More complex than skills: Rethinking the relationship between key competencies and curriculum content

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Abstract

The role that key competencies will play in a curriculum depends on how they are interpreted. Drawing on the New Zealand experience, this paper outlines two possible implementation pathways. The "skills" pathway could lead to modest improvements in teaching and learning. It is, however, unlikely to achieve longer-term goals such as strengthening citizenship, enhancing creativity and fostering lifelong learning. Such goals have future-focused and dispositional components. The "participatory" pathway could support these longer-term goals. Students are challenged to *use* knowledge, not just *get* it. However following this pathway requires a rethinking of how curriculum content is used, with implications for what is seen as evidence of learning. The presentation will draw on several common science topics and two of the key competencies as they were developed for the New Zealand Curriculum (Thinking; Using Language, Symbols and Texts). These will be used to illustrate possible changes in teaching and learning approaches. Implications for curriculum support processes will be raised.

The New Zealand context

In late 2007 the final version of an updated New Zealand Curriculum (NZC) (Ministry of Education, 2007) was released to schools. This curriculum represented quite a departure from the more detailed, outcomes-focused curriculum documents of the 1990s. Rather than seven separate curriculum books, one for each learning area,[1] NZC provides a *framework* for the school curriculum from year 1 to year 13. The whole of the nationally mandated curriculum is now outlined in one slim book. Every school has to work out how to build up a more detailed local curriculum based on this national framework.

[1] These are: English, mathematics and statistics, science, social sciences, technology, health and physical education, and the arts. The 2007 version has added an eighth learning area, learning languages, which was previously integrated with English.

New Zealand's schools[2] are set up to be self-directed to a considerable degree. They are expected to make their own decisions about how best to develop teaching and learning programmes for their students. The framework of NZC provides the context for working out how best to do this. The NZC was developed in close collaboration with the wider education sector so the nature of the framework did not come as a surprise. Research shows that NZC has generally met with wide approval (Cowie *et. al*., 2009). Nevertheless, some schools and teachers have found the professional freedom given to them by NZC to be very challenging, especially if they are more accustomed to thinking of a national curriculum as a prescription for the content that should be covered. Other schools have embraced the opportunity to work out how best to educate their students, according to the specific learning needs they identify via their assessment activities.[3]

The overall arrangement places a lot of responsibility on schools to work out the intent of the curriculum, especially the new features. The front sections of NZC signal a range of future-focused education outcomes. For example, the vision statement is for all our young people to become "confident, connected, actively involved lifelong learners" (Ministry of Education, 2007, p.8). Many people would agree that aspiring to these wonderful outcomes is very important, but what do these outcomes mean for actual teaching and learning? What do schools, teachers, students, and even parents need to do differently if the new features of the curriculum are to be put into action? This paper suggests that we can't answer such questions until the *intent* of a framework curriculum has been worked out. Even when that "big picture" thinking has been done it will not necessarily be clear just what needs to happen next. The sorts of changes signalled move into unfamiliar teaching and learning ground. Ideas for change need to be designed, tried out and evaluated. Thus, learning about the many dimensions of NZC and their implications for teachers' work will take time. Learning *how* to develop the NZC framework in schools is likely to be a spiral process of ongoing change. This paper illustrates the professional learning and curriculum development challenges by drawing on the key competencies, which are one of the new features of NZC.

Along with other new features such as the vision statement, NZC includes a set of five *key* competencies. These were new to most schools when the framework was first released. Before

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[2] New Zealand has 4560 schools, of which about 450 are secondary schools. Primary schools in rural areas tend to be small, but those in major urban areas are typically much bigger. The student populations of many of these schools are very diverse.

[3] New Zealand has no national testing at the primary or lower secondary school level, although a set of National Standards for literacy and mathematics is just starting to be implemented. Students' progress is determined by a process of "overall teacher judgement" based on achievement data from a range of standardised assessment tools, as well as student work and teacher observations. The school exit qualification for the final three years of secondary school - the National Certificate in Educational Achievement (NCEA) - has a flexible, modular structure underpinned by a National Qualifications Framework that extends to post-school learning pathways.

they could be integrated into the school's curriculum plan, people had to begin by working out the nature of the key competencies in general, as well as what each one might be all about. Where did they come from? Why might we need them? What does each one potentially encompass? How do they fit together? How do they fit with other parts of the curriculum? What might need to change in teaching and learning programmes so that students' competencies really will develop and grow stronger over time? This paper now looks at two different ways that key competencies have been interpreted as schools and teachers wrestle with questions such as these. The New Zealand experience could be useful for other nations as they consider how best to engage the future-focused challenges that key competencies are intended to address.

Developing meaning for key competencies

NZC defines five key competencies that "people need to live, learn, work and contribute as active members of their communities" (Ministry of Education, 2007, p.12). Their titles are: Managing Self, Relating to Others, Participating and Contributing, Thinking, and Using Language, Symbols and Texts. The New Zealand versions were adapted from a set of four developed by the OECD's DeSeCo[4] project. This project defined key competencies as the things people need to know and be able to do in order to live meaningfully in, and contribute to, a well functioning society (Rychen and Salganik, 2003). Some people use the word "capabilities" with similar intent (Reid, 2006). Learners draw on a wide range of competencies, but those labelled as "key" are seen to be universal rather than situation specific (Rychen and Salganik, 2003). The implication is that these competencies are transferable across contexts and continue to develop across the lifespan.

The NZC titles and descriptions of the nature of the key competencies were written in plain language with no "jargon" words. The curriculum developers wanted to communicate clearly what key competencies are and what they do. They hoped that everyone in a school community (parents and students as well as teachers and school leaders) would be able to talk about them. Many schools have carefully explored the curriculum definitions and made their own school versions written in "student friendly" language (some examples of this are described in Hipkins, Cowie, and Boyd, 2009). The intention is to use the same language in every classroom so that students do not get mixed messages about what is important, and so that the key competencies become touchstones for learning, i.e. they become a reference point for conversations *about* learning as it unfolds (Boyd and Watson, 2006).

These are obviously encouraging developments but there is a catch. The *scope* of the learning behaviours and attitudes cued by each school's personalised definitions will rest on how the members of the school community have interpreted and applied the official definitions. With hindsight, it does seem that some important aspects of the OECD versions of the key

[4] Defining and Selecting Competencies.

competencies were "lost in translation" when the plain language versions were developed for NZC.

Managing self as an example of definitional dilemmas

The OECD key competency entitled *acting autonomously* was changed to the title *Managing Self* in the NZC version. Its NZC curriculum definition reads:

> This competency is associated with self-motivation, a "can-do" attitude, and with students seeing themselves as capable learners. It is integral to self assessment. Students who manage themselves are enterprising, resourceful, reliable and resilient. They establish personal goals, make plans, manage projects, and set high standards. They have strategies for meeting challenges. They know when to lead, when and how to follow, and when and how to act independently. (Ministry of Education, 2007, p.12)

Only the very last sentence of this definition might cue a focus on enhancing students' *autonomy*, and even then only somewhat indirectly. Self-management of learning is obviously an important sub-set of autonomy but the OECD also identified several other important dimensions. These include the *ability to act within the "big picture" of learning.* The scope of a big picture here is:

> The larger – normative, socio-economic, or historical – context of actions and decisions, how that context functions, One's position in it, the issues at stake, and the possible consequences of one's actions, and taking these factors into account when acting (Rychen, 2003, p.4).

The "bigger picture" for school learning includes developing an understanding of where knowledge comes from – how it is made, what normative processes are used to decide what is true and reliable, and the features that users of knowledge should know to look out for when they are deciding what sources are trustworthy (i.e. so-called information literacy). This type of meta-knowledge is discipline-specific and hence cannot be taught generically. But this aspect of the OECD intent is not cued by the NZC definition and subject teachers may never even recognise this possibility unless it is pointed out and exemplified in practice, in ways that they find persuasive and easy to try out.

In her discussion of the scope of autonomy Rychen also notes that "it is ultimately up to individuals to identify and evaluate their rights, needs and interests and to actively assert and defend them" (Rychen, 2003, p.4). This is the sort of talk that could cause alarm in schools more used to disciplinarian approaches where students know their place! Again this dimension of autonomy is only hinted at in the very last sentence of the NZC definition, and doubtless would have been resisted by many teachers if the wording had been more explicit – at least as they initially get to grips with the nature and intent of the key competencies.

Two pathways for implementation

The idea of key competencies developed out of 1990s advocacy for a focus on employment skills[5] (Reid, 2006). Like many other nations, New Zealand's 1990s curriculum documents included these "essential skills". When NZC was introduced some teachers referred to the key competencies as the *replacement* for the essential skills and so missed their deeper intent (Hipkins, 2005). The NZC definition of *managing self* cited above could easily reinforce this perception with its focus on goal setting and related *behaviours*. This is problematic because interpreting the key competencies within the previous essential skills framing can lead teachers to look for aspects of their existing practice that seem to match what is required. Then they respond to the idea that changes in their practice might be needed by saying in all sincerity "we already do that!" (Hipkins, 2006a). Another response schools and teachers might make is to look at their existing curriculum documentation to see where the names of key competencies might replace existing references on essential skills. Curriculum theorist Alan Reid calls this "name and hope" planning (Reid, 2006). In this sort of planning there is no explicit indication of how the learning that students experience will actually be different. How will traditional teaching and learning activities need to change if students are expected to develop and strengthen their growing competencies?

Teachers who have the *skills* pathway in mind are likely to respond with some combination of "we already do that" and "name and hope" planning strategies unless they are supported to recognise a different pathway for implementing key competencies – one that intends something other than mere skills development. But what might this different implementation pathway look like? Alan Reid argues for key competencies (or capabilities as he calls them) to be seen as a means of *transforming* curriculum, not just improving traditional learning. The transformation he has in mind relates to fostering *citizenship* and *skills for learning* in the complex, heterogenous societies of the twenty-first century (Reid, 2006). However teachers will need to rethink some aspects of their work if this challenging agenda is to be achieved (Hipkins, Bull, and Reid, 2010). Learning experiences do need to change if competency development is an intended outcome. Doing more of the same, while calling it something new, will not work.

Participatory, democratic pathways as an alternative reading of competencies

NZC defines the key competencies as more complex than essential skills because they "draw also on knowledge, attitudes and values *in ways that lead to action*" (pg 12, emphasis added). The highlighted phrase here hints strongly that learning should be *participatory*, not just acquisitive (Sfard, 1998). Indeed the OECD developers described key competencies as being demonstrated and strengthened when students use their existing knowledge and skills to carry out actions in unfamiliar and/or more demanding contexts (Rychen and Salganik, 2003). Notice the reference to

[5] For example, the Mayer key competencies developed in Australia

attitudes and values in the NZC definition. Students may know how to do something in principle but not be willing to do it. There are *dispositional* components to competency. Another challenge is that a context that is new and challenging for one learner might not offer any learning stretch to another. One learner will have opportunities to strengthen their competency and the other will not. This implies that some degree of personalisation is needed if key competencies are to be enacted in a participatory manner.

The NZC definition also notes that key competencies do not stand alone. Their development is "both an end in itself (a goal) and a means by which other ends are achieved" (p.12). They "enable learning" (p.38) and opportunities for strengthening these competencies should be "integrated into existing programmes of work" (p.38). This curriculum guidance implies a strong link between the development of key competencies and learning-to-learn.[6] Developing this dimension requires that students are drawn into metacognitive conversations where they have opportunities to reflect on acts of meaning-making, including *how* and *why* they are learning, not just *what* they have acquired (Hipkins, 2006b). For such conversations to be rich and meaningful, the learning that is planned must be intellectually engaging for both students and the teacher. The teacher must be clear about the nature of the "big picture" to which the learning is making a contribution. If they are not clear about this, they will miss opportunities to help students make rich learning links between what they already know and can do and new *action* possibilities.

A number of curriculum commentators have pointed out that the democratic, participatory pathways for key competencies development aligns most appropriately with sociocultural theories of learning (for example Carr, 2004). This has implications for the ways in which the intent of key competencies is interpreted and then enacted in teaching and learning. Key sociocultural ideas that need to be taken into account for curriculum decision-making include:

- Learning is *situated* – it is typically accomplished in social situations where the tools of a culture are being employed (Brown, Collins, and Duguid, 1989).
- The people, tools, and learning environment act as *affordances*. If students can see how to use the resources and support available to them affordances become "action possibilities" (Gee, 2008, p.81). If, for any reason, students cannot recognise the affordances in a learning context, they are unlikely to learn what is planned.
- This means that learning is *mediated* by whether and how students understand and take up the available affordances (Wertsch, 1998).

These theoretical ideas are reflected in the NZC descriptions of key competencies. For example NZC notes that "social contexts" (p.12) are important enablers of progress in developing key competencies. Furthermore, the manner in which competencies develop over time is shaped by

[6] Learning-to-learn is one of eight principles that are expected to underpin all curriculum decision-making. It draws attention to the importance of thinking and talking about acts of learning.

students' "interactions with people, places, ideas and things" (p.12). Adopting a sociocultural framing for key competencies highlights them as being context-bound and *emergent*. Competencies come into view during learning interactions that vary according to the demands of the specific subject, the affordances that the planned learning offers individual students, and the various new contextual links that become apparent. This description stands in contrast to a more universalist view of learning where competency might be seen as a relatively stable characteristic, separately owned by discrete individuals (Delandshere and Petrosky, 1998). Again the implication is that key competencies cannot be taught generically. They have to be explored from a disciplinary perspective by teachers in each subject area and there is an element of unpredictability in their outcomes. Teachers need to be sufficiently confident in their subject expertise to be responsive to students' ideas and reactions, and to follow new learning possibilities as these unfold.

Many New Zealand teachers are unfamiliar with sociocultural theories of learning and so are likely to miss the subtle language cues in NZC. If they think about learning as being mainly the individual acquisition of knowledge and skills, they are likely to miss the part played by the affordances of learning environment they are responsible for orchestrating for their students. If they are unaware of constructivist theories of learning, the very possibility that different students will perceive different purposes for the new learning on offer, and hence create different links to what they already know and can do, might also pass the teacher by. Recent research suggests the transformative potential of key competences is more likely to be achieved if teachers learn to see them as just one agent in a *complex* curriculum, where the *interactions* between all the parts determine the learning opportunities that emerge (Cowie *et al.*, 2009). However teachers need rich examples of what such an integration of key competencies with other aspects of the curriculum could look like in practice.

Exemplifying the relationship between key competencies and curriculum "content"

The examples that follow have been chosen to exemplify how teaching of just one common topic - the water cycle - might change when a key competencies dimension is added. We initially chose to explore and design new approaches for teaching the water cycle because this core curriculum topic can potentially meet the key competencies "big picture" challenge of introducing learning that really matters for students, now and in their futures. At level 3 or 4 of NZC – towards the upper end of primary school – students are expected to: "Investigate the water cycle and its effect on the climate, landforms and life".

The key competency that I plan to foreground is *using language, symbols and texts*. This is the least well understood of NZC's five key competencies, which makes it a good candidate for

developing examples that show new learning possibilities.[7] The key competency *thinking* is also very much to the fore when learning takes the new directions sketched.[8] A competency dimension for learning, based on *using language, symbols and texts*, might emphasise the multi-modal nature of texts and the constructed nature of meaning-making. In science contexts, this emphasis can add 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). The NZC science learning area has a *Nature of Science* strand with four sub-strands. One of these is called *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).[9] This aim could be interpreted as being about basic literacy demands in science. No doubt such a skills-based approach would help some students improve their learning. However our aim in developing exemplars materials is to help teachers see practical possibilities for much more expansive meaning-making conversations with their students.

Rethinking purposes for teaching the water cycle

Understanding how water is recycled and redistributed from place to place is important for sustaining the health of planet Earth. This is implied in the NZC learning outcome cited above. However, with active citizenship in mind, more than simply *understanding* the dynamics of water movement will be needed. Citizens of planet Earth need to *work together* to develop solutions to resolve many water-related issues: global warming; climate change; increasing competition for water; usage that pollutes waterways; growing more food; and protecting wildlife; to name a few. People have to be *willing* to act in ways that help protect the integrity of naturally occurring water movement dynamics, both locally and globally. Thus this topic has the potential to contribute to

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[7] *Using Language, Symbols and Texts* was called *Meaning Making* in an early curriculum draft. NZC somewhat cryptically describes this competency as "working with and making meaning of the codes in which knowledge is expressed" (p.12).

[8] The OECD model of key competencies identified thinking as "cross-cutting" – i.e. developed in combination with the other key competencies. Concern that this would be neglected in its own right appeared to underpin the New Zealand curriculum developers' decision not to position thinking as cross-cutting in the NZC key competencies explanations.

[9] The science writing team developed a set of overarching aims for the sub-strands of the Nature of Science Strand. The format finally agreed for setting out the sets of Achievement Objectives for the eight learning areas did not leave a space for aims (other curriculum writing teams had not done this, even though it was a feature of the 1990s curriculum documents.) The science team managed to keep the aims on a poster version of their learning objectives, but they do not appear in NZC itself.

"big picture" democratic thinking and action. This makes it an important context for school science when we have competency development in mind.[10]

Before they can **use** knowledge about the water cycle for making big picture decisions, students need to understand that it is a complex and dynamic system, with multiple relationships that impact on each other. Traditionally, the water cycle has been taught as a simple system. Typical textbook diagrams simplify the underlying ideas in ways that can actually lead to misconceptions about the water cycle, and they certainly do not encourage students to engage with the messiness of a complex system, or with implications for their own lives. Typical visual texts such as those used in web sites that discuss water usage and issues often overlay a symbolic water cycle diagram on top of a picture of an actual place. This can lead to further misconceptions. Awareness of the different possible ways in which students might read meaning into different visual texts could encourage teachers to see deliberate *acts of meaning-making* as one possible focus of dynamic learning conversations. Such conversations could, in turn, result in deeper, more dynamic understandings of the water cycle and its relevance to every living thing on earth. The examples that follow illustrate some possible ways to set up meaning-making conversations about the water cycle.

A focus on simple diagrams as *thinking* devices

NZCER researches and publishes Assessment Resource Bank (ARB) items under contract to the Ministry of Education. We have used this opportunity to carry out several design experiments to explore students' understanding of the water cycle ideas as represented in various visual texts. ARB items have a formative assessment focus and students' responses are coded to determine the sense they have made of the task and to describe possible next learning steps to guide subsequent teaching. Figure 1 shows an incomplete water cycle diagram used in one such task. This task was completed by over 600 students from year 4 to year 10 of their schooling. The students were asked to add as any arrows needed to complete the diagram. Figure 2 shows the coding schedule used to make sense of their responses. A data base was created where we recorded each student's combination of arrows, using the letters shown (N = an arrow in the wrong place). For each lettered arrow we added a code that noted the direction of each arrow (2= arrow drawn and correct direction; 1 = arrow drawn but points the wrong way; 0 = this arrow not drawn). The combinations that we found told us a great deal about students' likely reasoning.

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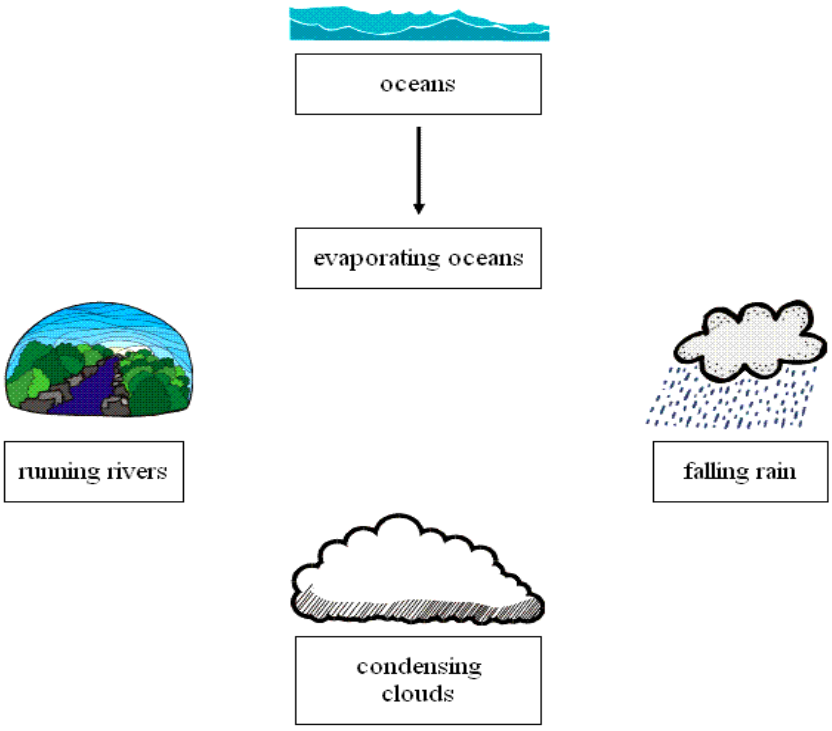
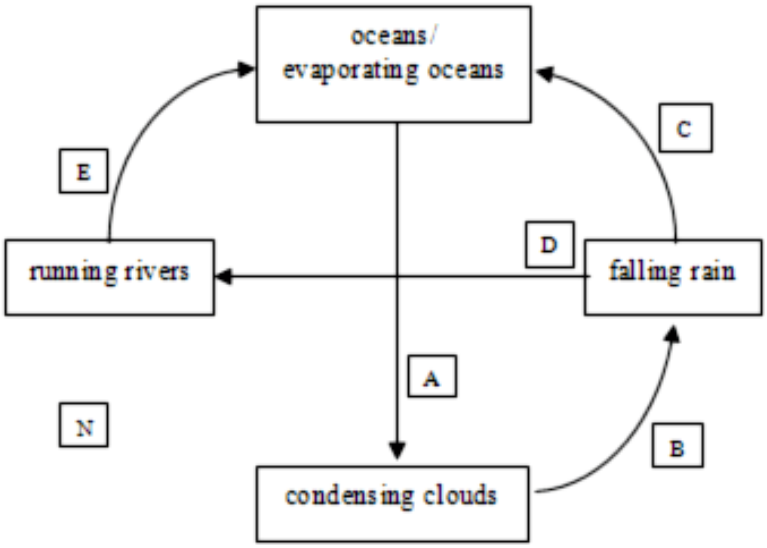
[10] Although the discussion that follows is about the key competencies using *language, symbols and texts* and *thinking*, recall Rychen's argument that "seeing the big picture" is an aspect of increasing autonomy, which is the wider sense intended for the NZC key competency called *managing self*. And the focus on taking action points to the key competency *participating and contributing*. Opportunities to develop all the key competencies come bundled together in rich learning experiences. From a *teaching* perspective, however, one or at most two are likely to be more deliberately in focus.

Figure One: Assessment Resource Bank diagram



Draw arrows to join boxes to complete the diagram. Source: NZCER Assessment Resource banks

Figure 2: The coding schedule for assessing students' responses



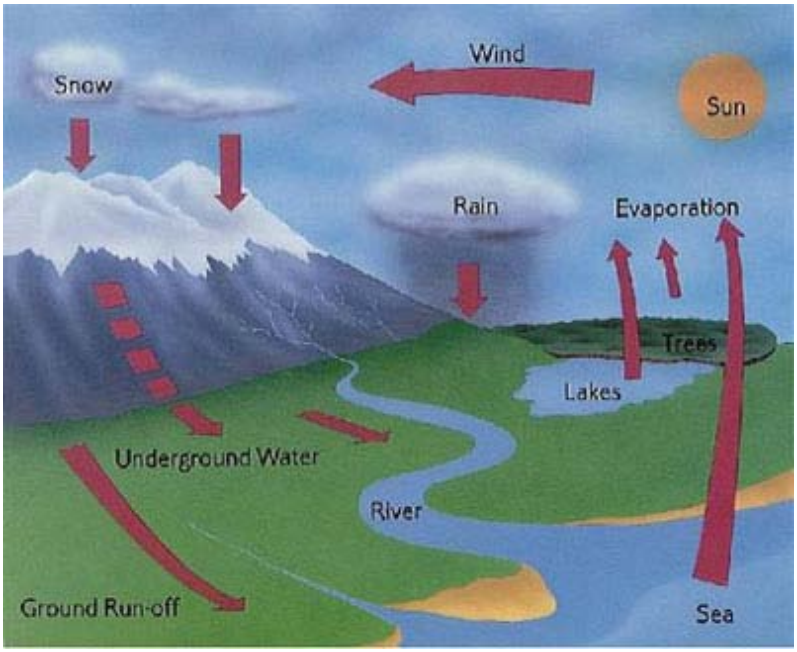
This was a simple task but very few students, even at year 10 (aged about 14-15), positioned all five possible arrows correctly. Yet by year 10 we would expect all New Zealand students to have encountered traditional teaching of the water cycle, quite possibly several times over. For many students, and not only the younger ones, positioning the oceans at the top of the diagram emerged as an apparent impediment to responding to the task. Many students could not bring themselves to draw arrows that appeared to make rain "fall up" instead of down (i.e. arrows B and C in figure 2). Their *embodied* experiences of water movement were at odds with the meaning-making conventions employed when composing this type of highly symbolic diagram. Scientists will position key elements of a diagram in any manner that suits their *thinking* purpose. In this simple case we could say that purpose is exploring *relationships* between the various elements of the cycle. Such diagrams are not intended to be illustrations in any real world sense and understanding this is a basic "nature of science" idea. Understanding this idea could make a small, specific, but potentially transferrable knowledge contribution to the development of *using language, symbols and texts* as a science competency.

I have introduced this example to teachers in a range of contexts. Occasionally teachers comment that the whole issue could have been avoided if we had put the oceans in their "proper" place at the bottom of the diagram. This instinct to smooth the learning path for students is understandable, given that such smoothing is often linked to being a "good" teacher. However the response misses the point when we have competency development in mind. As Guy Claxton would put it, students can only strengthen their "learning muscles" by exercising them (Claxton, 2008). The unexpected positioning of the oceans opens up a learning conversation with implications that potentially extend to more complex symbolic texts such as flow charts and diagrams that require multiple elements to be integrated during meaning-making.

Reading intended and unintended messages in visual texts

Following on from this simple design experiment, we have workshopped ideas for using Internet texts to raise teachers' awareness that there are interesting learning opportunities in exploring the intended and unintended meanings conveyed by visual representations of ideas such as the water cycle. A simple search using a programme such as Google Images provides many water cycle images that could be compared and contrasted. What elements are present in some but not in others? What does the mix and composition of elements suggest about the "message" the image was created to convey? Did the composer create any unintended messages as they put their chosen elements together to build the visual text? The water cycle shown in Figure 3 illustrates the possibilities of this type of learning experience. Like many such examples, arrows provide a symbolic representation of several key water cycle processes (evaporation, run-off) overlaid on a landscape that looks not unlike Switzerland (or New Zealand). Does that mean there is no water cycle in a desert? Does wind only ever blow water vapour towards mountains and does it only ever snow there? It is not that these are incorrect representations of some parts of the water cycle at some times. The point is that they are incomplete and oversimplified. And the overlay of symbolic ideas on real texts adds to the potential that a literal reading will be cued.

Figure Three: Typical web-based visual text



Source: http://www.metoffice.gov.uk/education/images/water_cycle.jpg

Teachers particularly enjoy exposing unintended messages in the visual texts we have created ourselves! We see this as helpful for rethinking attitudes to mixed messages in texts. Unintended messages are not "mistakes" (and hence a shortcoming on the part of the text creator) but rather an inevitable consequence of trying to re-present real word complexities in a chosen text form, which will then be interpreted by different readers accordingly to their own life experiences and purposes for using the text. Perfectly unambiguous meaning-making is simply not possible. Coming to understand this arguably contributes to strengthening students' abilities to think autonomously. With competency development in mind, the opportunity here is to foster students' dispositions to bring meaning-making questions to their critical reading of all the complex visual texts they encounter in their learning and in their life beyond school.

Care needs to be taken that this type of exploration does not foster a relativist sense that "anything goes and nothing matters" when communicating ideas. This is a danger that science teachers will strenuously avoid, even if they only sense the challenge implicitly (Hipkins *et al.*, 2010). Integrating "nature of science" dimensions into the learning can help here. Scientists use communally agreed diagrammatic and other text conventions because they place a high value on clear communication. Students can also learn to ask simple questions about arrows that illustrate this point: what does this arrow represent? Who decided to use arrows like this? Why do they point that way? This is particularly pertinent to food chains and food webs for example. Arrows in these diagrams represent the flow of energy through an ecosystem and hence point in a counter-

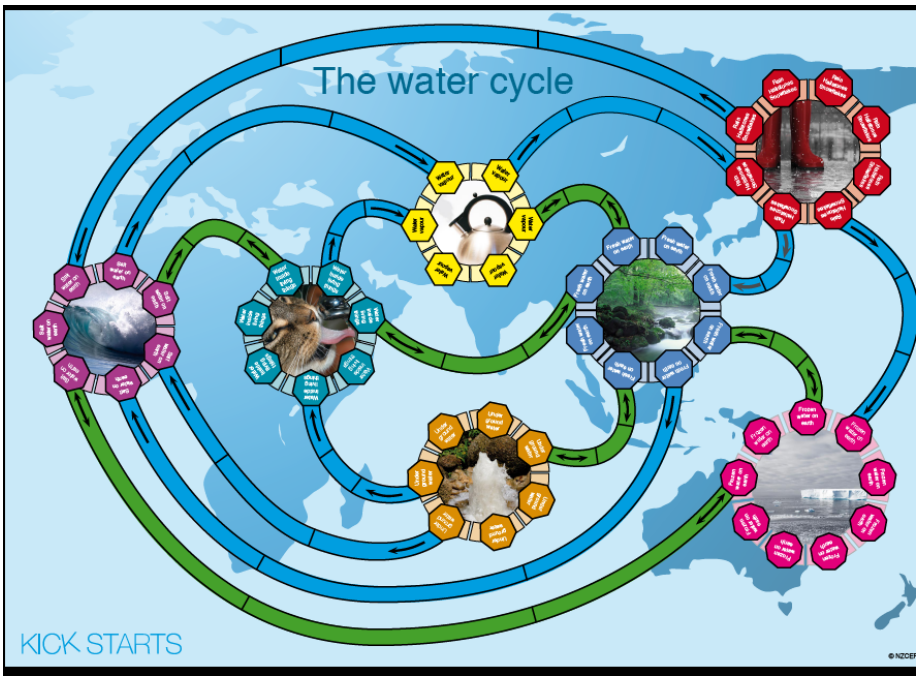
intuitive direction if students expect them to show "what eats what". Arrows in a simple life cycle diagram actually have different meanings (an egg cannot literally turn back into the adult from which it came at the start of the cycle) (Bull, Joyce, Spiller, and Hipkins, 2010). Again the key competency point is that acts of meaning-making can and should be a productive focus of learning in their own right.

From simple cycles to systems thinking

Developing the idea of the water cycle as a complex system was rather more challenging than exemplifying the simple teaching changes outlined above. Figure 4 shows a prototype of a game-like visual text we developed to foster *systems thinking*. The various coloured stations represent places where water in its different forms might be found: fresh water; frozen water; salt water; water vapour; water in living things; ground water. We found we also needed to include one station to "drive" the cycle: rain, hail and snow. The pictures inside each circle are intended to be illustrative but also to provoke questions that provide opportunities for students to make *personal links* between the intended conceptual learning and their own experiences and interests. For example, the living thing depicted is a cat: could it be any other type of animal? Could it be a plant? What about bacteria? What about us? The prototype included an image of a kettle in the water vapour circle.[11] Many students thought this was a penguin! (See image at top centre of figure 4.) In any case water vapour is not visible and in the final version we simply left this circle blank.

[11] We had in mind the demonstrations where teachers use a jug of boiling water and the steam from the jug's spout to make a model of parts of the water cycle.

Figure Four: The water cycle as a complex system



Source: (Bull, Hipkins, Joyce, and MacIntyre, 2007)

The arrows were intended to be discordant with expectations of a board game format. Some have double heads to show movement can occur in either direction. The intention here was to confound the idea that there is one simple unidirectional water cycle. We have anecdotal evidence that this strategy worked. During trialling in one secondary school, some year 10 boys who were normally rather disengaged from science became quite animated when exploring the game format. Once they noticed the double arrows, they were encouraged by the teacher to consider the processes represented by the short arrow between fresh water and water vapour. They soon determined that this arrow was about evaporation in one direction and condensation in the other. One student then observed "Sir, this is a cycle inside a cycle isn't it?" This is just the sort of emergent understanding of the water cycle as a complex system that we had hoped to foster.

Once we had developed this prototype we invited a number of teachers to work with us to develop a range of ideas for the effective use of the resource with students of different ages. We explained our intent and the teachers experimented with their own students to refine their initial ideas. The result was two pages of suggestions in the teachers' guide, and enthusiastic support for the resource. However not every teacher who has used it since has been so positive. For example one secondary teacher told us her very able class of boys became impatient with the exploratory approach – they just wanted to move on because they "already knew" the water cycle. Another teacher said he could not use it because it would be too complicated for his students to memorise and draw in a test. On the surface these are very different responses. However underlying both is a tacit view that learning is for "getting" content knowledge. A *thinking* tool such as this is for

asking questions, exploring relationships, and making links to real world places and events that stimulate ongoing explorations of new possibilities. Learning here should include the recognition that the water cycle is something important that everyone should *care* about. The key competencies point is that the purposes that both students and teachers perceive for any learning experience will determine how that learning unfolds, and hence whether or not the potential for competency development is actually realised during the learning.

Concluding comment

In this paper I have taken one very simple science topic and used it to illustrate the difference that a focus on key competencies might make to the way that topic is taught. Some of the differences from traditional teaching might include:

- The teacher has a clear "big picture" purpose in mind; the learning matters for something more than just getting new content;
- The learning is set in context and links to students' life experiences; where possible these links are sufficiently open that students can personalise these connections to what matters to them;
- Acts of meaning-making are an explicit focus of learning, not just something that happens (or not); the nature of the relevant knowledge-building discipline (e.g. science, history) is in focus;
- The teacher does not smooth away challenges in the learning path by doing the intellectual work for the students. Instead students' ideas are used in ways that establish and sustain their connection to the intended learning while also setting up new challenges that strengthen their "learning muscles".

Teachers do need support to work out what key competencies will mean for their practice. We cannot expect them to do this work by themselves. Resources for one small topic cannot support change across a whole science curriculum. Our hope is that teachers will use the growing range of examples we and others are creating, together with more generic principles such as those listed above, to design and try out changes in other topics. There is much for everyone to learn and the cycles of our collaborative learning are likely to deepen with each important new insight we gain. Equivalent learning will also need to take place in all the other learning areas of the curriculum. As far as we are aware, content-specific development work such as the examples described in this paper is happening only in patches. We have undertaken the design research described here because we saw a need and could find ways to fund the work. A systematic programme of curriculum debate and exemplar development would greatly enhance opportunities for more widespread and consistent teacher professional learning.

It will be evident that teachers cannot provide the sorts of learning experiences described above while continuing to "cover" a large body of curriculum content. Even though NZC gives them the mandate to make a selection of content most relevant to the needs of their own students, many schools and teachers will continue to feel uncomfortable about doing this, especially if they see

efficient and clear content coverage as a hallmark of good teaching and hence as their main responsibility to students, parents and the system that employs them. Messages teachers get back from school leaders, assessment systems (e.g. school-exit assessments for qualifications), students and parents can all reinforce a traditional view of their role. Thus understanding the difference that key competencies are intended to make is *everyone's* business. Education leaders have a role to play. They need to organise, support and participate in learning conversations between all parties who have an interest in the work of schools. Without a wider mandate for change, many teachers will not risk trying out new approaches, or even see the need to do so. We cannot leave teacher learning to chance. If we do that, the potential for key competencies to make a real difference for the learning of today's students is likely to be squandered.

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