Talking and thinking using concept cartoons: what have we learnt?

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ABSTRACT Concept cartoons were created more than 20 years ago. For several years, Keogh and Naylor's research provided the only evidence for how concept cartoons can be implemented in the classroom and what impact they have. More recently, a wide range of researchers have added to that research base. This article identifies some of the major implications for teaching and learning, including using concept cartoons to promote cognitive conflict and argumentation, for formative assessment, challenging misconceptions and enhancing motivation and engagement. It also identifies some aspects of teacher professional learning, including implementing constructivist approaches and promoting change in professional practice.

Brenda Keogh and I created our first concept cartoons more than 20 years ago (Keogh and Naylor, 1993). Our purpose in creating them was to provide a strategy that would promote discussion, elicit and challenge learners' ideas and lead to rethinking. Dialogue was the critical factor in this. Concept cartoons appeared to offer a means of generating such dialogue, where talking and thinking would be mutually reinforcing.

Teachers and learners responded positively to these early concept cartoons, so we began to create them more systematically, drawing on our own teaching experience and on published research such as Driver, Guesne and Tiberghien (1985) and Driver *et al*. (1994). Although our early attempts were not bad, slowly but surely we learned how to make concept cartoons more engaging, more dialogic and more effective. Some of what we learned is evident in a comparison of our early published resources (e.g. Naylor and Keogh, 2000) with more recent versions (e.g. Turner *et al.,* 2014; Moules *et al.,* 2015).

Concept cartoons always now include the following features:

- They are based on everyday situations, so learners lacking in confidence are less likely to be intimidated by the science and more likely to engage in dialogue and share their ideas.
- They present plausible alternative viewpoints on the situation, including the scientifically acceptable viewpoint(s). Most of the concept cartoons embed scientific ideas in everyday contexts, and the contextual features can influence how the problem is interpreted. In many cases there can be more than one scientifically acceptable alternative. This presents an additional challenge to learners, especially to high-achievers.
- The speech bubbles include common misconceptions, so these can be identified and addressed directly in the lesson.
- All the alternative viewpoints have equal status. When the teacher presents a set of alternative viewpoints in a concept cartoon, all these viewpoints are seen as legitimate. This helps less confident learners say what they think, because someone else has already articulated their ideas. If their ideas are incorrect then they can put the blame on the concept cartoon character!
- They have a blank speech bubble to show that there may be more ideas than those illustrated, and learners are encouraged to discuss what might be in the blank speech bubble and explore alternative ideas.
- The background text is written in accessible language, so it can speak directly to learners if the teacher feels this is appropriate.

As well as learning about the nature of concept cartoons, we also learned a lot about how and why teachers might use them in the classroom. Some

of these alternative uses were obvious from the outset, others less so. Here are some possibilities:

- Using them to generate discussion through which learners make their ideas public and create a purpose and direction for follow-up enquiry to develop their ideas. The concept cartoon shown in Figure 1 would probably be used in this way.
- Using them to illustrate different types of science enquiry is another possibility. However, it is easy for science enquiry to be interpreted as meaning setting up a 'fair test', where variables are identified, isolated and controlled, when, in reality, science enquiry is much broader than this. The concept cartoon in Figure 2 shows a situation that would be investigated by making observations over a period of time, not by fair testing.
- Using them to create opportunities for creative thinking and applying ideas, by presenting a concept cartoon with only the first speech bubble filled in and asking learners to discuss what the other characters might be saying. An example of this is shown in Figure 3 (the complete concept cartoon is also shown).
- Another possibility is to use them as 'thinking homeworks', which engage learners, encourage them to think, maybe get them talking to other family members, and set the scene for follow-up discussion and enquiry in the next lesson. Figure 4 shows a concept cartoon that might be used in this way.

What Brenda and I had not expected was how much we would learn about more fundamental

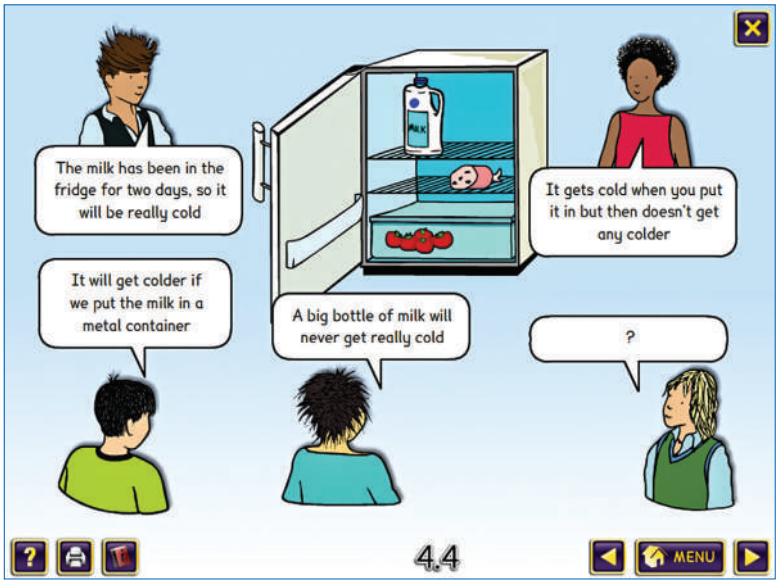

Figure 1 How cold is the milk in the fridge? (from Moules *et al*., 2015)

Figure 2 What happens to living things when they die? (from Moules *et al*., 2015)

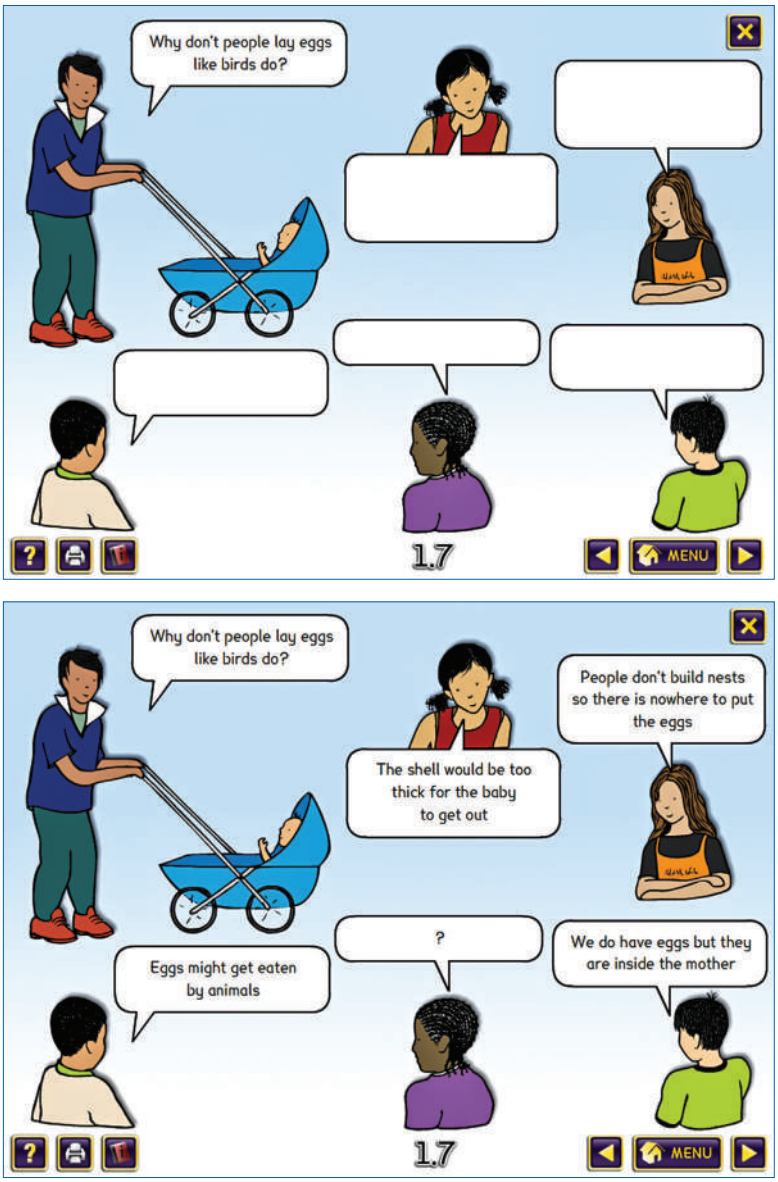

Figure 3 Why do humans not lay eggs like many other animals? (from Naylor and Keogh, 2014)

aspects of teaching, learning and assessment through the process of creating, developing and researching concept cartoons. Many things are clearer with hindsight, and it is easier looking back now to see how concept cartoons built upon and implemented the valuable research carried out by colleagues. The rest of this article attempts to set out some of the themes that have become evident in our work with concept cartoons.

Dialogic teaching

When I was at school, a good lesson was a quiet lesson and a quiet lesson was usually a good lesson. Fortunately, most teachers have moved on from that view and recognise the importance of dialogue. Neil Mercer (2000) uses the idea of 'exploratory talk' to describe what learners do when they are trying to work out the answer to a problem. He describes 'exploratory talk' as talk in which learners engage critically but constructively with each other's ideas, using reason and evidence and considering alternatives before reaching a joint decision. Mercer's research shows how this type of talk helps in promoting understanding and developing reasoning skills, both of which are vital aspects of learning in science, as well as revealing the learners' ideas to the teacher. In addition, exploratory talk is especially valuable in helping learners to discover that sometimes there isn't **one** answer – there are several **possible** answers – and talking together can help them work out which is the best answer from the various alternatives. The *Thinking Together* project (Dawes, Mercer and Wegerif, 2000) provides useful guidance on how to promote exploratory talk in the classroom, such as developing a set of ground rules for talking in groups.

Similarly, Robin Alexander writes about dialogic teaching (2008), where the voices and ideas of the learners are valued in lessons, and

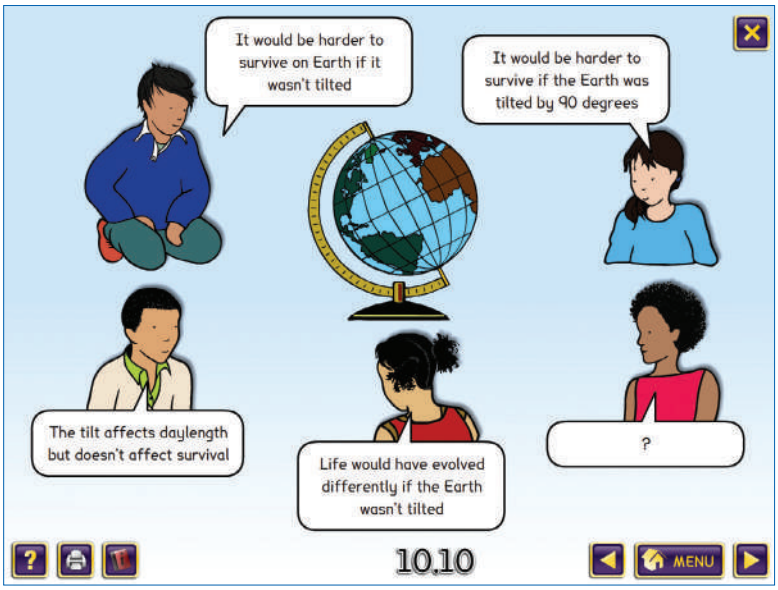

Figure 4 What would happen if the Earth's tilt was different? (from Moules *et al.*, 2015)

talking together (rather than just doing practical activities together) is viewed as a natural and obvious part of learning. Mortimer and Scott (2003) take this further, describing how classroom roles and relationships vary, and highlighting interactive, dialogic learning situations as especially powerful in challenging and developing learners' ideas.

What these descriptions have in common is a view of talk that focuses on explanation rather than assertion, on evidence rather than authority, and on the expectation that learners (including very young learners) should justify their ideas using evidence and reasoning. This is a view of talk that concept cartoons support. They present a dialogic model of learning, where all the characters in a concept cartoon contribute different ideas to the discussion, providing an explicit illustration of exploratory talk, and the only way that the characters can resolve their difference of opinion is through evidence and reasoning.

Some teachers use concept cartoons because they are already committed to this way of working and they view concept cartoons as a quick, simple and effective way to make this happen in their classroom. Other teachers may be less committed. Harrison (2012) notes the importance of shifting the balance of classroom talk, from teacher talk being dominant to learners having much more of a voice. What concept cartoons can do is help to shift that balance. We have seen many examples of how using a concept cartoon at the start of a lesson sets the tone for the rest of the lesson and creates a different kind of learning environment, so that talk becomes more exploratory and dialogic. It is helpful if teachers set out to create this type of learning environment by modelling productive talk, providing time and space for talk and using ground rules to guide classroom talk. Nevertheless, we have seen concept cartoons make a difference to classroom talk even in the absence of any support from the teacher (Keogh and Naylor, 2007).

Motivation and engagement

Thinking is a voluntary activity. As teachers, we may be able to control what learners do in the classroom, but we cannot control what they think. If they are not engaged then they will not be thinking much (or, to be more accurate, not thinking much about what we want them to think about). Engagement is therefore critical to effective learning in science.

One of the ways in which we can enhance engagement is by getting learners talking and arguing about their ideas. Ogborn *et al.* (1996) and Osborne, Erduran and Simon (2004) are not alone in finding that learners are more engaged when we give them opportunities to argue and debate in science lessons. The connection between argument and concept cartoons seems obvious; after all, a concept cartoon is little more than an argument presented in visual form. The plausible alternative viewpoints force learners to give serious consideration to the alternatives, and our research shows clear evidence of concept cartoons leading to increased motivation and engagement for learners of all ages and backgrounds and in

a variety of circumstances (Keogh and Naylor, 1999). A recent study with student teachers in Turkey found a similar impact on their motivation, quoting one student teacher as saying that concept cartoons *rescue students from boring traditional teaching* (Birisci, Metin and Karakas, 2010).

One interesting aspect of using concept cartoons is that of confidence and self-esteem. Confident, articulate, high-achieving learners are often used to getting most things right in most lessons, and this can easily lead them to dominate classroom discussion. Being confronted with plausible alternatives that they probably have not considered before can prevent them being over-confident and help them to realise that uncertainty is often associated with science enquiry. This, in itself, can be an important learning outcome. Equally, having a character in a concept cartoon saying what you think – and saying it first – is much less threatening than putting forward your own views, so less confident, low-achieving learners can receive a big boost to their confidence. In other words, concept cartoons can help to reduce what is often a large gap between the levels of confidence of learners in a group and this can have a positive effect on group dynamics (Keogh and Naylor, 1999).

Cognitive conflict and metacognition

Research into effective classroom practice (e.g. Hattie, 2009) shows that cognitive conflict and metacognition have a high impact on learning. Concept cartoons draw on published research into common misconceptions and build examples of these into the concept cartoon statements. In this way, the concept cartoon characters articulate what appear to be plausible alternative viewpoints.

The purpose of presenting alternatives, especially plausible alternatives and/or alternatives that are partly correct or correct in some circumstances, is to generate cognitive conflict. A typical response of learners in a group is that they will have different interpretations of what the characters are saying and will draw on different experiences and emphasise different evidence in making a judgement about which character they agree with. Fierce arguments are common. Learners find themselves in a position of having to give serious consideration to the alternative viewpoints, and this creates cognitive conflict.

As discussion continues, learners have to think about a variety of viewpoints, weigh the evidence that supports each of them, reflect on their own ideas and decide to what extent their ideas are supported by evidence – in other words, they have to engage in metacognition. This can be a valuable step in getting them to think more deeply about scientific concepts (Keogh and Naylor, 1999) and can be especially important for confident, high-achieving learners.

In this way, not having an obvious right answer, and frequently not having a single right answer, makes cognitive conflict and metacognition more likely.

Constructivist teaching that takes learners' ideas into account

It is not necessary to rehearse here the significance of the learner's existing ideas in influencing learning. It is a very well-researched aspect of science education. However, accepting the principle of taking learners' ideas into account and doing this in practice are very different things. There has always been a problem with constructivist research and models of learning not translating readily into constructivist teaching approaches. It was in 1989 that Robin Millar pointed out that a model of learning is not the same as a model for teaching, and how constructivist models of learning might be translated into specific teaching approaches is far from clear (Millar, 1989). What much of the constructivist research from the 1980s onwards failed to get to grips with is the question of what exactly does constructivist teaching look like. Although the constructivist research is compelling, many teachers ignore it because constructivist teaching approaches seem too difficult to achieve. Finding out individual learners' ideas can be futile if the teacher does not have the capacity to do anything to take those ideas into account in a typical lesson.

Our research (Keogh and Naylor, 1999) suggests that concept cartoons help to alleviate this problem. When they are used in a science lesson, concept cartoons typically create uncertainty across the class and identify areas of disagreement, and this provides a purpose for a whole-class enquiry to resolve the dilemma. The follow-up enquiry is a response to the disagreement, not to individual learners' ideas. Teachers are able to take learners' ideas into

account in manageable ways, without having to find out or assess what individuals think. Learners also feel that their learning experiences are personalised, without the teacher having to deal with classroom situations that are impossible to manage.

Formative assessment

The value of formative assessment is taken for granted by most science educators. Colleagues writing about assessment for learning have been very classroom-focused and produced many helpful suggestions about how to make it happen. While much of the research and development has taken place in the UK, sadly much of their work has been misrepresented and, at times, mangled by successive government Education Secretaries. Thus we often see the form rather than the substance of assessment for learning in classrooms – such as, for example, a requirement to share learning objectives at the start of a lesson, even if this might result in teachers revealing the outcome of an investigation before pupils have actually *done* the investigation.

Concept cartoons are just one of many learning strategies that can help teachers to implement formative assessment in classrooms. Self- and peer-assessment are obvious and inevitable when learners engage in discussing a concept cartoon, and teachers who are attentive listeners can make good use of these opportunities. Equally obvious is the opportunity they provide for diagnostic feedback to teachers about the uncertainties, confusions and misconceptions learners will have in any science topic. The fact that they help to depersonalise situations, so that learners are more willing to put forward their ideas, frequently makes formative assessment easier to achieve. However, probably most significant is the strong link between elicitation of ideas and learning in easily managed situations. Discussing a concept cartoon makes the links between sharing, challenging and developing ideas clear and direct, as well as providing a purpose for any follow-up enquiry.

Changing teacher professional practice

Some teachers are willing in principle to make changes in their professional practice, but are uncertain about why or how to do this. We have seen how concept cartoons, and other teaching and learning approaches that promote dialogue, can act as a Trojan Horse and offer a way forward in these circumstances (Keogh and Naylor, 2007).

I can imagine myself, at an earlier stage in my career, as an uncertain and hesitant teacher. There is no big investment in using a concept cartoon, so I would probably be willing to give one a go and see how it works. Maybe I find that, when I use a concept cartoon, learners seem to respond well to this stimulus. Even if I generally use a didactic approach, a lesson based on a concept cartoon may be atypical, with more opportunities for dialogue and argument than would normally be the case. If learners find this motivating and the class response is better than usual then I may be tempted to give it another go in another lesson. When this happens on more than one occasion, I start to become convinced by the evidence from my own classroom and begin to embed this change in my teaching. Concept cartoons lead towards cognitive conflict, dialogue, metacognition and social construction of ideas. This is what happens in classrooms, even if it is not the teacher's intention, and this can be a stepping stone on the way to more fundamental shifts in professional practice.

In this way, professional change is progressive, with change in professional values and beliefs being a consequence of change in practice, rather than a prerequisite for change in practice. This view of professional change as evolutionary has been explored in more detail in our *Active Assessment* project, into which concept cartoons are integrated (Naylor and Keogh, 2007).

Looking forward

Concept cartoons have proved to be popular with teachers in a wide range of countries, even where the local educational culture is very different from that of the UK. Quick, simple and effective ('deceptively simple', as one colleague described them) is what makes them attractive to busy teachers, and dialogue is the key to this. The dialogue between the concept cartoon characters draws in learners immediately, and the cartoon-style representation of a conversation between different characters makes it really obvious what is going on. However, it is the dialogue they generate between learners that is critical. Of all the things we have learnt about concept cartoons over the years, this is the most important. Talking and thinking are inseparable: talking makes thinking better, and thinking makes talking more productive. Talking and thinking together enable

learners to engage in the discourse of science, and concept cartoons can make a valuable contribution to making this happen.

Two sets of concept cartoons for science are now available, as well as sets for English, mathematics, sport and fitness, and sand dune ecology (see www.millgatehouse.co.uk for details of these). In principle, it should be possible to create them in any subject where there is a possibility of alternative conceptions and conflicting viewpoints. Our plans include sets for personal, social and health education, history, financial literacy and aspects of pedagogy.

Readers who are interested in research into concept cartoons will find a fairly extensive list of references on the Millgate House Education website (www.millgatehouse.co.uk/concept-cartoons-research)

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Although **Brenda Keogh** died in 2013, her ideas, her insight and her inspiration are evident throughout this article.