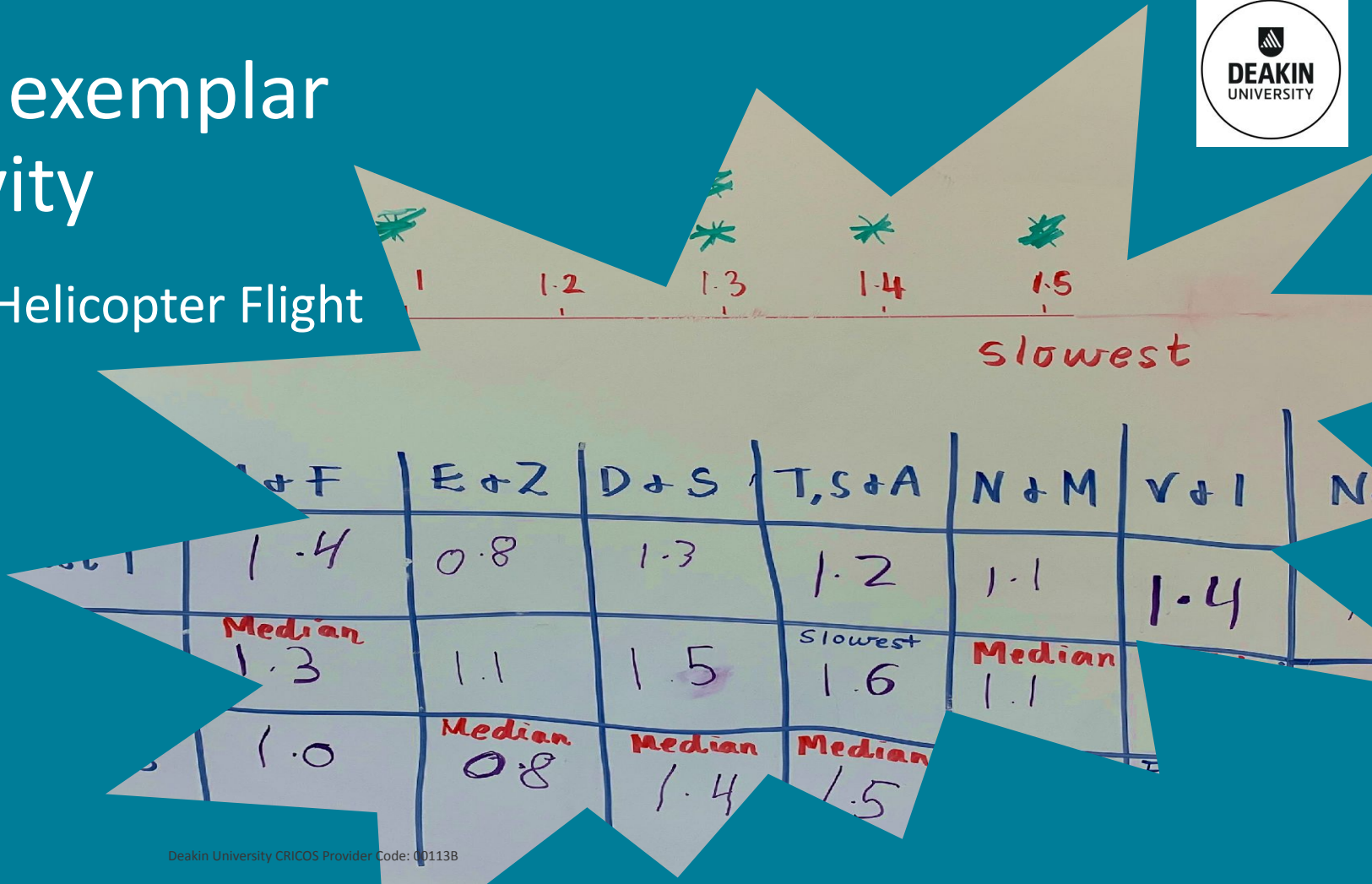
Topic (predominantly science)	Grade level	Mathematics concepts and practices
Chemical science: Dissolving and mixing, chemical change, cooking.	2	Representing time sequences of mixing and dissolving under different conditions, timing cooking-measurement for cooking recipes: standard and informal units, fractions, proportion.
Astronomy: Shadows, sun movement, explaining day and night: earth and space perspectives.	1, 4	Angle as rotation and length of shadow (formal and informal measures), graphing shadow length, time sequencing, perspective taking.
Ecology: Living things, diversity, distribution and adaptive features related to habitat.	1, 4	Variation, data modeling of living things in sample plots, tables and graphs, space and mapping, measurement, area, coordinates, directionality, sampling, using a scale.
Astronomy: Solar system, day and night, planetary features, moon movement and phases.	5/6	Conceptualising ratio of planetary size and distance, angle measurements for moon observations, compass points, tracking position over time, perspective taking from earth and space, representing cosmological distances: powers of ten.
Plant growth: plant structure and function, life cycle, growth needs and patterns.	2	Measurement of plant height, leaf size, shape and number, tracking growth over time, tables, line graphs, units (cm and mm- formal units), time intervals, using a scale.
Measurement (height): height measure and variation, differences between populations.	5/6	Measurement (m and cm), data modeling, variation, measures of central tendency and of variation, comparison through graphs, categorizing/ organizing data, sampling.
Flight: Whirlybirds: Flight and air flow, modeling and design.	2	Measure of whirlybird parameters, time, data variation, data modeling, number line.
Motion: Representing speed, distance and time relations, constant speed, acceleration.	1, 4	Embodied representation of relation between distance, time and speed, length measures, modeling variation, graphing speed, distance, time, distance-speed-time relations for motion down a ramp.
Water: personal use and conservation of water.	2	Estimation and measure of water use, informal and formal measures of volume.
Light: vision, reflection and image creation.	4/5	Angle, rotation, reflection, directionality, symmetry.

https://imslearning.org/resources/



One exemplar activity

Paper Helicopter Flight



STEME

Science Technology Engineering Mathematics and Environmental Education Research Group

Re-imagining futures in STEME

https://deakinsteme.org/resources/ideas-for-teaching-science-years-p-8-education/

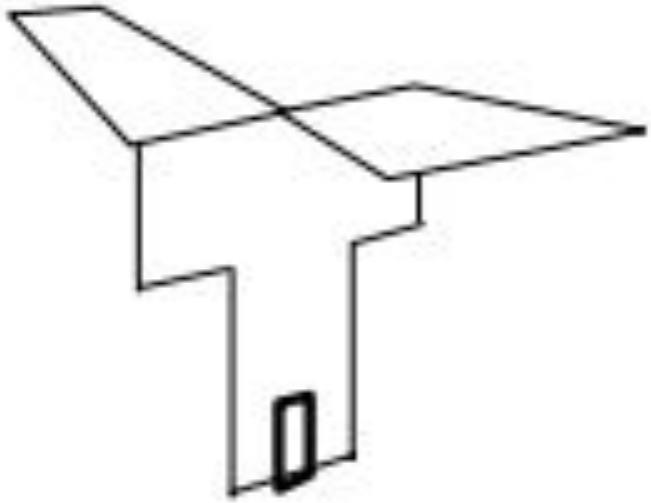
Ideas for Teaching Science: Years P–8

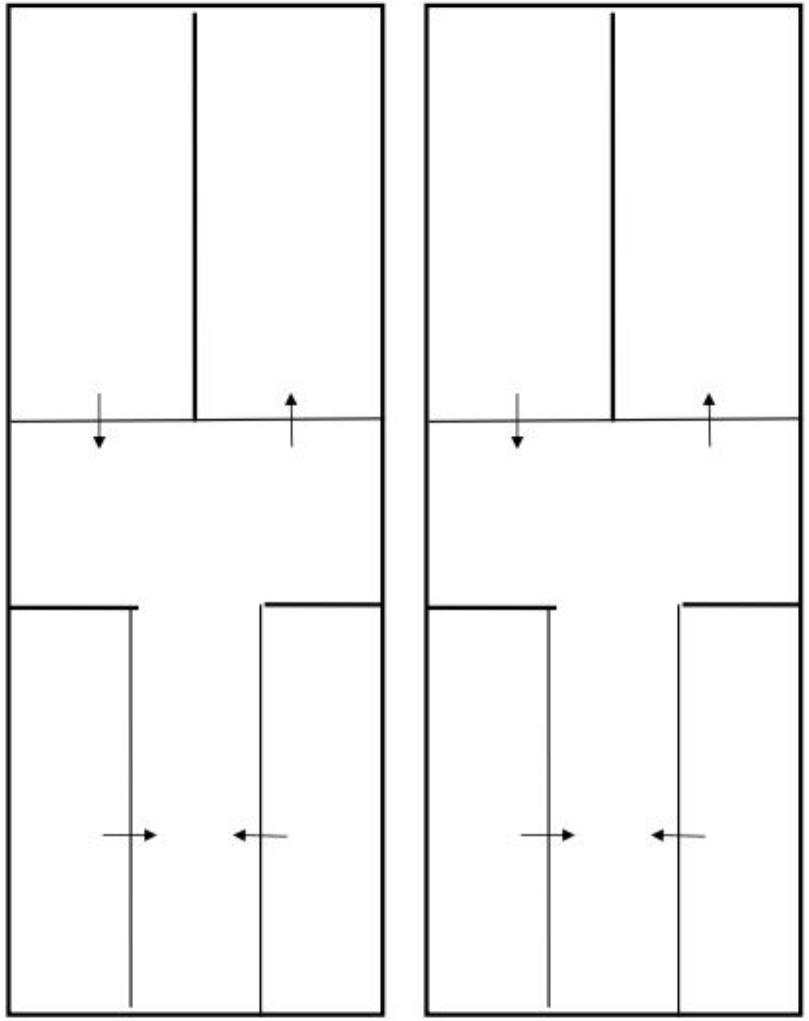
https://blogs.deakin.edu.au/sci-enviro-ed/early-years/

Topics

The topics covered in these materials are:

- Working scientifically
- Air and flight
- Floating and sinking
- Light, vision and colour
- Sound and music
- Magnetism
- Electricity
- Force and motion
- Earth in space
- Rocks and soil
- Physical changes to matter
- Chemical change
- Bodies and skeletons
- Plants as living things
- Animals





Fun with Physics - Wheezing Whirlybirds

Making the Whirlybirds

“Science Thrills” Avik, Anush, and Amrita Kamath

Paper Helicopter Flight

You are going to time the drop of paper helicopters with different wing lengths. First, we look at the variation in times for one drop, and think about how we deal with this.

Timer /phone

- Time the drop using your phone, and display your result in the chat.
- Each person decides on a way to represent the data in order to make a decision about a valid measure of the time.
- Compare the different displays – what sort of things do the different displays show? What do they hide?
- What is the 'best' measure of the time of drop?
- What is the cause of the variation?

We are going to repeat this for five wing lengths. How will we set out the data?

- With the data collected, the group should discuss how best to display data to show the relationship between wing length and drop time.
- Each person then constructs a display to represent the relationship, and an annotated drawing to explain why the wing length affects the drop time.
- Compare the displays. What can we learn about paper helicopter flight, and about data displays?
- What discussions would be important to have when teaching this?

Collaborative Investigation… Documents

Paper Helicopter Flight

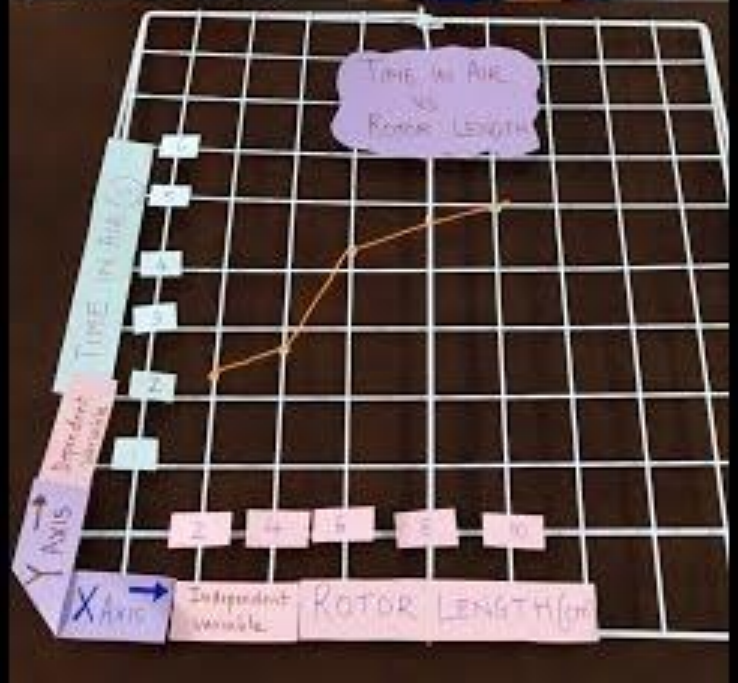
Video - https://video.deakin.edu.au/media/t/1_zmosnhbg

Google doc -
https://docs.google.com/document/d/1EuVFjsi-vB4RwOuN7NAX48oiC3BYVGttKuZ6RKqTb-U/edit?usp=sharing

Youtube -
https://www.youtube.com/watch?v=s9cLwJPd924&list=PLN6Fz3VnYzeaaZa9pS_4NhTxC4uylb3m7&index=17

Working Scientifically - Creating a line graph

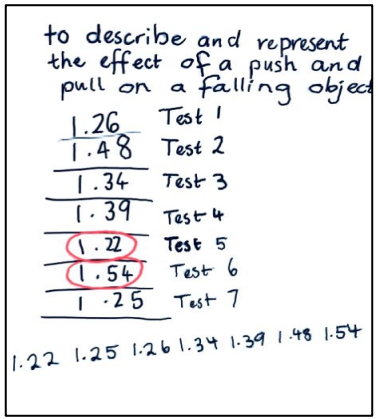
“Science Thrills” Avik, Anush, and Amrita Kamath

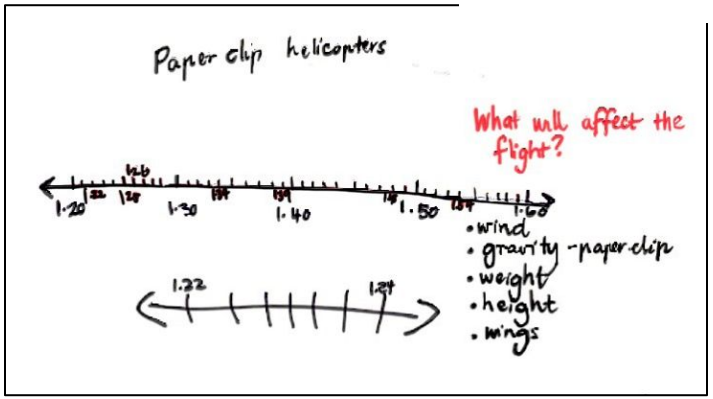


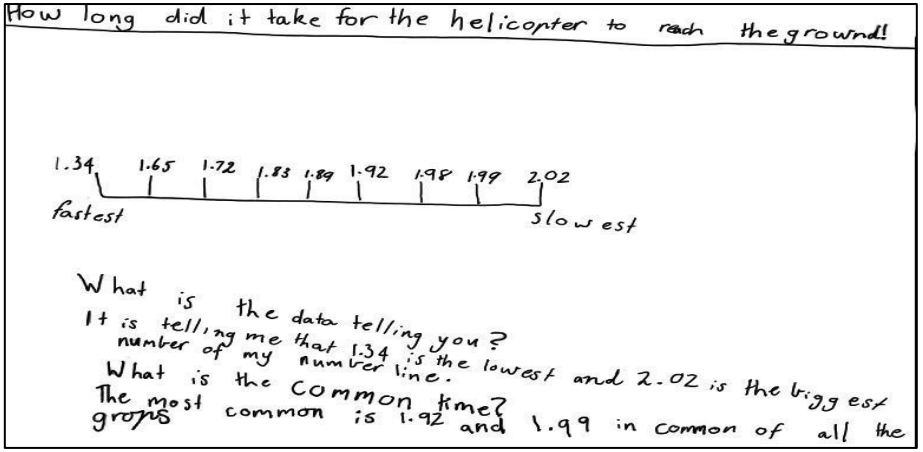
Grade 2 paper helicopter
3 Lessons at the end of a Primary Connections unit

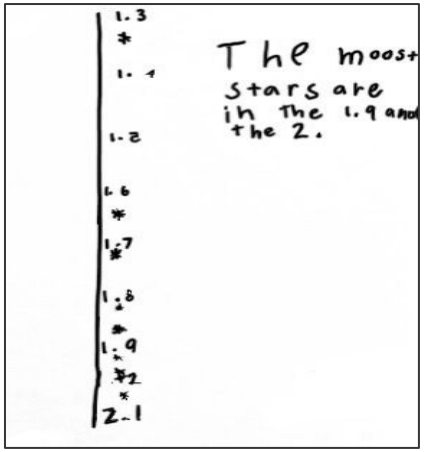
Lesson 1: Timing the fall of a standard helicopter

Focus on measurement and variation



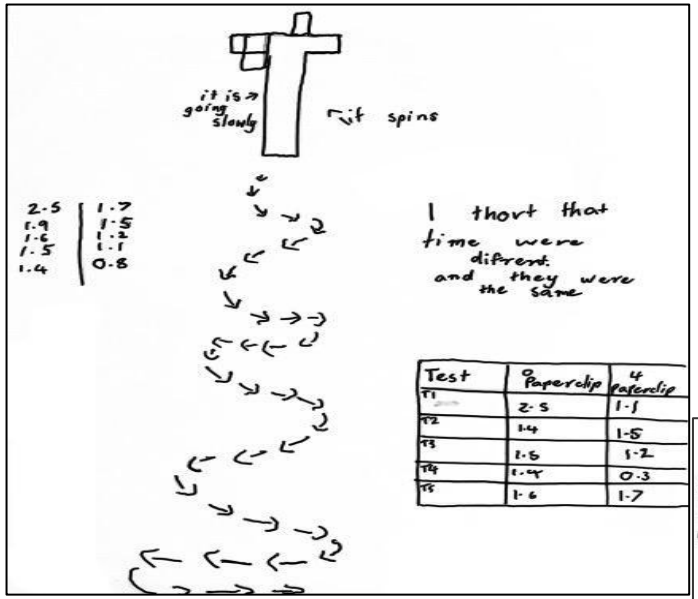


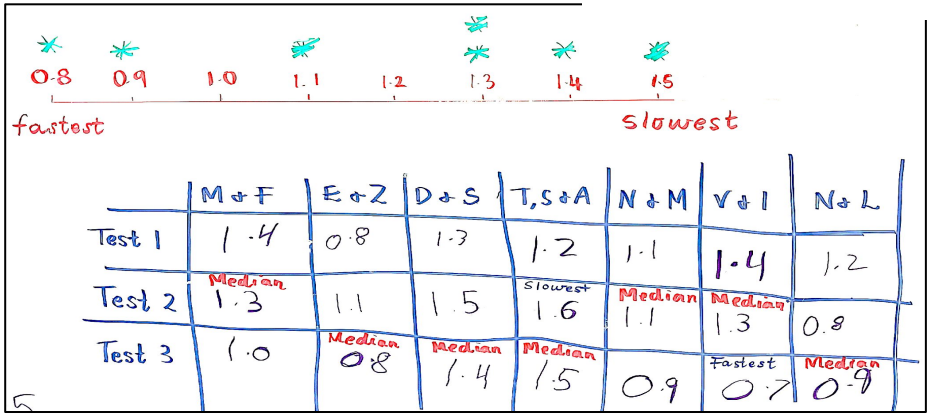


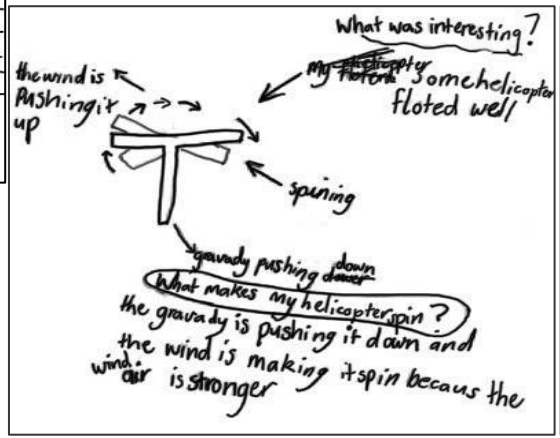


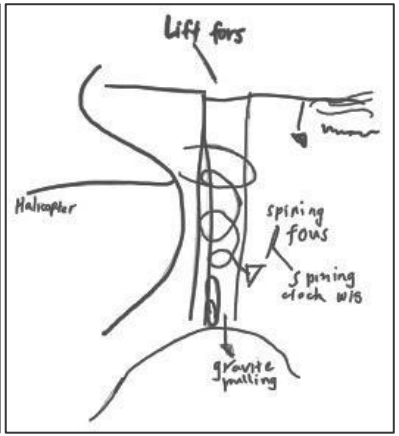
Grade 2 paper helicopter

Investigating the effect of different numbers of paperclips (L2) and different designs (L3)









From post sequence interviews

Variation:

I didn't want to choose them the same because it's really unlikely that they're going to be the same. So, I chose different ones because I think that some of them are going to be slow and some of them would be a bit fast.

It fills in some of the gaps and it also means that the wind was different when they dropped it.

Measure of central tendency

I'd choose 1.5 because I don't want it to be too fast or too slow, so I'm choosing the ones that are perfect, not to high and not too low.

If it was 2.0 seconds it would be the highest amount of time, but if it was 1.0 second it would be the lowest. So, it wouldn't be one of those two, it has to be directly in the middle.

On representing with a number line

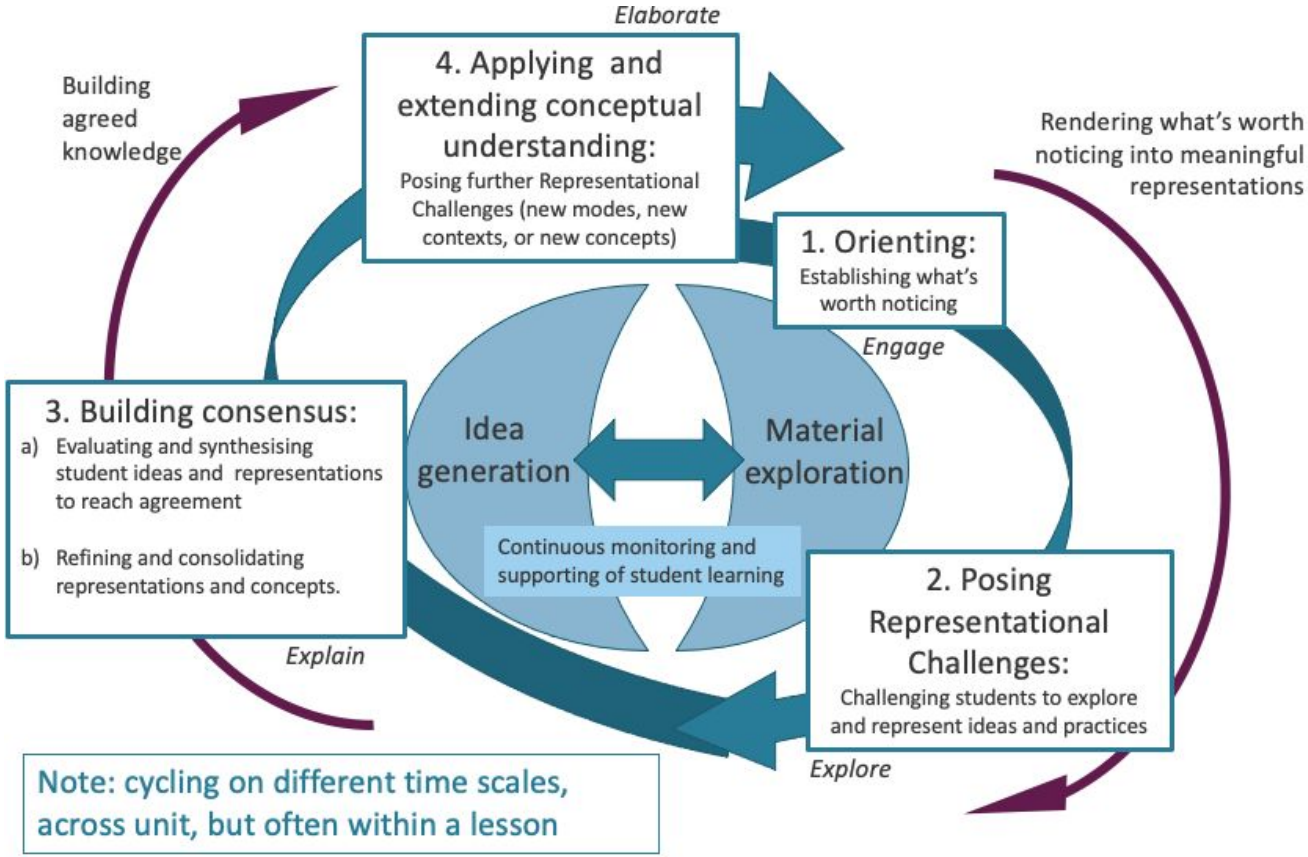
The timeline shows how close the times are, and it helps you measure time, because it shows you how close the times are to all the other times.

I think (the table) doesn't show how many times it happened clearly.

It's way easier to understand than this (table) because you can tell how, there's just one, but if there's two you put two x's, and it makes it a lot easier to understand.

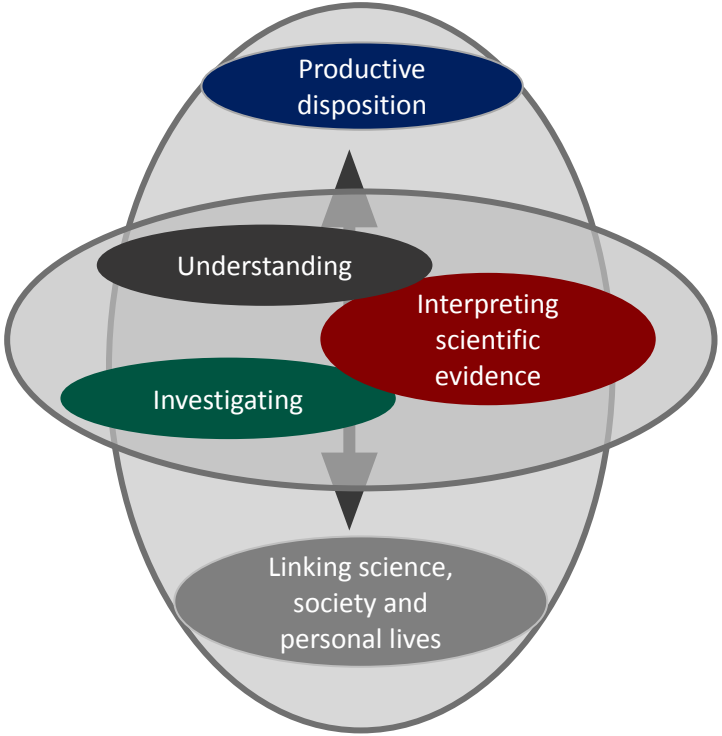
You can see it more easily. The numbers are spread out and you can read it easily.

IMS Pedagogy in relation to the 5Es



The science proficiencies

How does or could these activities contribute to each of the science proficiencies?



Productive disposition: Developing curiosity, objectivity and resilience in relation to science ideas, commitment to sustainability and other ethics, and an increasing propensity to value and utilize scientific knowledge.

Understanding: Developing the capacity to draw on key science concepts to interpret, explain and reason about phenomena

Investigating: Developing increasing independence to propose, pursue and interpret a variety of types of scientific investigation.

Interpreting scientific evidence: Developing the capacity to reason through linking ideas with evidence and to understand how knowledge is built in science.

Linking science, society and personal lives: Developing increasing understanding of interactions between science, technology and society, the ways science can inform our personal decisions, and how science interacts with other knowledges and values in socio-scientific issues.

Thank you

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