Meaning making for democratic participation

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Introduction

This paper presents an example of a modest educational design innovation (Bereiter and Scardamalia, 2008). Compared with the lifelong literacy project discussed in the first presentation in this symposium (Twist and Hipkins, 2009) this is a short discrete piece of research designed to explore a specific working hypothesis. The focus is on just one of the five key competencies in the New Zealand Curriculum (Ministry of Education, 2007). *Using language, symbols and texts* is arguably the least well understood of the five competencies so the paper begins with a brief overview of its potential scope and ways the meaning of this key competency might be interpreted in practice. The design experiment took place in the context of developing items for New Zealand's Assessment Resource Banks (ARBs) and the second section of the paper provides a brief outline of the processes followed. The third section then documents the thinking behind the development of one specific item and reports on results when it was trialled with students. The final section briefly outlines wider implications of shaping learning conversations that focus on communication processes designed to support our meaning-making.

Multiple meanings for "Using language, symbols and texts"

When the New Zealand Curriculum was being developed, *Using language, symbols and texts* was, for a short time, called *meaning making*. This was received rather derisively in some quarters, even though the curriculum definition finally settled upon clearly conveys the sense of this competency as being about acts of meaning making:

> *Using languages, symbols and texts* is about working with and making meaning of the codes in which knowledge is expressed. Languages and symbols are systems for representing and communicating information, experiences and ideas. People use languages and symbols to produce texts of all kinds: written, oral/aural and visual; informative and imaginative; informal and formal; mathematical, scientific and technological.
>
> Students who are competent users of language, symbols and texts can interpret and use words, number, images, movement, metaphor and technologies in a range of contexts. They recognise how choices of language, symbol or text affect people's understanding and the

> ways they respond to communications. They confidently use ICT (including where appropriate assistive technologies) to access and provide information and to communicate with others. (Ministry of Education, 2007, p.12)

One research project carried out in "early adopter" schools in 2006 (when the curriculum was still in draft form) found that *using language symbols and texts* was the least well understood of the five key competencies, and was likely to cue already familiar ideas about the literacy and numeracy demands embedded in all learning areas (Boyd and Watson, 2006). This illustrates a challenge inherent in all the key competencies: if read at a surface level, they are very easy to relate to good practice as this is currently understood and say in all sincerity "we already do that" (Hipkins, 2006). In this specific instance:

> …the use of the term [literacy] at once also provides a comforting answer: we are all "doing" literacy. This answer then acts as a full stop to further essential thinking and analysis. Once the ointment of literacy has been spread evenly across the problem areas, we have all done our bit and that might then be that. (Kress, Norris, Schoenholz, Elias, and Seigle, 2004)

The first row of a table from a pamphlet the Ministry of Education sent to all schools in 2007 illustrates the advice provided to teachers to help them expand their thinking about what the key competencies could look like in action and how their inclusion in the curriculum might be signalling a change to curriculum-as-usual.

Table 1 **Refocusing assessment challenges: MOE pamphlet excerpt**

Traditionally assessed outcomes	**Challenge for 21st century learning**	**How key competencies refocus outcomes**	**Assessment challenges**
Literacy and numeracy —the "old basics" These are assessed using a range of tools, including some that are nationally benchmarked—e.g. PATs and asTTle.	Multi-modal communication methods combining written text, pictures, moving images, music etc., which can be free of time, place, or the need for participants to be physically present.	Multi-modal communication adds "new basics". Students need to learn how to use the various tools and representations of each learning area, and to become more skilled at combining them.	Traditional print-based pencil and paper tests are not sufficient to provide the range of evidence that can demonstrate these additional more complex outcomes.

(Hipkins, 2007, p.8)

NZC explicitly states that key competencies are "not separate or stand-alone. They are key to learning in every learning area" (Ministry of Education, 2007, p.12). The advice provided to teachers in the above pamphlet, and other curriculum materials, emphasises the multi-modal nature of texts and the constructed nature of meaning-making. This emphasis in turn introduces the idea of communication practices related to becoming literate *in a specific discipline area,* for example becoming "scientifically literate". This key competency adds a dimension of what Yoram Harpaz calls "normative thinking", that is, thinking patterns and practices that have to be learned as a specific set of practices related to the norms of a discipline area (Harpaz, 2007;

Hipkins, 2008).[1] Congruent with this line of reasoning, an attempt was made to align the key competencies and the "nature of science" strand at the draft curriculum writing stage (Barker, Hipkins, and Bartholomew, 2004). This resulted in one of the sub-strands of the *Nature of Science* strand being titled *Communicating in Science.* Its aim is that students should "develop knowledge of the vocabulary, numeric and symbol systems and conventions of science and use this knowledge to communicate about their own and others' ideas" (Ministry of Education 2007, supplementary materials). As already indicated, this aim could be read as being about basic literacy demands in science. Alternatively, as I hope to illustrate in this paper, much more expansive meaning-making conversations could be opened up by reading this aim in a deeper, more nuanced manner.

Although the final column of the table above addressed early concerns about assessment, this seemed to us at NZCER to put the cart before the horse. We believed that teachers needed to be provided with rich examples that illustrated how a focus on key competencies might change the nature of the intended learning in a specific learning area, especially before any form of summative assessment and reporting was attempted. We sought opportunities to explore the potential of the key competencies in small design experiments, including using an existing contract with the Ministry of Education. Ironically (in view of my comments here) this is an assessment contract, but its focus is formative assessment.

The potential for design experimentation during the development of Assessment Resource Bank items

Development of items for New Zealand's Assessment Resource Banks (ARBs) is contracted to NZCER by the Ministry of Education. ARBs are an electronic repository for small discrete assessment tasks, typically pencil-and-paper but sometimes involving more practical activities, in the subject areas of English, science and mathematics. Each pencil-and-paper item is trialled by a sample of at least 200 students, typically from around five or six different schools. "Difficulty levels" are determined on the basis of the pattern of trial students' responses. Originally intended to allow schools to benchmark their students against national achievement patterns, around six years ago the focus of the whole project moved to formative assessment. Analysis and reporting of response patterns changed to emphasise the way in which students understood and responded to the task (not simply whether they could do it). Thus each item could now be conceived as a small design experiment, with the aim of gaining insights into an aspect of students' understanding, in order to describe possible next learning steps.

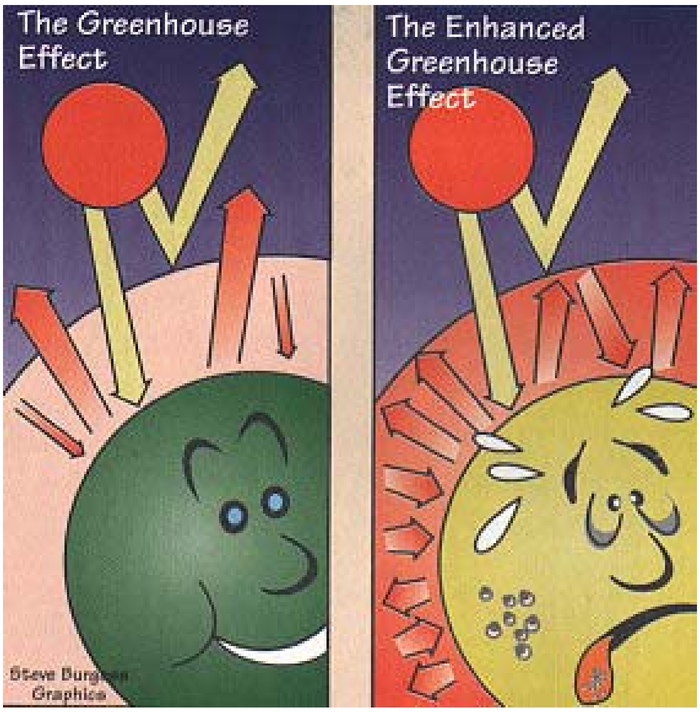
The NZCER science team works together to analyse response patterns for science tasks, first reading and discussing a sample of completed scripts, then building and applying a coding

[1] Note how another key competency—*thinking*—becomes thoroughly intertwined with using *language symbols and texts* here. The OECD described *thinking* as a competency that cuts across all the others (OECD, 2005). NZC took a different stance and it was included as one of a set of five key competences with no differentiation in their status.

schedule based on the researchers' emerging understanding of the patterns of responses. The team typically completes coding by working in the same space, so that any different responses can be discussed, and the coding schedule adjusted if necessary. Students are usually asked to answer four or more questions that together make up a trial booklet. At the end of each booklet students are given the opportunity to make a personal response about enjoyment and difficulty levels of items.

As is typical of science curricula elsewhere, New Zealand's curriculum claims that learning science is necessary for making "informed decisions about the communication, application and implications of science as these relate to [students'] own lives and cultures" (Ministry of Education, 2007, p.28). Recently created science ARB items have experimented with the integration of a foregrounded key competency with some aspect of curriculum content, and we have endeavoured to do this in a manner that reflects learning area messages such as the science one just quoted. The ARB item to be introduced in this paper investigated the manner in which students addressed a task that asked them to "read" the intended message in a graphic text. Professional science communicators often commission graphic artists when they face the challenge of conveying a complex science idea in an area of wider public concern. Thus it seemed to us that developing skills for more deliberate acts of reading of such populist graphic texts could be an important focus for our research attention. Our working hypothesis was that students are likely to need support to enact such readings, and that the patterns of their responses would assist us in the provision of advice for teachers about what to look out for, and what to do about learning challenges they might anticipate. As with all ARB items recently developed, we wanted the assessment activity to be useful for formative/learning purposes.

Figure 1 **The graphic text students were asked to interpret**



The graphic text in Figure One was designed to illustrate the enhanced greenhouse effect. It was originally commissioned by New Zealand's Ministry of Agriculture and Fisheries (MAF) for their website. The comic-style drawings depict two scenarios for the greenhouse effect side-by-side—one a status quo situation and the other an extrapolation of what "enhancing" the greenhouse effect might do to our planet. We used this image to develop an ARB item that asked students to explain the artist's intended message in their own words. Because the trial booklets go out "cold" we have no way of knowing if students have encountered the relevant conceptual ideas. We did not want lack of knowledge of the greenhouse effect to prevent students from attempting an explanation of the message they saw in the visual text so we developed a preceding item that included a more traditional diagram of the greenhouse effect, and we began this item with a single multiple choice question designed to draw attention to the meaning of the word enhanced. (As we had intended, most students got this simple question correct). The next section reports on our analysis of the open responses from 244 year 10 (age 14–15) students from a representative sample of schools.

Insights from the student responses

We identified three ideas that students might be expected to read into the artists' visual text: the earth is warmed from outside (preferably mentioning the sun as the source of heat); excessive warming is likely to be a feature of the enhanced greenhouse effect and this would not be good for life on earth; however we do need the greenhouse effect, and a certain amount of warming, for conditions to be "just right" for life on earth. We coded all three ideas separately. Table Two shows the results.

Table 2 **Frequency of inclusion of main ideas in students' explanations (n =244)**

Idea from text	Difficulty level[2]
External source of heat/sun	difficult
Excessive warming is harmful to life on earth	easy
Normal range greenhouse effect is necessary for life on earth	difficult

The most common *combinations* of these ideas were of points 2 and 3:

> Greenhouse effect is good to a certain level. But if there is too much greenhouse gases it is bad and causes earth to get too hot.

[2] Vey easy (80-100%); easy (60-80%); moderate (40-60%); difficult (20-40%); very difficult (0-20%) of appropriate responses

> The greenhouse effect is currently perfect, keeping the Earth warm and all of its creatures growing. If this effect was enhanced the Earth would be too hot and all of its organisms would die. At the moment the Earth is a very happy chappy.

The second of these answers was unusual in not being focused only on human interests. Most responses did focus on humans, which is perhaps not surprising given the personification of the earth by the artist. While both students might need to work on use of appropriate genre conventions, detail and specificity, it is clear that they each read the message conveyed by the visual text broadly as the artist intended. However 12 percent of the students' explanations showed that they did not see the text as intended and thus misunderstood the ideas the artist intended to convey. Analysis of these responses suggest that, if the intention of this task is to focus on the key competency *using language, symbols and texts*, and specifically how science ideas are conveyed in populist visual texts, a very first level of analysis of a text involves clarifying what exactly is being symbolically represented.

Table 3 **Examples of misreading of symbols (12% of responses)**

Symbol and how interpreted	Examples of student explanations
Larger circles (earth) read as representing the sun	It is showing how the sun gets heat from the greenhouse's effects. But the enhanced greenhouse effects will be too much hard work for the sun. The message that the artist is giving us is that the greenhouse effect we have now (which is shown by the happy sun) is working and is fine how it is, but if we have the enhanced greenhouse effect that we could have in some years to come (which is shown by the tired and exhausted sweaty sun) it is not working and our world will slowly destroy itself.
Arrows (energy flow) read as movement of gases	They are conveying the idea that if our atmosphere let no gases out we would roast because the warm air has no way to escape. The message about the greenhouse effect is that we will all not be happy when the greenhouse effect is enhanced as it means that more gases will be entering and exiting the atmosphere so it really isn't a good idea.
Colour intensification (temperature increase) read as visual pollution	With global warming the heat cannot escape the earth's atmosphere because the ozone layer is blacked up maybe from pollution etc. It basically shows how the greenhouse effect works. If we have a relatively clean environment the earth will not get too hot because the sun's rays will go out of earth's ozone, but if we have a dirty environment the earth will get hotter and hotter.

Readers with a science background will have spotted several misconceptions in the students' explanations (21 percent of responses contained at least one misconception and what follows is an illustrative rather than an exhaustive list). An important message for teachers from this design experiment is that foregrounding a key competency does not need to entail the neglect of “content” or ideas. On the contrary, it could provide a rich opportunity to assess students’ existing understandings of some important science ideas:

- Misconceptions about the atmosphere *as a system* were common. For example some students thought that changes to overall volume of the atmosphere caused the greenhouse effect. This idea was likely to be linked to thinking the arrows represent gases rather than energy flow. Some students who thought this also seemed to think we could deal with the issue by taking unwanted gases to the edge of the atmosphere and thence discard them into the space beyond our earth system.
- Some students seem to think that the greenhouse gases themselves are the source of heat energy, a misconception that, not surprisingly, also seems to combine with thinking the arrows represented the movement of gases rather than energy.
- As other research would predict (Boyes and Stanisstreet, 1996; Dove, 1996) conflation of greenhouse gas issues with other environmental issues was common, especially issues related to the thinning of the ozone layer, or to particulate pollution (which can have the opposite effect to greenhouse enhancement, for example when soot particles scatter incoming energy back into space).
- A number of students saw greenhouse gases as something human made, and therefore different to gases that would be found naturally in the atmosphere.

As demonstrated in this and other tasks we have trialled, the integration of key competencies into well designed tasks *enhances* rather than replaces a knowledge focus. Examples of all the above misconceptions can be found in the teachers’ notes on the ARB website, and some are cross-referenced to other ARB items that probe students’ understandings of the same or a similar idea. During informal conversations, teachers who have used this ARB item have confirmed the existence of these ideas in their classes, and this alone seems to be sufficient to encourage them to keep using it. However it would be a pity if the potential for conceptual diagnosis is allowed to obscure the intended focus on building communication competencies, with both present and future learning benefits in mind.

What now?

Findings such as those summarised above support our working hypothesis that the act of reading of a visual text is worthy of attention *for its own sake*. The pattern of responses suggests that developing *using language, symbols and texts* as a science competency, should at the very least include fostering the disposition to ask what each element of a text that includes symbolic elements (shapes, arrows, colour etc) is intended to represent, before beginning to decode its meaning.

The symbolic elements of visual science texts, whether formal or informal (as in the above example) are deliberately selected and shaped by some-one, for a specific purpose. Often the same symbol can have very different meanings. Arrows are a case in point. Conventions of science sometimes render their meanings counter-intuitive, for example arrows in food webs and chains, by convention, represent energy flow through ecosystems and thus point from eaten to eater rather than the common-sense expectation that they would point the other way around (what eats what). This is a simple "nature of science" understanding yet our ARB item development reveals that many students lack awareness of this convention, right through into their secondary school years, despite near certain exposure to this type of symbolic text.

In other ARB design experiments we have detected unintended meaning-making impacts of compound texts where a purely symbolic representation (e.g. a cycle of words connected by arrows) is overlaid on a realist visual text that depicts a context where that idea/process might play out. Examples of water cycle diagrams that combine texts in this manner abound. As a search using Google images quickly reveals, they convey an idea that the water cycle operates primarily in places that look like Switzerland (or New Zealand!) and can leave students unaware that water also cycles in very arid places, and in many different combinations and sequences of complex interlinked cycles, not just in one mega-cycle where the inevitable destination for any water vapour is the sky. Given a series of boxed words to connect with arrows, we have found students reluctant to draw connections that could be interpreted as making rain "go uphill" and we suspect that this is the result of embodied experiences of gravity, in combination with the visual texts that typically introduce students to water cycle ideas (see Joyce, Bull, Hipkins, and MacIntyre, 2008 for an extended discussion of these points).

All this takes us a long way from a reading of the key competency *using language, symbols and texts* as being about basic reading literacy, and hence, for a specified discipline area as likely to be concerned with only the vocabulary and maybe grammars of formal written texts (although these continue to be important). The paper illustrates why teachers who intend to support students to learn how to read the symbolic texts of a discipline need to have considerable knowledge of how and why those texts might have been constructed as they are—that is they need to know about the *nature of the discipline* and its knowledge-building conventions and other meaning-making norms.

The manner in which experts make meaning when constructing or using visual texts has been a focus of "science studies" research for some time. For example Law and Lynch (1990) provided a fascinating example of how observational field guides are constructed differently according to each author's theory of how those observations should best be enacted. The more we discover through our modest design experimentations, the more we realise there is to learn about this meaning-making challenge in *science education*. If we do not pay attention to the manner in which ideas are communicated, we can hardly expect students to become critical consumers of science-based information from across the wide range of genres where it is to be found. Since we typically claim this future-focused benefit as a key reason that science should be part of all students' core curriculum, we do need to much more consciously and deliberately support students to develop the relevant communication competencies.

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