



Thinking in Scientific Ways

Developing and Communicating Scientific Understanding

ACCESS THE SCIENCE EXEMPLARS ONLINE AT www.tki.org.nz/r/assessment/exemplars/sci/

LEVEL 1 2 3 4 5

How Do We See? 3

THE LEARNING CONTEXT

The teacher's intended outcomes were for the students to:

- develop their ability to construct new understandings in discussion with others
- use scientific ideas to explain how we see.

The intended outcomes were aligned to the following "big ideas":

- Scientists (and other people) clarify and develop their ideas in discussion and debate with others.
- We see when light that is reflected from objects enters the eye.

In order to establish their initial levels of understanding, the teacher asked the students to draw a diagram to explain how we see. She then provided a range of experiences involving light, sight, and colour. The students experienced extremely low light in the darkened library (see *Light and Colour*, Building Science Concepts, Book 10, page 10). They identified, listed, and discussed light sources and reflectors (see *Light and Colour*, page 12).

In groups, they conducted trials to find better reflectors among a range of everyday materials. The class investigated how easy it was to see various colours in a darkened "peep-box" (see *Light and Colour*, page 14). Each student developed signs that could be seen in low light conditions. Again in groups, they demonstrated that they could "bounce" light around the classroom and tried "target shooting" with mirrors. Some students also took on the challenge of creating "the light path with the most reflections".

This exemplar demonstrates the effective use of good assessment practice. Part way through the activities, the teacher led a discussion on "how we see" and recorded the students' theories on the whiteboard. She wanted to know if the students were ready for more challenging ideas about reflection and the absorbency of colours.

The discussion enabled her to gather assessment information as well as to help the students clarify and reconstruct their ideas about light. The students debated their ideas as they tried to explain what they had observed in their shared experiences. The next day, they recorded the changes they had made to their views in a second diagram.

Teacher-student conversation

Considering Rochelle's second diagram:

Teacher: Tell me about the arrows in your diagram.

Rochelle: They go this way because light from the sun hits the object, and then it can go back to your eye, here.

Teacher: What if the arrows went this way [from the Sun directly to the eye]?

Rochelle: Then you'd be looking straight at the Sun. You're not meant to do that!

WHERE TO NEXT?

To move Rochelle towards the next learning step, the teacher could help her to focus on:

- developing her powers of argument, for example, by asking questions such as "Sandi says we can see on a cloudy day with no Sun – can you justify to her that your explanation would still work?" (thinking in scientific ways)
- making the new idea she has constructed a familiar part of her thinking by applying it in a range of contexts, for example, with other light sources, such as a candle, a searchlight, the Moon, and other reflected light in various positions (developing and communicating scientific understanding)
- extending her scientific vocabulary through the use of scaffolding prompts, for example, "What scientific words might you use to explain your ideas?" and "Can you explain your diagrams using the terms 'light source', 'reflection', 'eye', 'surface', and 'light ray'?" (developing and communicating scientific understanding).

The teacher could:

- explain how scientists debate theories and encourage a continuing debate in the class about how we see
- build on Rochelle's understanding of the "big idea" of how we see by moving to further work on coloured light. (See *Light and Colour* and *Seeing Colours*, Building Science Concepts, Books 10 and 11.)

CURRICULUM LINKS

Science in the New Zealand Curriculum

Achievement Objectives

Level 3: Making Sense of the Nature of Science and Its Relationship to Technology

Students can recognise when simple investigations can be classified as a "fair test" and make decisions about the worth of results.

Science in the New Zealand Curriculum, page 30
http://www.tki.org.nz/r/science/curriculum/p30_31_e.php

Levels 3 and 4: Developing Scientific Skills and Attitudes Processing and interpreting:

Students can use organised data and scientific ideas to suggest an answer to their selected questions and problems and to make an evaluation of their investigation.

Science in the New Zealand Curriculum, page 46
http://www.tki.org.nz/r/science/curriculum/p44_51_e.php

Level 3: Making Sense of the Physical World

Students can investigate and describe their ideas about some commonly experienced physical phenomena to develop their understanding of those phenomena.

Science in the New Zealand Curriculum, page 76
http://www.tki.org.nz/r/science/curriculum/p76_77_e.php



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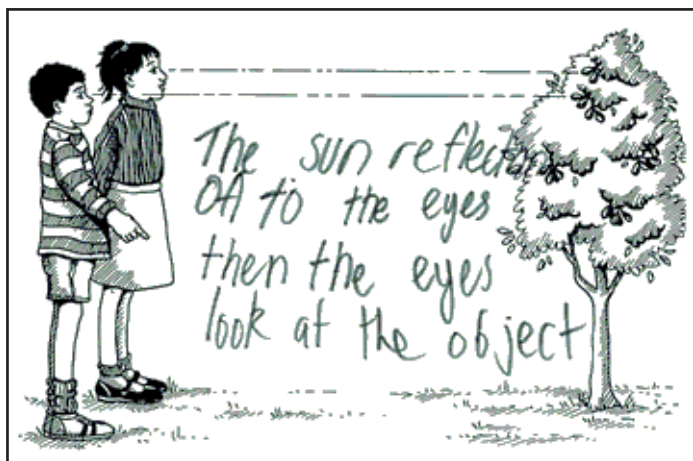
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LEVEL	1	2	3	4	5
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WHAT THE WORK SHOWS

This is an interesting exemplar for discussion as the teacher used the draft science matrices to identify the strengths and weaknesses in Rochelle's work and to suggest "where to next". Rochelle's first explanation of how we see ("before" view) shows that she has constructed her own explanation and expresses it clearly. Her second explanation shows that while her use of scientific vocabulary is at level 2, her ideas to do with developing and communicating scientific understanding and an aspect of her ability to "think in scientific ways" are at level 3.



Rochelle's "before" view

Progress Indicator
Thinking in Scientific Ways

Suggesting explanations

Rochelle suggests explanations supported by some evidence and uses evidence to support or refute them.

Comparing and evaluating explanations

Rochelle explains why she changed her ideas, referring to the evidence.

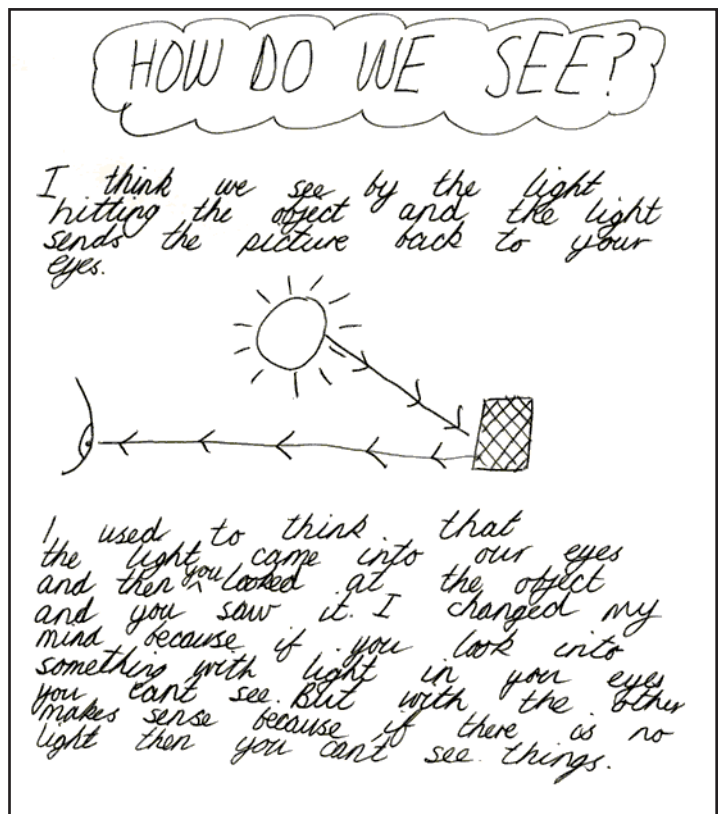
Progress Indicator
Developing and Communicating Scientific Understanding

Using scientific ideas in constructing explanations

Rochelle constructs a plausible explanation for an experience using some scientific ideas. She is able to link ideas about light sources, reflection, and the eye as a receiver of light to provide a better explanation. She supports her explanation with diagrams.

Using scientific vocabulary

Rochelle is experimenting with vocabulary to describe her scientific experiences (L2).



Rochelle's "after" view

REFERENCES

Ministry of Education (1993). *Science in the New Zealand Curriculum*. Wellington: Learning Media.

Ministry of Education (2001). *Light and Colour: Our Vision and the World*. Building Science Concepts, Book 10. Wellington: Learning Media.

Ministry of Education (2001). *Seeing Colours: The Spectrum, the Eye, and the Brain*. Building Science Concepts, Book 11. Wellington: Learning Media.