Teacher as a trigger for change:

Characteristics, strategies and resources for effective teaching of science

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Primary Connections offices - Sydney

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What is Primary Connections?

- a multi-pronged IBSE approach

Professional learning program

Complimented by curriculum resources

Based on research

Primary Connections - a way of thinking about teaching and learning in science

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Funding, Philanthropist and Patron

Funded by the Australian Government 2005 – 2018 $14.7 million AUD

Professor Brian Schmidt, Nobel Laureate – philanthropist to Primary Connections

Sir David Attenborough – Patron of AAS Education and Public Awareness programs

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Continuum for teaching science as argument

Activity based	Investigation based	Evidence based	Argument based
Fun, hands-on activities designed to motivate students and keep them physically engaged	Abilities to engage in inquiry; ask testable questions and design fair tests; focus on collecting data	Need to support claims with evidence; evidence is not questioned in terms of quality, coherence etc	Argument construction is central; coordinating evidence and claims is viewed as important; emerging attention to considering alternatives.

Zembal-Saul, C. (2009). Learning to teach elementary school science as argument. *Science Education*, 93(4):687-719.

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PrimaryConnections 5Es framework

Phase	Focus
ENGAGE	Engage students and elicit prior knowledge ***Diagnostic assessment***
EXPLORE	Provide hands-on experience of the phenomenon ***Formative assessment***
EXPLAIN	Develop scientific explanations for observations and represent developing conceptual understanding. Consider current scientific explanations ***Formative assessment***
ELABORATE	Extend understanding to a new context or make connections to additional concepts through a student-planned investigation ***Summative assessment of investigating outcomes***
EVALUATE	Students re-represent their understanding and reflect on their learning journey and teachers collect evidence about the achievement of outcomes ***Summative assessment of conceptual outcomes***

Light shows – Year 5 unit

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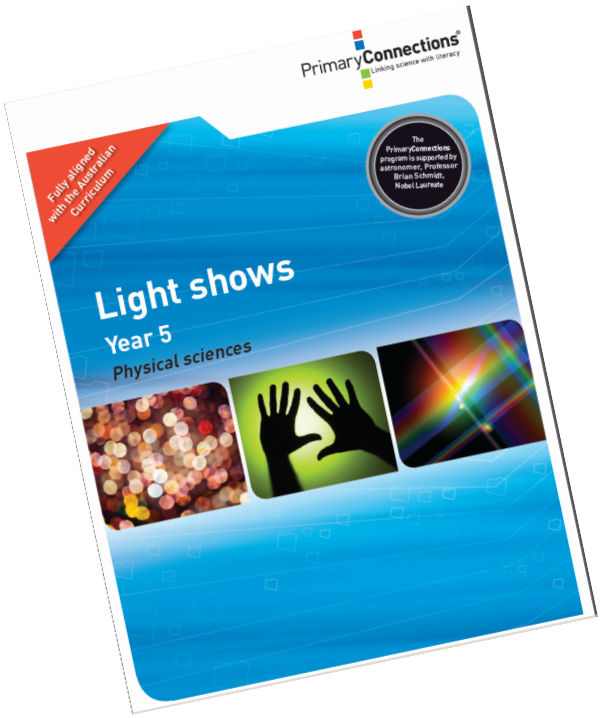

Contents

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Curriculum unit features

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Curriculum unit features checklist

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Teacher background information for the unit
5Es phase tabs
Teacher background information — for that lesson
Key lesson outcomes, science and literacy
Equipment and preparation in lesson steps
Literacy focus in lessons
Assessment focus in lesson steps
Student resource sheets in lessons
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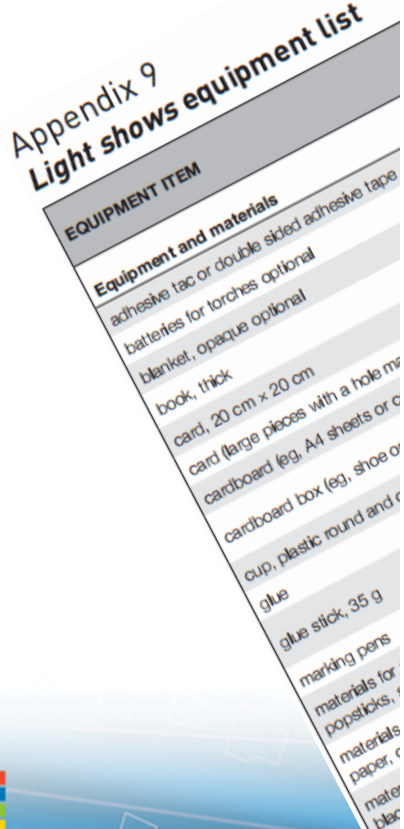
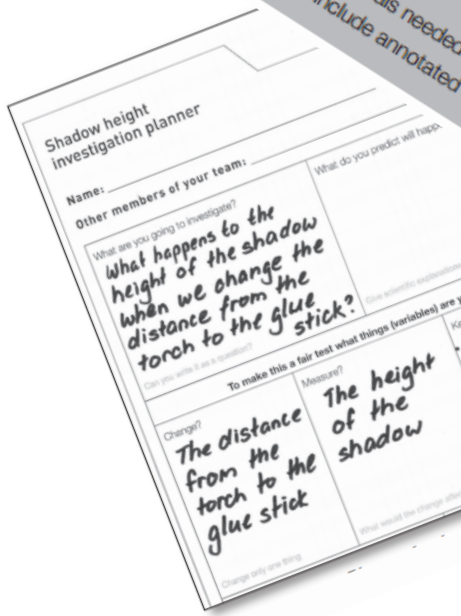
Appendix: unit overview





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Literacy focuses

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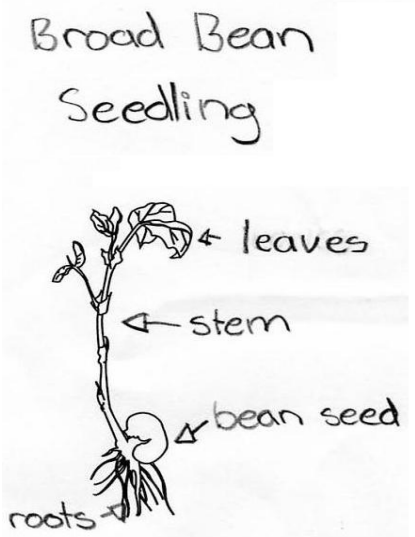
Literacy focus

Why do we use a labelled diagram?

We use a **labelled diagram** to show the shape, size and features of an object.

What does a labelled diagram include?

A **labelled diagram** might include a title, an accurate drawing, a scale to show the object's size and labels showing the main features. A line or arrow connects the label to the feature.



Literacy focus

Why do we use a procedural text?

We use a **procedural text** to find out how something is done. We can read a **procedural text** to find out how to do things.

What does a procedural text include?

A **procedural text** includes a list of materials needed to do the task and a description of the sequence of steps used. It might include annotated diagrams.

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Literacy focuses in PC units

- Annotated drawing
- Drawing
- Cross section
- Cut-away diagram
- Design portfolio
- Factual recount
- Factual text
- Flow chart
- Force-arrow diagram
- Glossary
- Graph
- Ideas map
- Information report
- Interview
- Labelled diagram
- Map
- Narrative
- Oral presentation
- Picture map
- Poster
- Ray diagram
- Report
- Role play
- Science journal
- Storyboard
- Summary
- Table
- Timeline
- T chart
- Tree diagram
- Venn Diagram
- Word wall

Appendices

How to …
facilitate evidence-based discussions: QCER

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Question, Claim, Evidence and Reasoning

In science, arguments that make claims are supported by evidence. Sophisticated arguments follow the QCER process:

Q What **question** are you trying to answer? For example, 'What happens to the height of the shadow when we change the distance from the torch to the glue stick?'

C The **claim**. For example, 'The nearer the torch to the glue stick, the taller the shadow.'

E The **evidence**. For example, 'We measured the size of the shadow each time we moved the glue stick closer to the screen. Our results were: 5 cm from the torch to the screen—the height of the shadow was 19.3 cm; 10 cm—16.1 cm; 15 cm—14.7 cm; 30 cm—13 cm.'

R The **reasoning**, saying how the evidence supports the claim, for example, 'Light travels in straight lines so the closer the object to the light source the more light it blocks out and therefore the bigger the shadow.'

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How to … facilitate evidence-based discussions: question starters

Science question starters

Science question starters can be used to model the way to discuss a claim and evidence for students. Teachers encourage team members to ask these questions of each other when preparing their claim and evidence. They might also be used by audience members when a team is presenting its results. (See Primary**Connections** 5Es DVD, Chapter 5).

Science question starters

Question type	Question starter
Asking for evidence	I have a question about _____. How does your evidence support your claim_____ ? What other evidence do you have to support your claim _____ ?
Agreeing	I agree with _____ because _____.
Disagreeing	I disagree with _____ because _____. One difference between my idea and yours is _____.
Questioning further	I wonder what would happen if _____? I have a question about _____. I wonder why _____? What caused _____? How would it be different if _____? What do you think will happen if _____?
Clarifying	I'm not sure what you meant there. Could you explain your thinking to me again?

How to… construct and use a graph

Light shows

Appendix 7

How to construct and use a graph

Introduction

A graph organises, represents and summarises information so that patterns and relationships can be identified. Understanding the conventions of constructing and using graphs is an important aspect of scientific literacy.

During a scientific investigation, observations and measurements are made and measurements are usually recorded in a table. Graphs can be used to organise the data to identify patterns, which help answer the research question and communicate findings from the investigation.

Once you have decided to construct a graph, two decisions need to be made:

- What type of graph? and
- Which variable goes on each axis of the graph?

What type of graph?

The type of graph used depends on the type of data to be represented. Many investigations explore the effect of changing one variable while another is measured or observed.

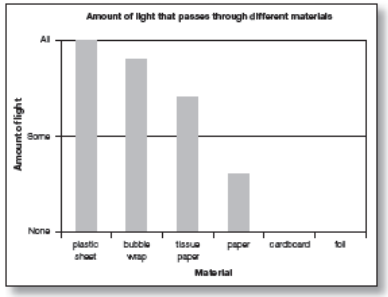
Column graph

Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, material) a **column graph** is used. Graph A below shows how the results for an investigation of the effect of material type on the amount of light that passes through it **(data in categories)** have been constructed as a **column graph.**

Table A: The effect of material on the amount of light that passes through

Material	Amount of light
plastic sheet	all
bubble wrap	almost all
tissue paper	most
paper	not much
cardboard	none
foil	none

Graph A: The effect of material on the amount of light that passes through



Line graph

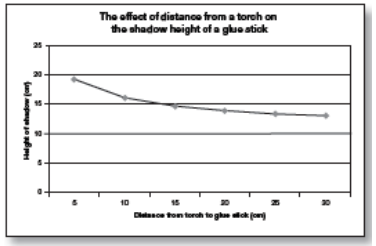
Where the data for both variables are **continuous** (that is, we use **numbers** that can be recorded on a measurement scale, such as length in centimetres or mass in grams), a **line graph** is usually constructed. Graph B below shows how the results from an investigation of the effect of distance from a light source **(continuous data)** on the shadow height of an object **(continuous data)** have been constructed as a **line graph.**

Note: For the 'Big shadow, little shadow' lesson in this unit, a line graph would be the conventional method to represent findings from this investigation as the data for both variables are continuous. It is suggested, however, that students construct a column graph as this is appropriate for Year 5 students. You might produce a column and a line graph and discuss with students why a line graph would normally be used to represent the data.

Table B: The effect of distance from a torch on the shadow height of a glue stick

Distance from torch to glue stick (cm)	Height of shadow (cm)
5	19.3
10	16.1
15	14.7
20	13.9
25	13.3
30	13

Graph B: The effect of distance from a torch on the shadow height of a glue stick



Which variable goes on each axis?

It is conventional in science to plot the variable that has been changed on the horizontal axis (X axis) and the variable that has been measured/observed on the vertical axis (Y axis) of the graph.

Graph titles and labels

Graphs have a title and each variable is labelled on the graph axes, including the units of measurement. The title of the graph is usually in the form of 'The effect of one variable on the other variable'. For example, 'The effect of distance from a torch on the shadow height of a glue stick' (Graph B).

Steps in analysing and interpreting data

Step 1 – Organise the data (for example, construct a graph) so you can see the pattern in data or the relationship between data for the variables (things that we change, measure/observe, or keep the same).

Step 2 – Identify and describe the pattern or relationship in the data.

Step 3 – Explain the pattern or relationship using science concepts.

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Questioning to analyse graphs

Questioning for analysis

Teachers use effective questioning to assist students to develop skills in interrogating and analysing data represented in graphs. For example:

- What is the story of your graph?
- Do data in your graph reveal any patterns?
- Is this what you expected? Why?
- Can you explain the pattern? Why did this happen?
- What do you think the pattern would be if you continued the line of the graph?
- How certain are you of your results?

Analysis

For example, analysis of Graph B shows that further the distance from the torch the shorter the height of the glue stick's shadow. This is because as light travels in straight lines, the closer the object to a light source the more light it blocks out and therefore the bigger the shadow.

Professional learning

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Primary Connections Ready

Pre-service Teacher Program, Day 1

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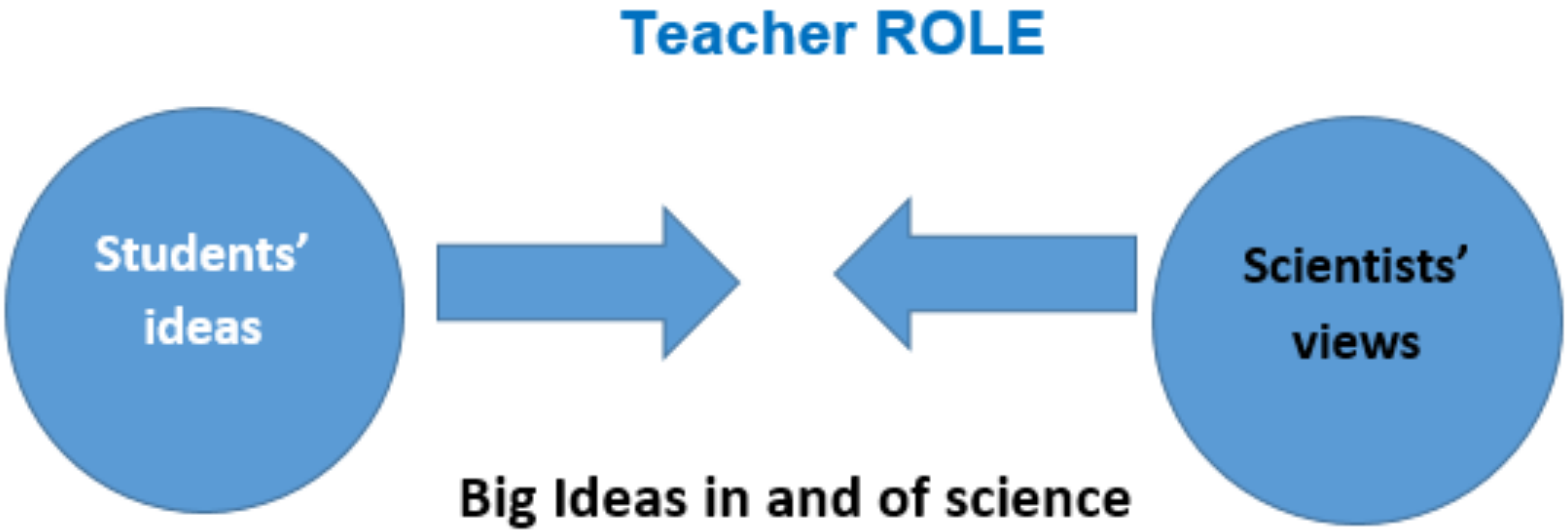
Teacher role



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Vision: Engaged students – Confident and competent teachers

Purpose: Increase the quality and quantity of science teaching and learning in primary schools

www.science.org.au/primaryconnections