ASTRONOMY IN PRIMARY SCHOOL AS A MULTI-MODELING PROCESS

Russell Tytler
Deakin University

Team Members for the IMS project:
Peta White, Joanne Mulligan, Vaughan Prain, Lihua Xu Richard Lehrer, Leona Schauble, Melinda Kirk, Chris Speldewinde, Chris Nielsen

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Key question

What are the challenges to visualising earth and space relations for primary school children?

To consider this I will draw on:

A learning sequence on shadows and night and day, and the moon, from the ARC projects:

1. IMS: ”Enriching maths and science learning: An interdisciplinary approach” (Grade 1)
2. EQUALPRIME: “Exploring quality primary education in different cultures: A cross-national study of teaching and learning in primary science classrooms” (Grade 3)

https://imslearning.org/

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IMS LEARNING

Interdisciplinary Maths and Science Learning

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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.

"

Maths and Science together makes sense!

Year 4 student

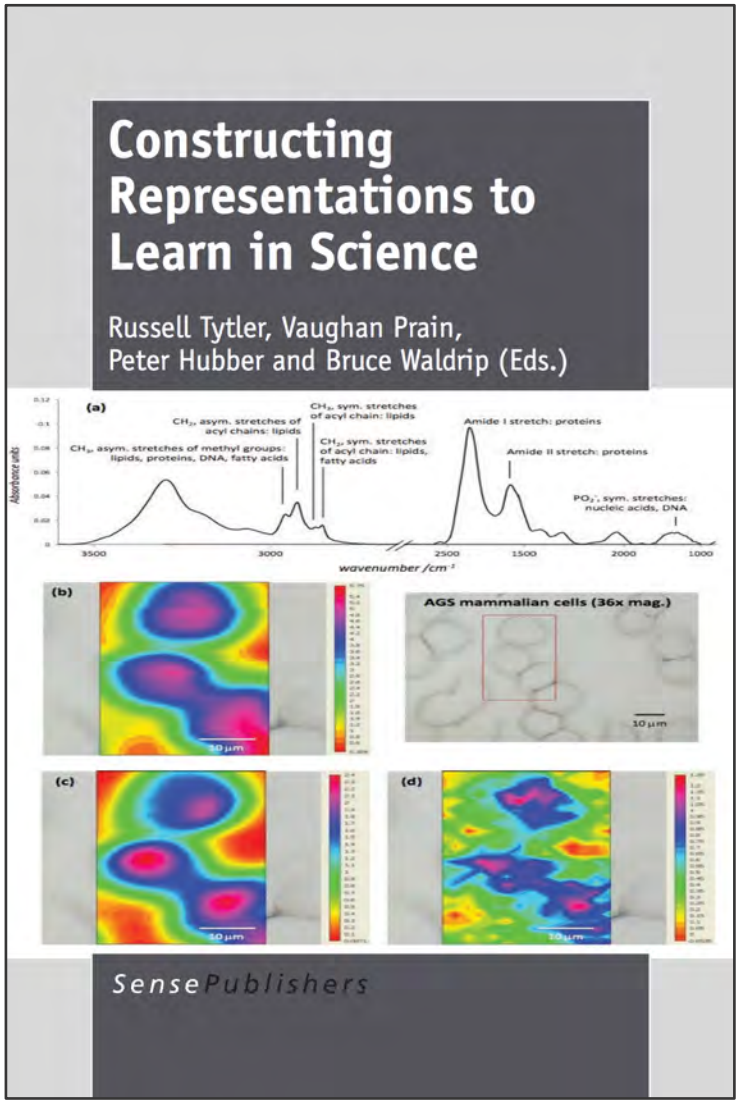
Key features of the IMS project

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.

Year 1 Astronomy

Structure of the sequence

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Lesson sequence

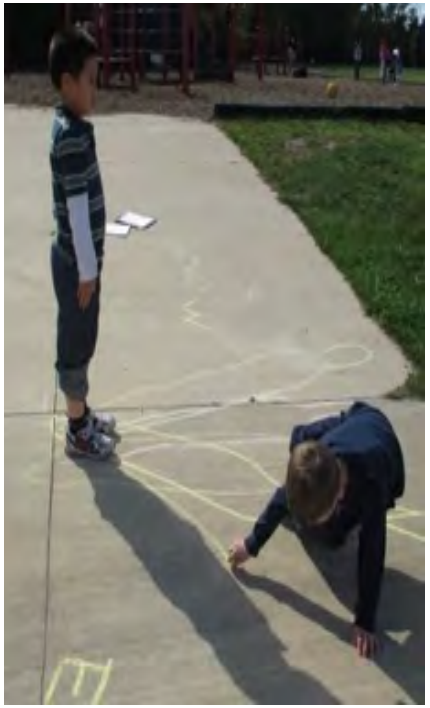
Lesson 1: What do you know about the sun?

Lesson 2: Conducting a Shadow Investigation

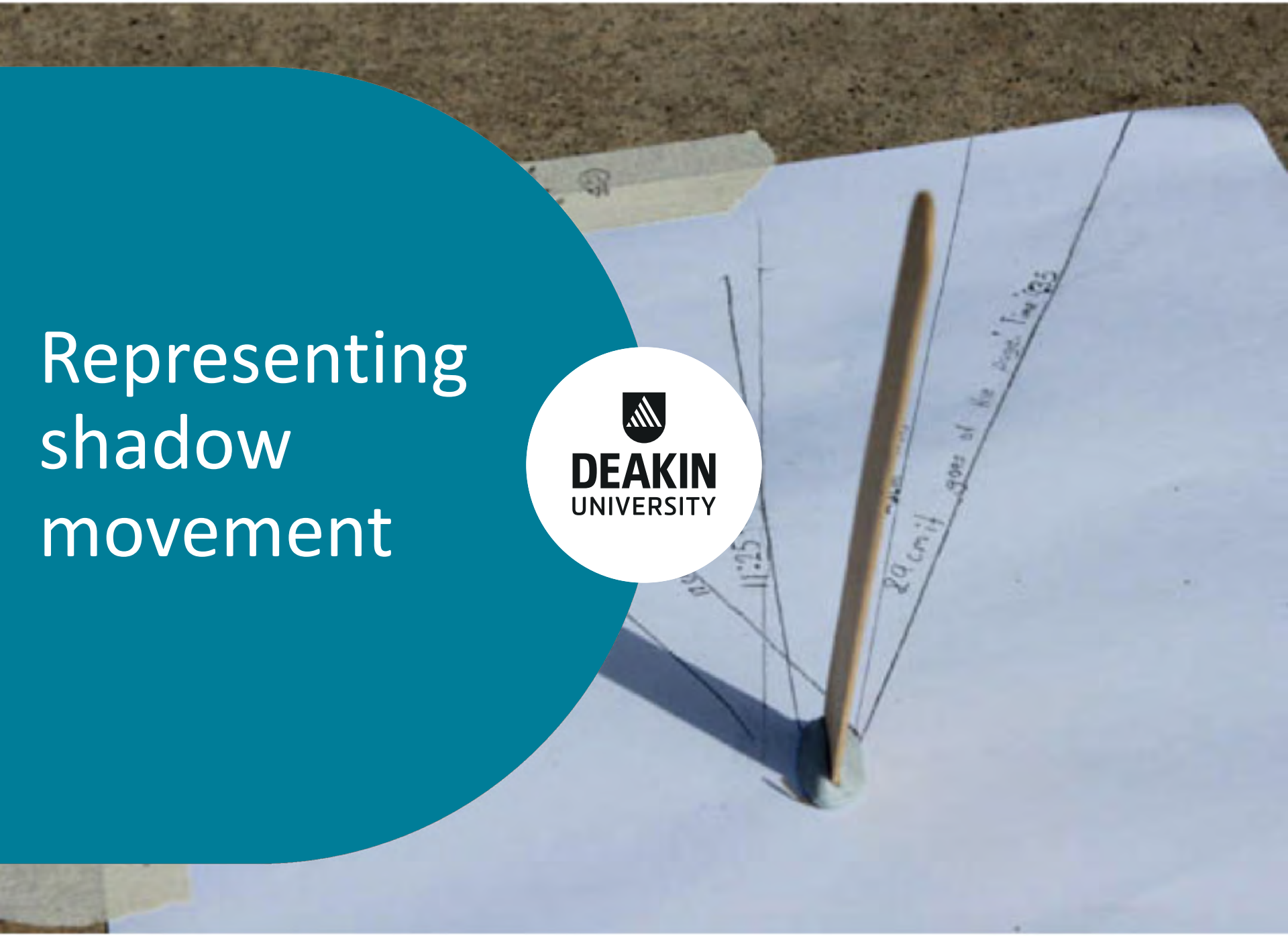
Lesson 3: Representations and Modelling Shadow Investigation Data.

Lesson 4: Explanation and Modelling Earth's Rotation

Lesson 5: Clarify Day and Night Understandings



Representing shadow movement



Lesson 1: Children's prior ideas and preparation for shadow tracking

Lesson 1: What do you know about the sun? *Establishing prior knowledge of the sun and day and night. Setting up of predictions and procedures for recording shadows and the suns movement.*

Children predict the shadow might 'move and change direction', 'get longer', 'get shorter' (because the sun's really big).

On observing shadows informally:

Student

"The shape of the shadow changed"

(written on board)

"It got smaller and turned to the side"

What does that mean - it moved to the side.

Teacher

Jen (student) indicates with gestures

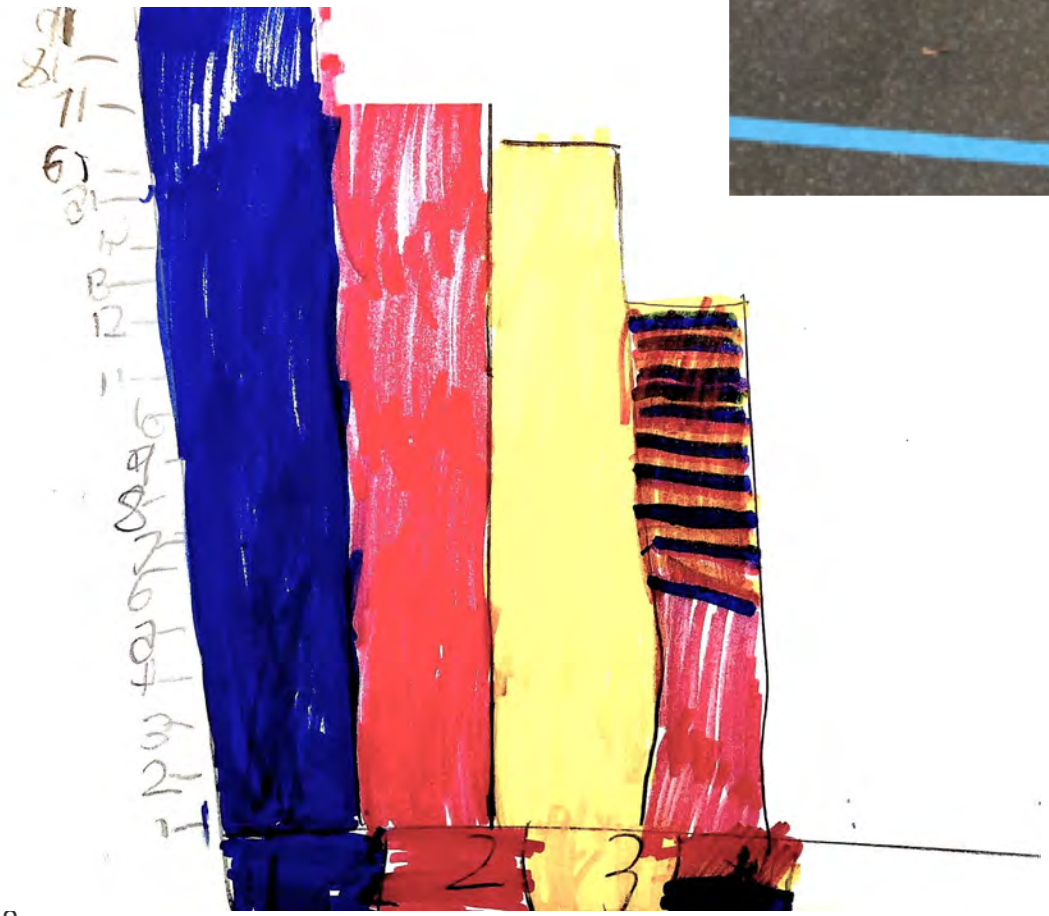
"Oh so you mean moved around"

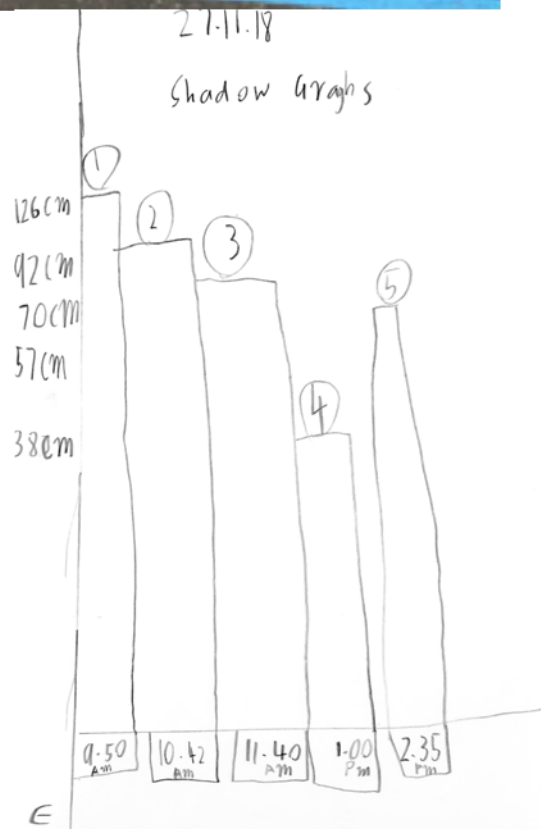
- How are you going to show how your shadow's changed?
- How are you going to record how the time has changed?

Different classes made different decisions about measuring length:

using streamers or using blocks.

Lessons 2-3

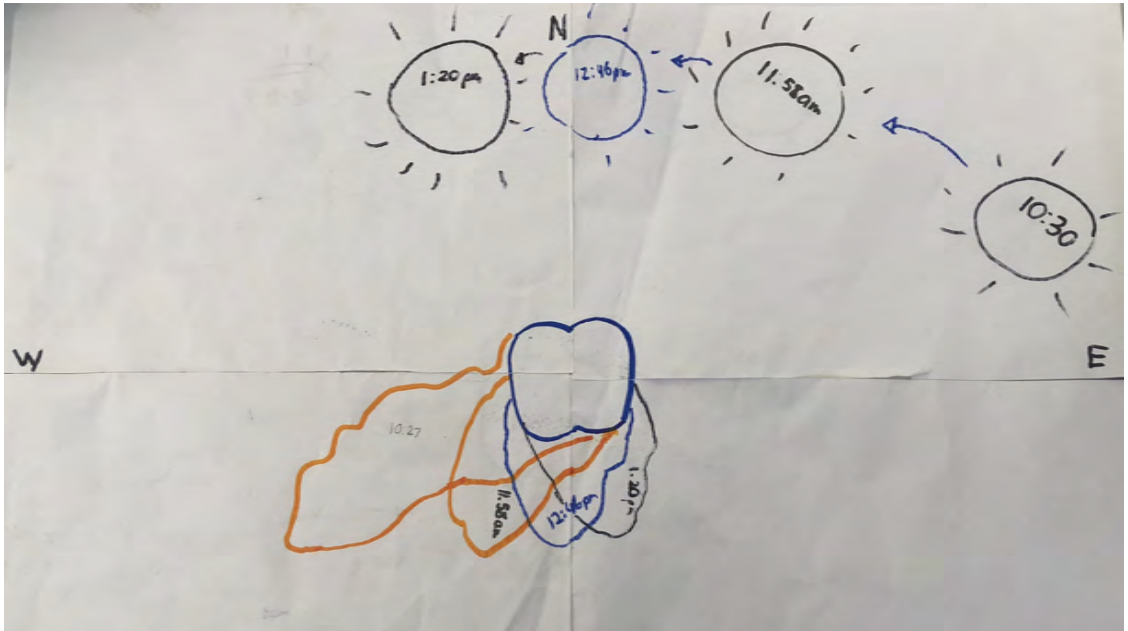



27.11.18
Shadow Graphs
126cm
92cm
70cm
57cm
38cm
1
2
3
4
5
9.50 AM
10.42 AM
11.40 AM
1.00 PM
2.35 PM

Gnome shadow modeling

Establishing sun and shadow relations using the gnome


9.00
9.45
10.30
11.00
2.30
3.00
3.30
4.30
5.00


N
1:20 pm
12:46pm
11.58am
10:30
W
E
10.27
11.58am
12:46pm
1.20pm

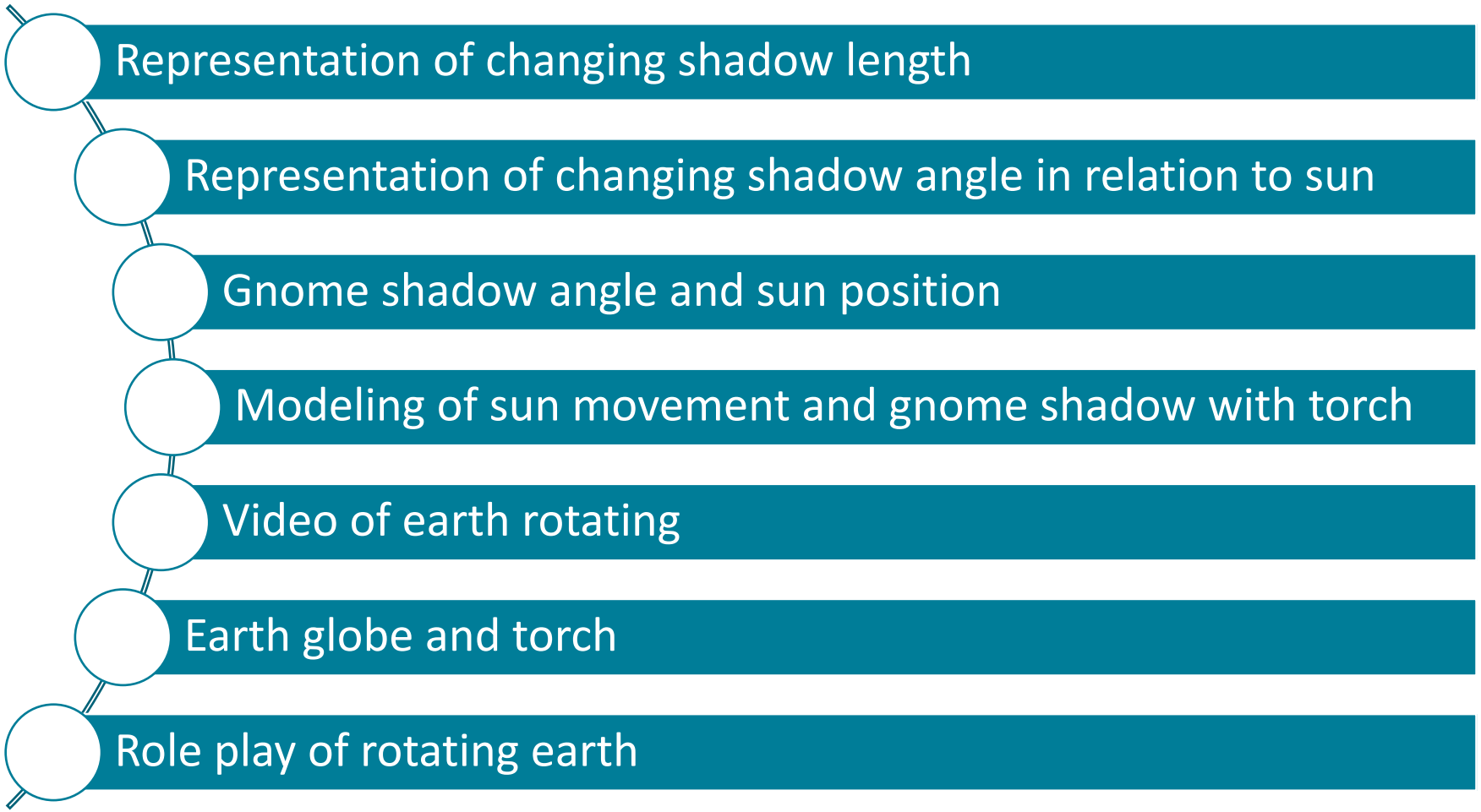
Modeling the sun's movement with a torch and gnome, then embodied representation

The teacher moves the torch to duplicate the sun's movement …

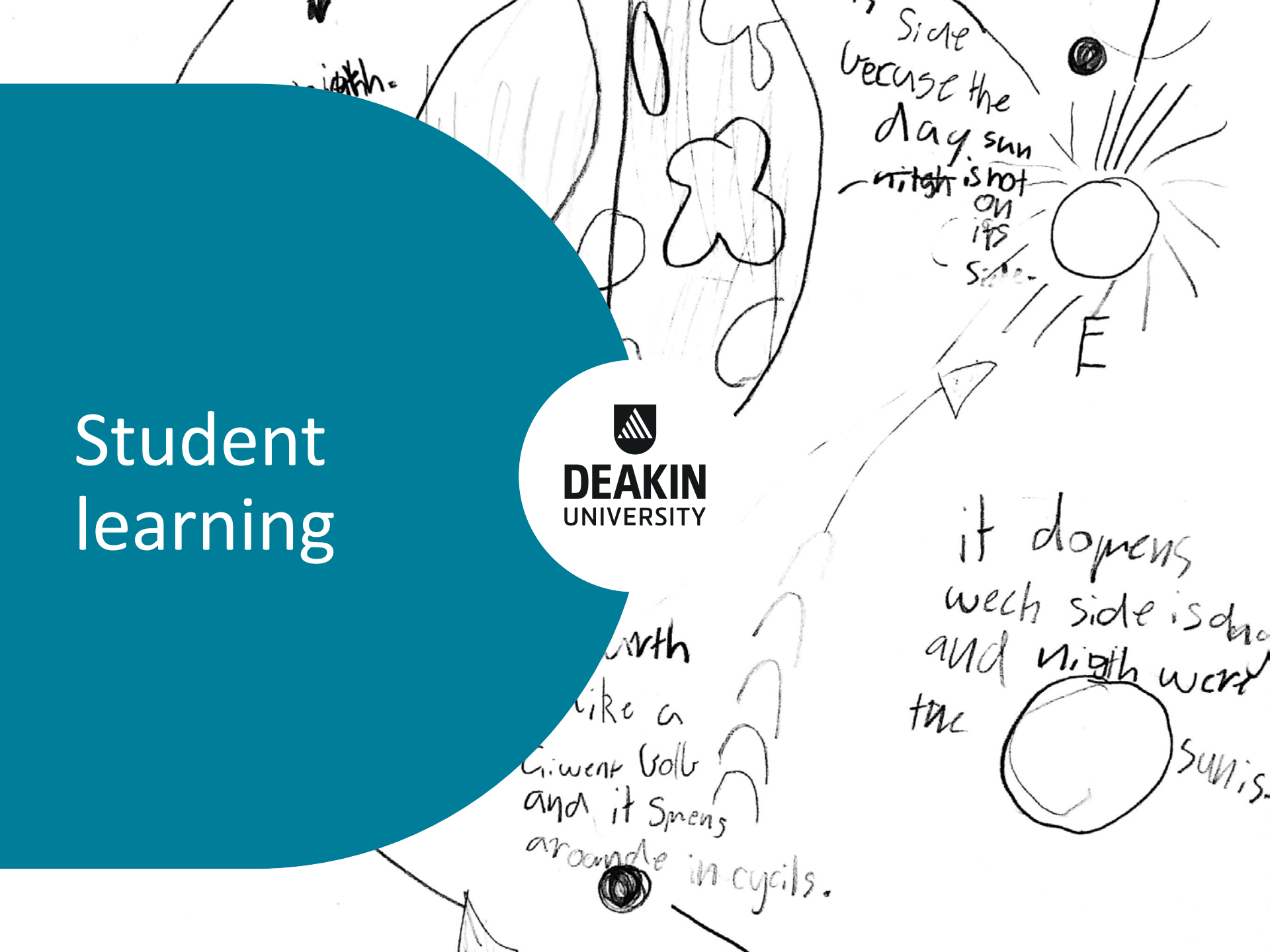
…. then has a student point to the sun and the shadow tip, to establish they are opposite in direction.

Modeling night and day

Sequence of representations



Student learning

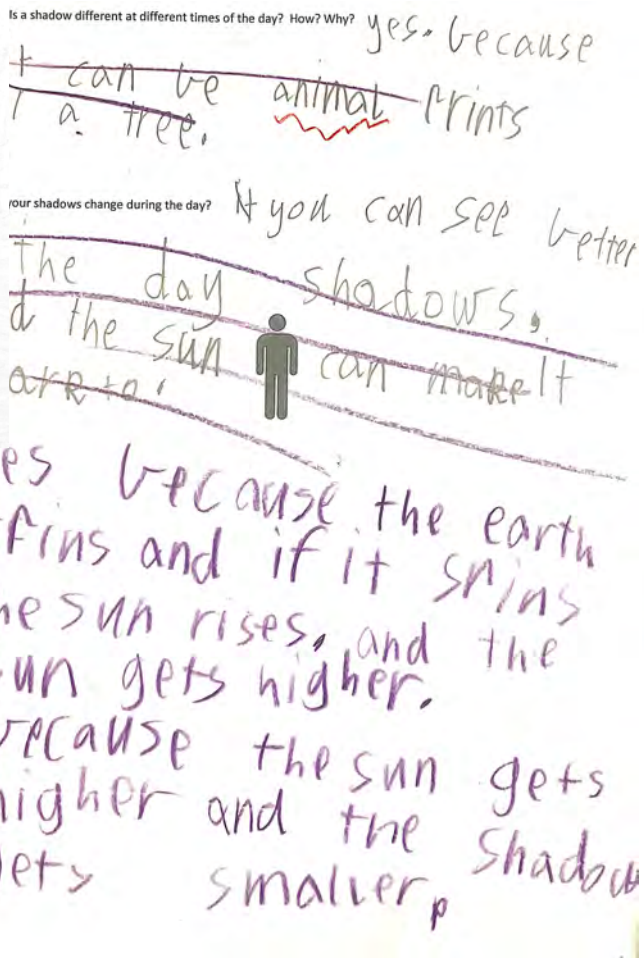


today I leant that the Earth is spining whil going around the sun.

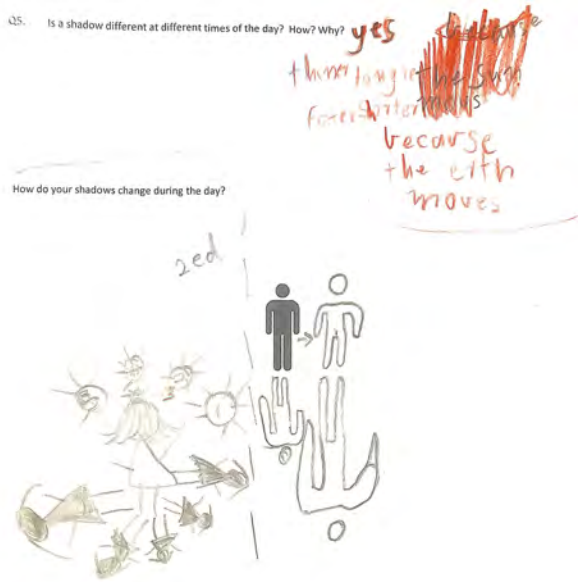
It takes 1 year to orbet around the sun.
it spins once ons every 24 hours.

Changes to children's ideas about shadows

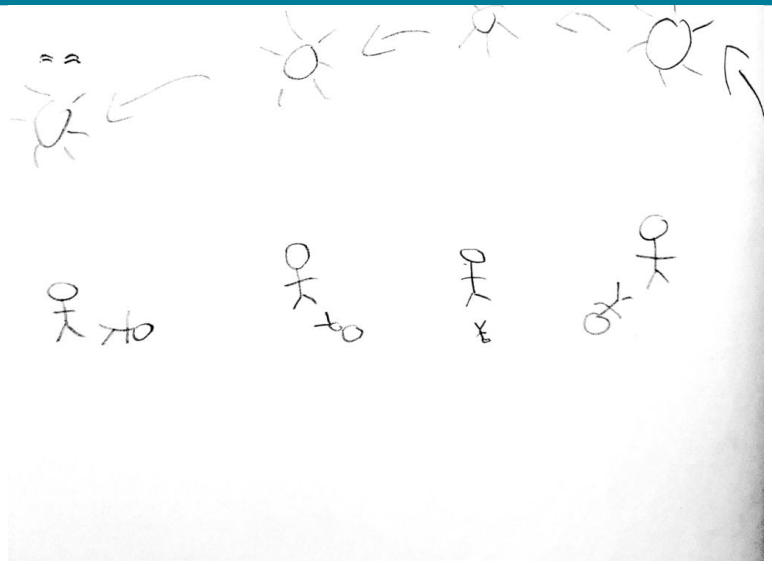
Naïve post test entry

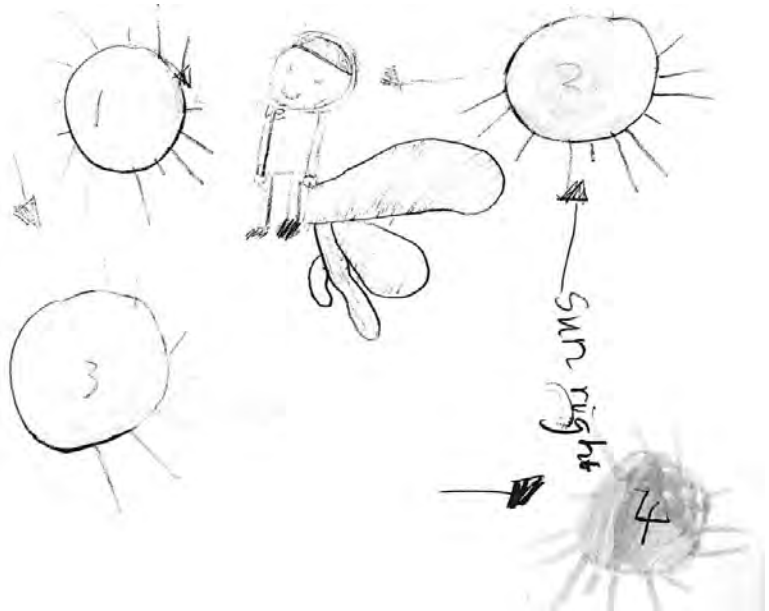


Changes to student ideas



Final representations





We Went outside and we traced our shadows. When we got there the direction of the sun was was est and the shadow was long in the west. Then the sun start moveing to the west and the shadow got smaler. when the sun was above us it was relly smal. when the shadow was on the west the shadow started to get bigger on [illegible] side.

Pre- & Post test: Movement of sun in the sky

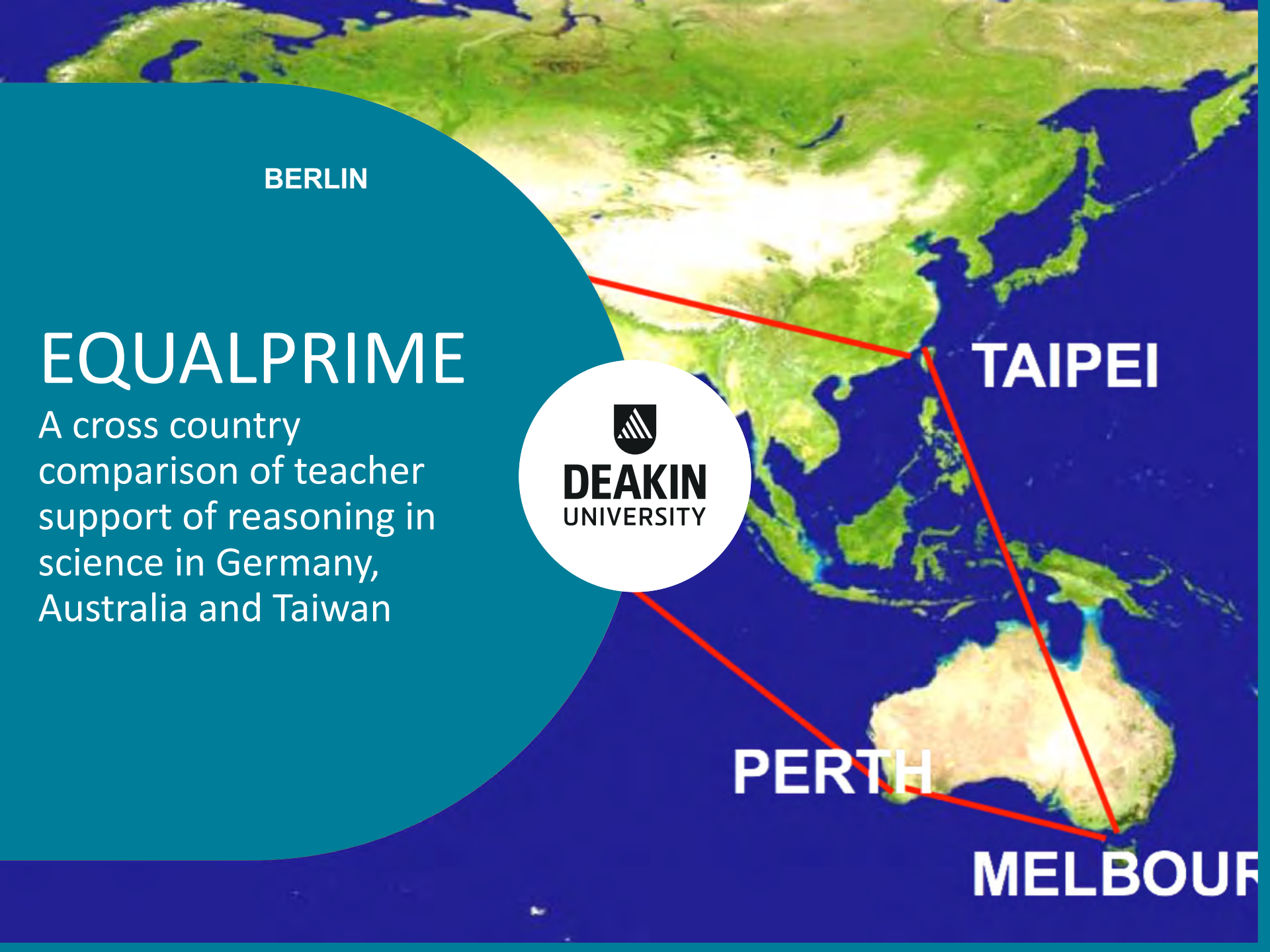
	Incorrect (sun moves up and down , or from west to east)	Correct	Unclear
Pre test	36	7 (14%)	7
Post test	5	40 (80%)	5

In focus groups, students often spontaneously used the globe to explain night and day, even orchestrating role plays.

If America is daytime and the earth is spinning around, then people's shadow in America would be bigger. Rotate the earth please. Then America's night time now, so Australia –

So what have we learned?

- Understandings of the movement of the sun and it's relation to day and night involves coordinating earth and space perspectives
- This involves the coordination of multiple, multimodal representations (2D, 3D, embodied, text)
- This involves, for Grade 1 children, difficulties with spatial skills/visualisation
- Teachers need a strong understanding and insight into these coordinated spatial relations
- In other research we have identified the critical importance of linking these representations



EQUALPRIME

A cross country comparison of teacher support of reasoning in science in Germany, Australia and Taiwan

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Ms Petersen moon phase sequence

Teacher: What do you think, how would you see a crescent?
Student: If the Moon turned this way.
Teacher: Well, position it!
Student: Well, if the Moon turns this way, so that it beams its rays here somehow.
Teacher: ***The way the Moon is positioned right now, what do you think what phase of the Moon would you see? You are there on the Earth, Sami?***

Representation 2: Children model moon phases

Teacher: So, ok … Take care that you... Can you see how the Moon is illuminated here? (Ss: Yes!) ***Now if one was a little man on the Earth, one would see the Moon this way (positioning the eye to look from earth to moon). Ok. So what does a new moon look like?***

Representation 3: Revisiting the Tellurium

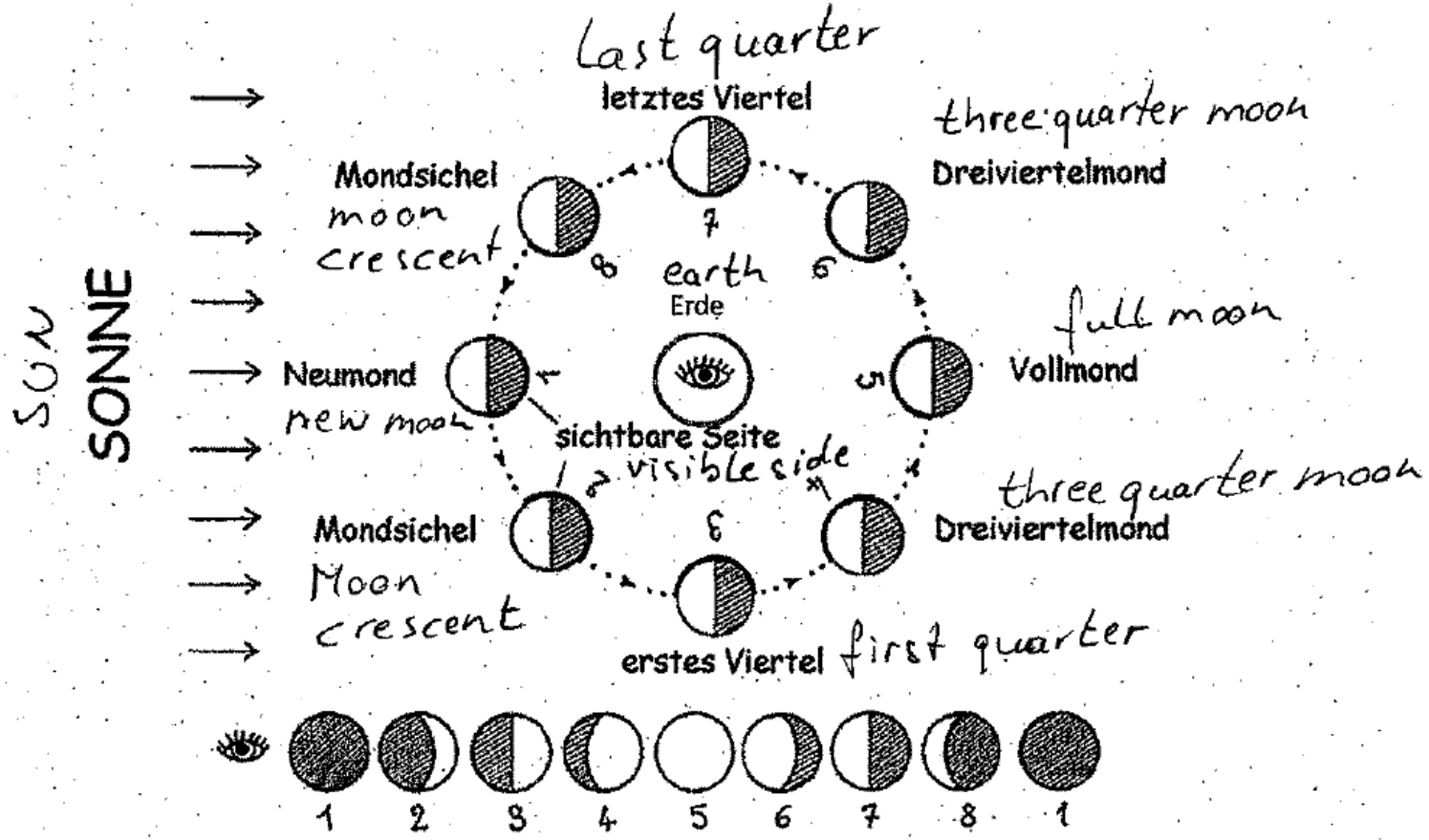
Teacher: *So, Ma..,* ***look, you are here, in Berlin. Go stand there in Berlin and look at the moon. How do you see it illuminated right now?***

Student Ma: *Noo!*

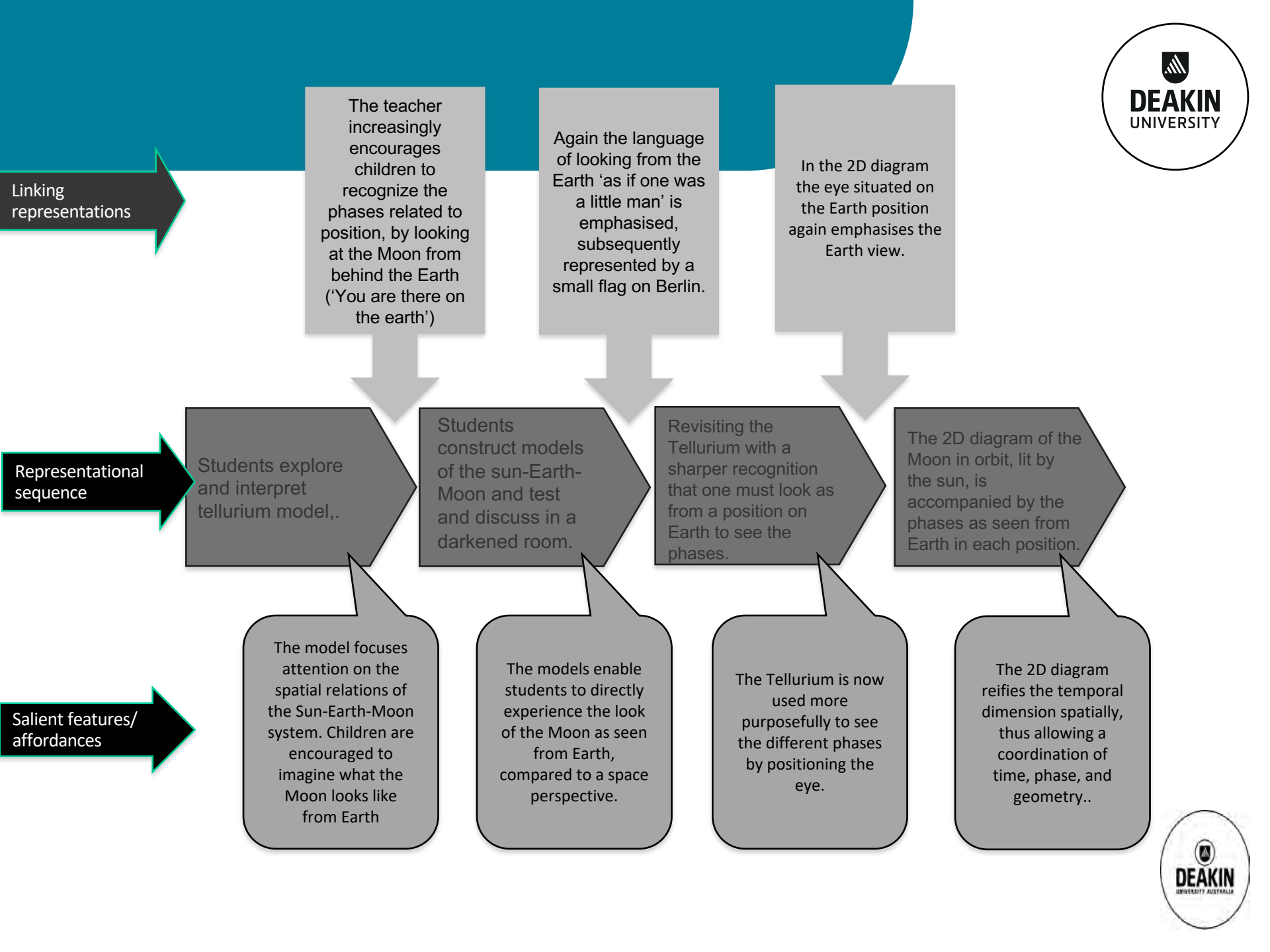
Teacher: *So, what kind of a moon is it?*

Student Ma: *Mhhh [.] New moon?*

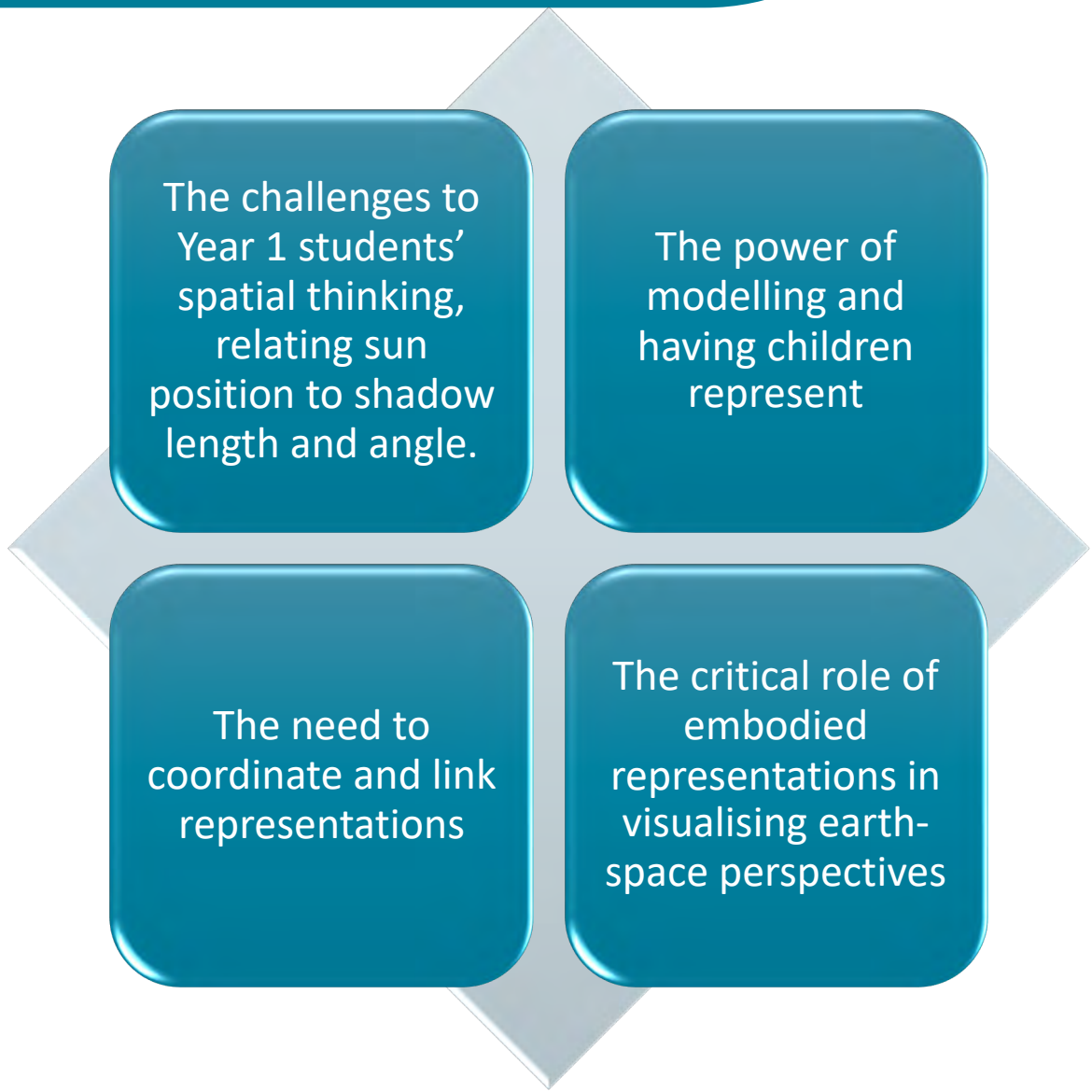
Representation 4: 2D diagram aligning the moon p with orbital positions



Children filled in a worksheet answering questions about this diagram. Note the earthbound eye!


Linking representations
The teacher increasingly encourages children to recognize the phases related to position, by looking at the Moon from behind the Earth ('You are there on the earth')
Again the language of looking from the Earth 'as if one was a little man' is emphasised, subsequently represented by a small flag on Berlin.
In the 2D diagram the eye situated on the Earth position again emphasises the Earth view.
Representational sequence
Students explore and interpret tellurium model,.
Students construct models of the sun-Earth-Moon and test and discuss in a darkened room.
Revisiting the Tellurium with a sharper recognition that one must look as from a position on Earth to see the phases.
The 2D diagram of the Moon in orbit, lit by the sun, is accompanied by the phases as seen from Earth in each position.
Salient features/ affordances
The model focuses attention on the spatial relations of the Sun-Earth-Moon system. Children are encouraged to imagine what the Moon looks like from Earth
The models enable students to directly experience the look of the Moon as seen from Earth, compared to a space perspective.
The Tellurium is now used more purposefully to see the different phases by positioning the eye.
The 2D diagram reifies the temporal dimension spatially, thus allowing a coordination of time, phase, and geometry..

Findings


The challenges to Year 1 students' spatial thinking, relating sun position to shadow length and angle.
The power of modelling and having children represent
The need to coordinate and link representations
The critical role of embodied representations in visualising earth-space perspectives

Thank You

Russell Tytler
russell.tytler@deakin.edu.au