

CONCEPT CARTOON CONVERSATIONS LEAD TO INSPIRING INVESTIGATIONS

How Yanoula Constantinou used concept cartoons and cognitive acceleration to enthuse children in science lessons



Figure 1 Investigating burning candles after a concept cartoon prompted in-depth discussion

At Deansfield Primary School, Eltham, south-east London, we are always striving to enable children to become successful learners who are confident and enthusiastic. We have endeavoured to give more emphasis to science teaching and learning by bringing it up to date through research and creating a positive attitude to it among the teachers and children. It was important to get all teachers on board by introducing various pedagogical approaches and new concepts to their everyday practice.

In order to support the rest of the school as science leader, I was sent on two courses with the Royal Greenwich Teaching Schools Alliance. The first focused on scientific subject knowledge and included the use of concept cartoons and cognitive acceleration (Box 1). For the second, guided by Professor Andrew Lambirth of the University of Greenwich, I was encouraged to pursue my own

action research. I decided this was the opportunity for me to use cognitive acceleration, particularly cognitive conflict, by incorporating the ideas into my own practice to investigate the effects and, more importantly, the benefits of these approaches. I planned some topics that began with lessons using concept cartoons and compared these to the topics where the initial lessons did not include a concept cartoon. My action research and work with Andrew also allowed me to work collaboratively with Thomas Tallis School, our local 11–18 comprehensive, and help bridge the gap between primary and secondary science education.

Causing cognitive conflict

It is clear that children enter our classrooms every day with their own ideas as to how the world around them came about. Some of these ideas can be misconceptions, but their preconceptions are not mistakes or

false beliefs: they are what the children have seen or experienced (Driver *et al.*, 1994). Often our job is to address these misconceptions by creating a physical experience that provides the children with evidence to contradict their existing ideas. One way to stimulate this is by using a concept cartoon. From my own experiences of using these resources they are a fantastic way to ignite discussion, and quickly let you as the teacher pick up on the children's ideas and/or gaps in their learning.

Concept cartoon discussion

The first research lesson was also the first lesson on our topic of 'Materials'. In small groups, I let the children watch a burning candle and posed a concept cartoon question: 'What happens to the wax of a burning candle?' (Figure 2).

After giving the children some time to think about this question, I gave them a lit candle to observe and

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Box 1 What is cognitive acceleration?

Cognitive acceleration has its roots buried deep in theory. It is a series of techniques you can adopt in the classroom that may help to 'accelerate' children's learning. It is not a bought-into science package, but a mind-set, an environment that all teachers can embrace. As educators, it is important that we lean away from the content-heavy and restrictive science activities that many bought-into packages provide, lead by example and be confident in our own ability and teaching. Research in mathematics has shown an increase in the cognitive ability of children when teachers are assisted with cognitive acceleration. It supported the idea that relative intelligence is not fixed and that collaboration can benefit the children's own thinking (Shayer and Adhami, 2010). Furthermore, studies have also shown that exposure to cognitive acceleration materials develops reasoning ability and that children demonstrate a more mature attitude towards science teaching (Moore, O'Donnell and Poirier, 2012). Cognitive acceleration programmes such as 'Let's Think' have added to the evidence by showing that children who are exposed to such teaching techniques score higher than control

groups on cognitive development measures at the end of the programme and in the subject matter up to three years after the end of the programme (Adey, 2011).

There are three main parts to cognitive acceleration (Adey and Shayer, 2011):

- **Cognitive conflict.** Creating puzzlement in the child's mind; the activity or the discussion should conflict with the child's preconceived ideas rather than them passively accepting what is being taught, therefore pushing the boundaries of Vygotsky's ZPD (zone of proximal development).
- **Social construction.** Group work should be evident, so that children can build on or oppose each other's ideas. Allow children to not only learn from the teacher but from each other as well.
- **Metacognition.** Reflecting on one's own learning not only consolidates the learning but let's children realise their own potential. Simply asking children 'What have you learnt?', 'How did you learn that?' or 'Who told you?' empowers children and lets them realise the potential of their own abilities.

time to study the concept cartoon (social construction). They read each statement from the cartoon characters and individually decided which statement they most agreed with and which they most disagreed with, and wrote these down. They then discussed this in their groups and if they felt they wanted to change their opinions they could. Their responses and ideas included:

I don't think the candle gets fatter because it doesn't, it gets smaller but I don't really know why.

I agree with the wax melts, because you can see it there on the side of the candle.

The candle's hot so it melts the wax; you can see it's wet in the middle.

The candle doesn't fall apart; it doesn't just break because the wax melts.

At this point the candles were significantly smaller after burning during the discussion, so I brought their attention back to the candle and asked 'Where has the wax gone?' The children appeared very confused so I redirected them back to the concept cartoon and let them continue with their discussion:

The wax can't dissolve because there isn't any water.

table was not enough to reconstruct the original candle.

Developing further questions

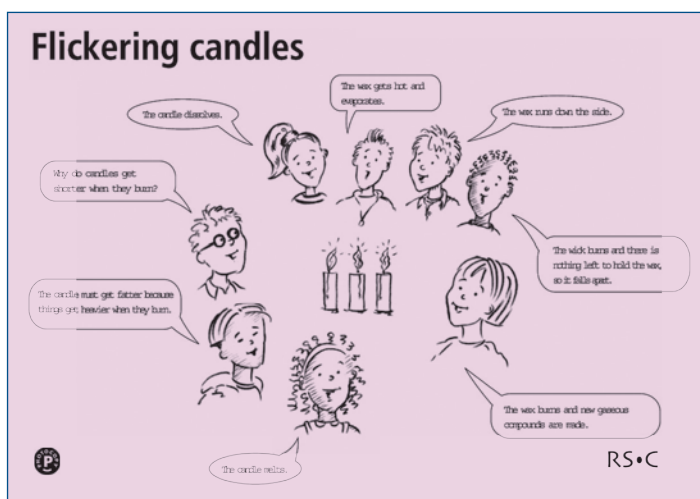
So what really did happen? In my training course it had become clear that a cognitive acceleration lesson doesn't mean the teacher shouldn't teach, so I explained that some of the wax burns, some evaporates and some melts. Now the children were aware of what happens to the wax they became even more curious and wanted to experiment with different variables. In groups, they discussed the possibilities. Each group tested the height of the burning candle over time using variables such as width, scent, temperature and presence of wind (Figure 1).

During the lesson, it was clear from the discussions children were having and the confusion they were experiencing that cognitive conflict was present. The concept cartoon was a good resource to draw the children back to as their own ideas were limited, and it presented different ideas for the children to either agree or disagree with, using their knowledge and experiences to justify their opinions. For this particular lesson, using a concept cartoon provided a platform for the children to become scientists and ignited their natural inquisitiveness, which inspired them to

I still think the wax melts but now instead of being long it looks like a puddle.

I decided to intervene at this point as I had realised their experiences of burning candles were limited. Although they had seen candles burn and wax melting, watching a candle burn to the end was something new. They realised that the wax that was left lying on their

Figure 2 Using a concept cartoon to promote discussion and explore children's ideas (image courtesy, Royal Society of Chemistry)



investigate further. The following lessons were predominantly child led. They decided on their hypothesis and, with little guidance, conducted experiments and recorded their results using line graphs, which then allowed them to make comparisons and draw conclusions on the impact of their variable.

Exploration in space

Another lesson that was part of my research was during the topic of ‘Earth and Space’. I had an experiment in mind, but before jumping straight into modelling how to set up the equipment and ‘telling’ the children what they were looking for, I decided to let them explore. On their tables they had a ball of plasticine, a protractor, squared paper and a torch.

In groups of four, the children were challenged: ‘Using the equipment in the middle of the table can you show how the Earth experiences seasons?’ Some groups immediately used the ball of plasticine as the Earth and the torch to represent the Sun (Figure 3). One group was using the squared paper; when asked what that represented a boy said ‘It’s the galaxy’. In response to his idea another child replied ‘But do we need the galaxy to explain the seasons?’ At this point you could see him questioning his idea and thinking about what his partner had said; he was experiencing cognitive conflict as his idea of the how the Earth experienced seasons involved the universe.

The lesson went on to provide the children with an investigation of the angles of the Earth during winter, summer and autumn so they could see what happens to the distribution of the Sun’s light during these seasons. When later asked to write down how the Earth experiences seasons and to circle which of Earth, planets, Sun, clouds, stars and universe was involved, the boy with the original misconception did not circle the universe.

What did my action research show me?

Even though I did not collect any quantifiable data, the lessons in which I actively applied cognitive acceleration methods

Figure 3 The children came up with their own ideas on how to demonstrate the seasons with the equipment provided



were more ‘lively’, children appeared more enthusiastic about their learning and took more control over it. In each lesson, where I was more ‘the observer’, the children were at the centre of their own learning, discussing and debating scientific concepts with their peers and learning from each other, as evidenced from the ‘Earth and Space’ lesson. By creating puzzlement you create discussion and a platform from which investigations arise. Over the year, from all the investigations the children completed in various topics, the candle investigation and the work produced from it was of the highest quality because of the strong engagement of the children as they tested their own ideas and were free to record as they wanted.

This compares to more traditional lessons, where children relied on my lead a lot more, waited for me to model investigations and only asked me questions to which I would provide an answer. Such lessons lead to more subdued learners and a less energetic atmosphere, which is not exciting for the children or the teacher and does not allow for the wealth of discoveries to be made. From my own observation, applying cognitive acceleration methods to teaching and learning approaches can only benefit the children’s cognitive ability. While the only evidence I have is the classroom atmosphere these methods created and the work children produced, the approaches will become a central part of my science teaching. As a science leader within a school I have begun to share my knowledge and experiences, so that other teachers can incorporate them into their everyday practice.

Trying it for yourself

The ‘Let’s Think’ programme has proved highly successful in increasing children’s capacities for understanding

science and in developing their general thought processes (Adey, 1999). From my own action research I would suggest:

- **Don’t jump in to show children how to use equipment and how to set up an experiment. Let them have a go, use the equipment and show their partners or discuss how it could be used.**
- **Use concept cartoons, allowing time in your science lessons for discussion, in pairs or groups and then investigation/exploration.**
- **At the end of lessons discuss the children’s learning with them. What have they learnt? How did they gain that knowledge? Who/what helped them learn? (metacognition).**
- **Learn to be a guide. Cognitive acceleration is all about the children leading the learning and you as the teacher just guiding them.**

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