Supporting teachers' work

Rosemary Hipkins & Chris Joyce

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Key competencies

Are defined as

capabilities for living and lifelong learning

In science students explore how both the natural and physical world and science itself work

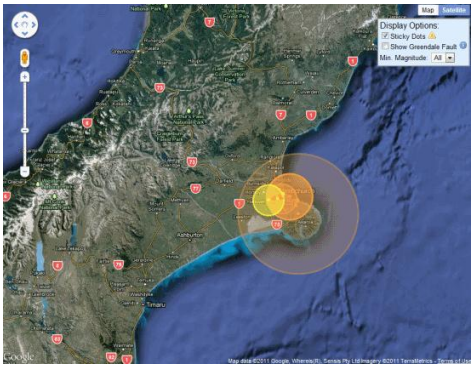
so that

they can participate as critical, informed, responsible citizens in a society in which science plays a significant role

Our notes to this slide: We're starting with the slow-burning challenge of interpreting and implementing NZC. It takes a long time to discover all the nuances and to find ways to weave the different layers together – like the link created on this slide for example. Creative teachers (and us as resource developers) have had to forge a way forward because until recently the subject-specific curriculum support for science was a bit piecemeal and hard to find. So what's changing?

A capabilities reading of key competencies asks:

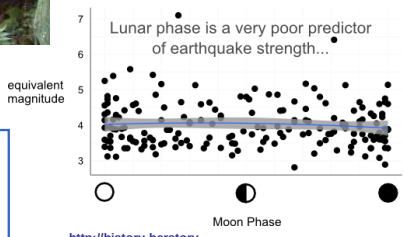
- **What are our young people capable of now?**
- **What do we hope they can become capable of in their futures?**



http://www.gearthblog.com/blog/archives/2011/02/resources_for_the_latest_christchur.html

Understanding key competencies as coming together in constellations of capabilities, which we put to use in a specific context, is a major step forward (they are much more than personality traits). New resources to support science education model aspects of capability development for science citizenship. We've been working up to them for some time, beginning several years ago with our earlier key competencies resource, taking the purpose for science, as set out in NZC, as our starting point.

Charlatan Ring merits contempt
Ring's tip sends families fleeing
(NZ Herald headlines)



http://history-herstory-scubanurse.blogspot.com/2011/03/galileo-could-kick-ken-rings-ring.html

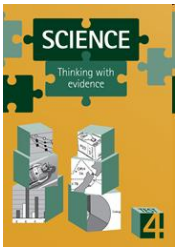
What knowledge, skills and dispositions are needed to think like this?

Can we teach them?

So let's look at an actual example where critical thinking was the type of capability required. Evidence gathered by this blogger clearly debunked an idea that was causing some panic in the Christchurch community. But the question of whether these sorts of critical thinking dispositions can be taught is a challenging one for teachers.

Science Thinking with Evidence (STwE)

- **Assesses aspects of thinking competencies relevant to science**
- **Spans years 7-10**
- **Four tests with one common scale**
- **Every item ranked for relative difficulty**
- **Students can also be located on scale**
- **Designed for formative use**



We think dispositions for things like being a critical thinker can be modelled and strengthened. Our aim with all our resources is to give teachers things that they can "think with" – in this case we really want teachers to think about how thinking competencies can be taught – and how students can get better at thinking with evidence when they can practice and receive helpful feedback

Cars that have good fuel efficiency can travel further on less petrol.

Things that can affect fuel efficiency include:

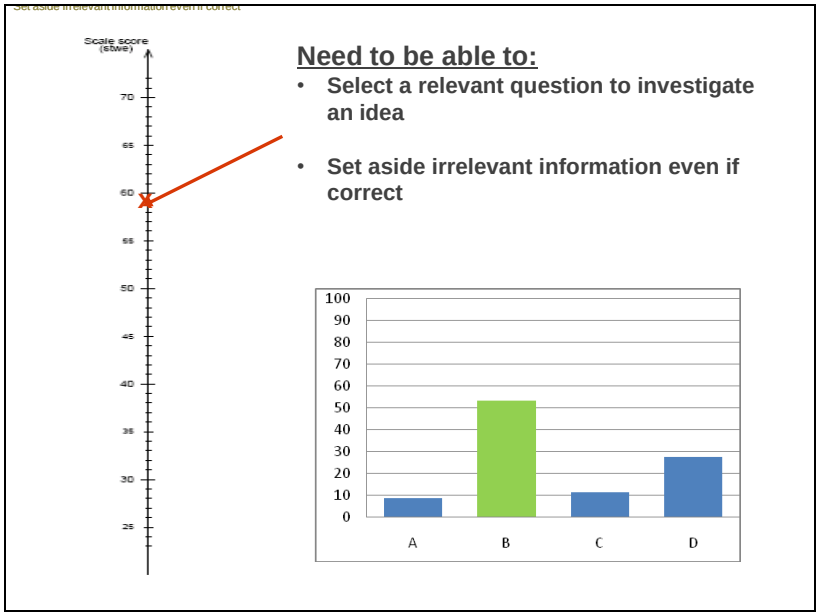
- **when the car was made. Newer cars are usually more fuel efficient.**
- **whether the car is well maintained mechanically.**
- **how the car is driven. Rapid acceleration and braking increase fuel use; the faster you drive the more fuel you use.**
- **keeping the tyres at the correct pressure.**
- **the size of the car engine. Small cars are generally more fuel efficient.**

Here's an example of the information provided in test 4 – this information supported a set of six questions – I just added the images because the slide looked a bit boring. Are you ready for one of the questions?

If you wanted to investigate practical ways to improve the fuel efficiency of cars in New Zealand, what would be a useful starting question to ask?

A. **Are warrant of fitness checks really necessary?**
B. **What is the average age of cars on our roads?**
C. **Should we increase the driving age to 18?**
D. **Should more people use buses?**

Take a second to choose an option – tell the person next to you.



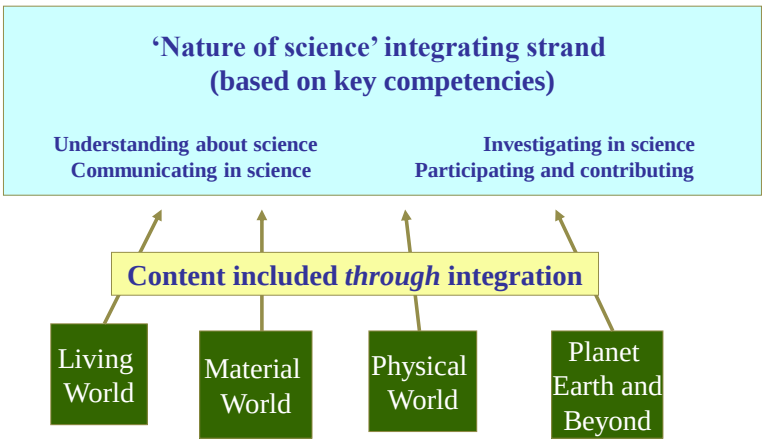
What would you say attracted nearly a third of the students to choose D? (That's the one about taking the bus.) What could you do if you found a number of your students did this?

Aspects of thinking competencies that STwE highlighted

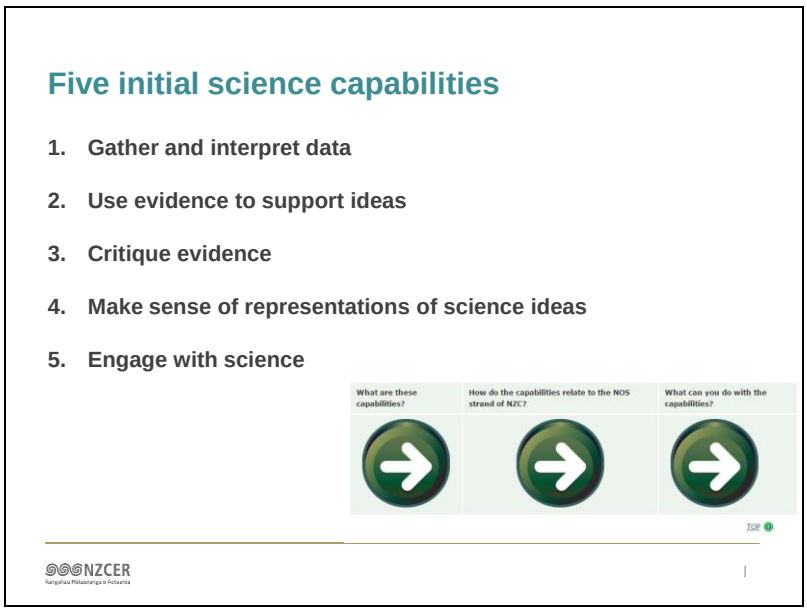
- asking relevant critical questions
- evaluating the value of a claim
- reading patterns in compound visual texts
- critical thinking about cause and effect
- an appreciation of the relative scale of events
- setting aside prior knowledge when irrelevant to the question at hand
- not rushing in (noticing details, taking time to think)

This list is based on our analysis of patterns in trial students' answers across the four STwE tests. But how supportive is a list like this? (There are too many capabilities to readily bring to mind in the classroom, and it's not necessarily clear what to do differently to build these capabilities, or any sense of how they build over time ...).

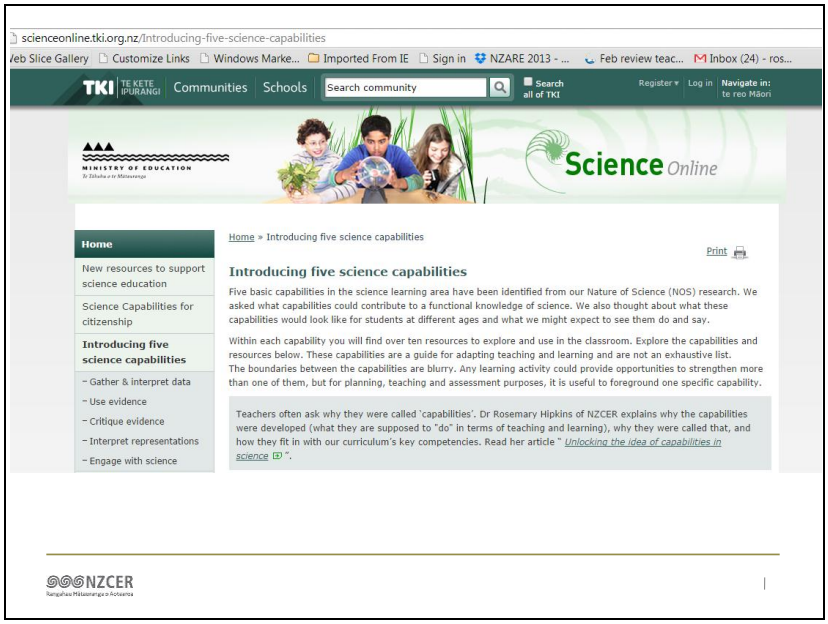
Can the NOS strand change the curriculum?



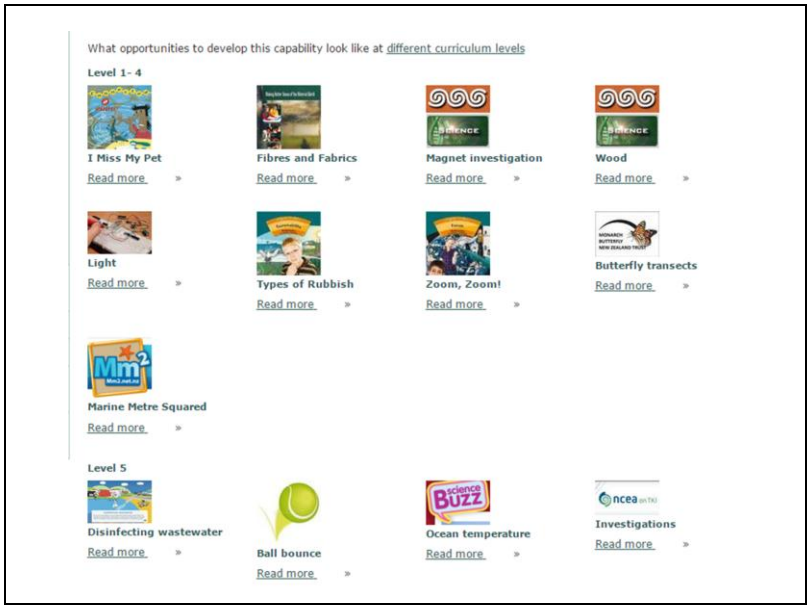
Our next support project was commissioned by MOE. The research we did in the initial stages pointed to challenges in how teachers were thinking about the 'curriculum work' done by the NOS strand. We could see the danger that it was becoming more "stuff" to learn. Could it – instead – have a role in fostering citizenship capabilities? We made a different set of resources as "things to think with…."



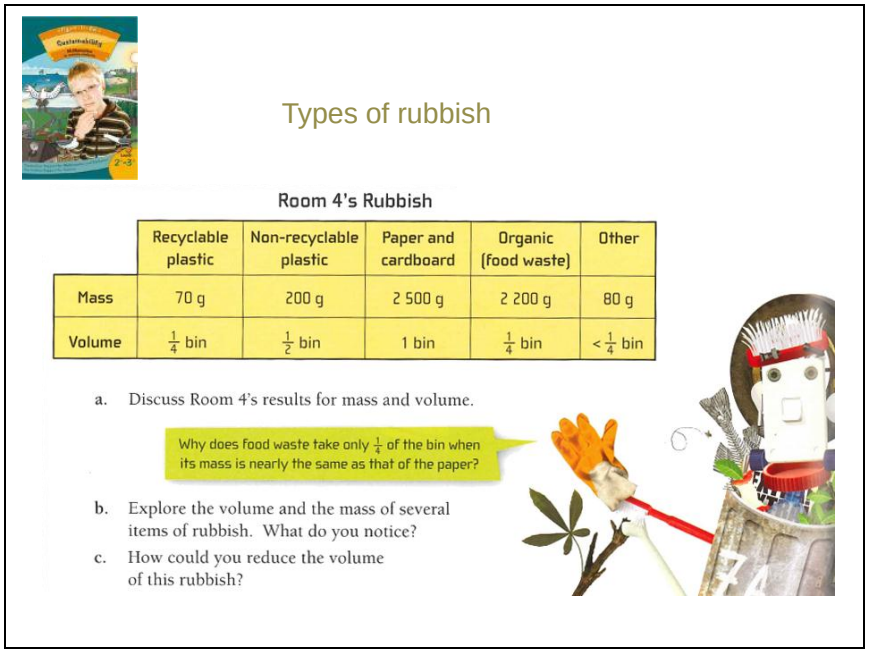
This list was derived from a distillation of the NOS literature, bringing this together with the NOS strand of NZC, the statement about the purpose for learning science, and the key competencies. As you can see, the idea of capabilities can translate to something very simple and deeply practical – when the dots all join up.



To support the capabilities work, a website was developed. It consists of: some general information about the science capabilities; a section for each capability with a short description of what the capability involves; sets of resources for each one. We're going to unpack several examples now. If you already know about this work, hopefully there will still be fresh insights in what we talk about next.



For each capability some suggestions for adapting resources already available to schools were developed. This slide shows the resources that were developed to support Critique evidence. In this instance resources include Connected, the Making Better Sense books, ARB resources, Figure It Out, NCEA resources, and various online resources.



This is an example for the capability *Critique evidence.* The resource is Figure It Out: Mathematics in science book, *Sustainability*. We chose it because: it provides an example of mathematics in a science context; sustainability is a future focused concept – one that is promoted in NZC; it relates directly to the citizenship purpose of science in NZC. This task obviously has a mathematics focus. How could it be adapted to add a science dimension, specifically, to address the science capability *critique evidence*?

Adaptation

Discuss with your class what questions they would want to ask Room 4 if they wanted to do a similar investigation and be able to compare their results with Room 4's.

The focus of this adaptation is getting students to ask questions that lead to a robust investigation (one that could be repeated by someone else, one that aims to eliminate alternative explanations by carefully managing variables).

Question	Reason for asking
How many students are in Room 4? Was most of the class present that day?	The number of students is likely to affect the amount of rubbish generated.
What age are students in Room 4?	It's possible different aged students might produce different amounts or types of rubbish.
Was the paper flat or screwed up?	This would affect the volume it took up.
When in the week/term was the investigation done?	At the end of the term when students are clearing up there might be more paper.
Was there any special event happening that would affect the amount of organic waste?	For example: a shared lunch.

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The resource provides some examples of questions students might ask – this provides teachers something to 'think with' as they get started. Here are a few of them (reformatted). What we envisage is that: once they get the idea, both teachers and students will think of more questions to ask; teachers will be able to use the idea to provide similar learning opportunities in other contexts.

What are we looking for?

Do they understand that how the data are gathered affects the trustworthiness of the data?

Do they understand that if you want to compare data sets you need to ensure the data were collected in the same way?

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For each activity a section called "What are we looking for?" is provided to support teachers to think about assessment for learning. Thinking about the capability *Critique evidence*, what we are looking for is evidence of understanding these two Nature of Science ideas. Understanding these two ideas is important for when students are developing their own investigations, but also when they are looking at/critiquing evidence presented by others.

Watch me example

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The next example relates to the science capability *Interpret representations*. This capability has links to the Nature of Science strand, Communicating in Science, and the Key Competency, Using Language, Symbols and Text.

Why is this important for students to know?

Reading and writing and argument are "central to any conception of science as it is currently constituted" (Osborne, 2002). Understanding and using the literacy practices of science supports students to think in new ways.

Being familiar with the literacy practices of science supports students to think in new ways and provides a foundation to critically interact with articles about science in the media.

These quotes are from the capabilities website. Sir Peter Gluckman, in his paper *Interpreting science - implications for public understanding, advocacy and policy formation*, said: "Public opinion is central to policy formation in a participatory democracy: that is why the public requires an understanding of how data can be well used or misused, how advocacy can create confusion, intentionally or otherwise, and why it is that science can appear to be used or misused by both sides a contentious argument" (Gluckman, 2013).

Photograph from University of Canterbury outreach programme

Now here's a rich example that explores the idea of observation and inference, and how these can lead to the formation of hypotheses. The capability is *Gather and interpret data*. The questions can be as simple as "I see…" "I think…" "I wonder" Note also that there is not a hard and fast distinction between observation and inference. What people know already informs what they "see". Conversations about this slide took on whole different nuances when the audience was Canadian – they "saw" a "type of cricket".

This is essentially the same activity at Level 1 and 2. The screen shot shows how the pieces of each resource are tucked neatly away until you want to look at them.

A future-oriented science curriculum should aim to:

- **Engage students intellectually and emotionally**
- **Foster the development of science capabilities**
- **Build understanding of powerful ideas of and about science**
- **Provide opportunities for creativity and knowledge building**
- **Carefully balance depth and breadth**
- **Provide opportunities for students to engage with complexity and uncertainty in real world issues**

Finally, here's a snippet from our newest support resource. You might like to ponder which of these characteristics have been on display in various activities we've given you a glimpse of this morning.

References

- Ministry of Education (2010) *Figure It Out. Mathematics in science contexts. Sustainability.* Wellington: Learning Media Limited.
- Osborne, J. (2002). *Science without literacy – a ship without a sail?* Cambridge Journal of Education, 32(2),203-208.
- Wallace, D. (2009). *Watch Me!* Wellington: Learning Media Limited
- http://scienceonline.tki.org.nz/Science-Capabilities-for-citizenship

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