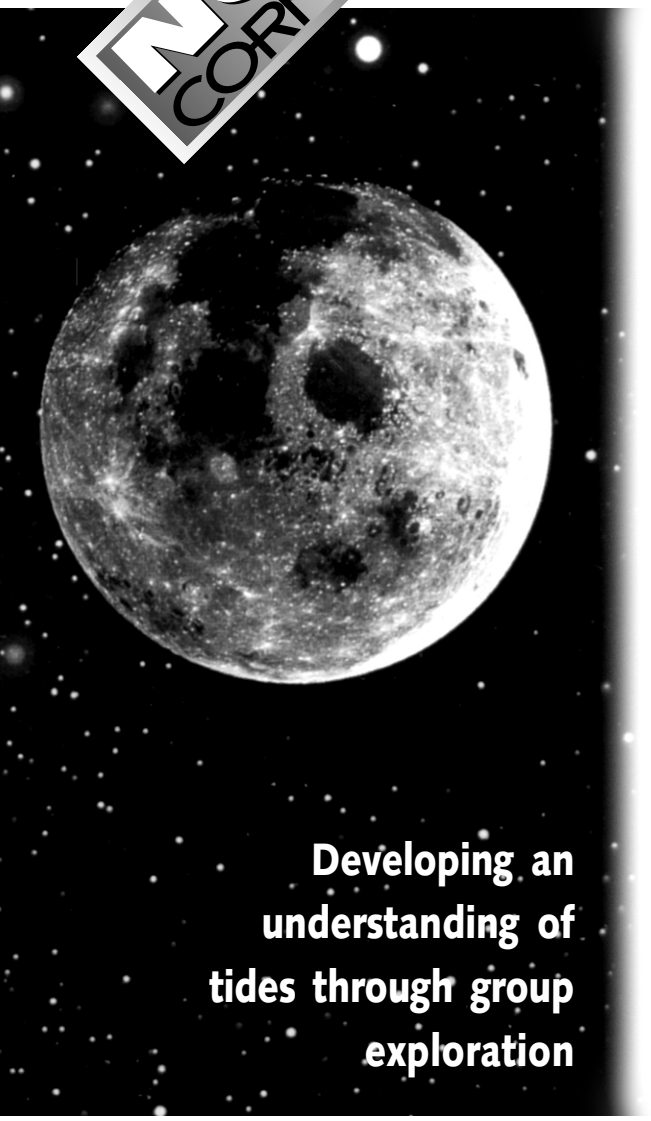
NQT CORNER

'Well you might be right but ...'



Developing an understanding of tides through group exploration

JENNY HATLEY RECOUNTS HOW HER GROUP OF PGCE STUDENTS GAINED UNDERSTANDING THROUGH SHARING THEIR KNOWLEDGE

Children and teachers find understanding the solar system, especially how the motion of the Earth and Moon causes seasons and tides, difficult. Often, within a group, each person knows part of the 'right explanation' but no one can put these parts together on their own. Within our group of trainee teachers each of us had a partial understanding of how tides work, but we hadn't put these parts together to arrive at the whole picture. This is how we extended our understanding through working together and sharing expertise.

Sharing our knowledge

One dark Wednesday afternoon in the first term of our PGCE course we congregated in the weekly 'science surgery' to explore the ideas of 'Earth and Space'. We struggled with some tricky questions arising from a science seminar the previous day, such as '*How many lunar eclipses are there in a month?*' and '*Exactly how do seasons work?*' We became engrossed in videos and in changing seats to 'see' the phases of the Moon; with only a projector and a sponge ball, the three-dimensional view suddenly made things clearer. However, the most enlightening moments came after the session had ended. A small group of us stayed behind for what was to prove at first a confusing, then an enlightening and eventually a thrilling voyage of discovery about tides.

We were already tuned in to the idea that when teaching science, sensory experience should come before abstract concepts. Before telling the children anything, we need to get them to observe and discuss what they 'see': the quality of their work will then be far better. We had made notes on this in our files, even highlighted it for future reference, but how real was it to us? We sensed that it must be true, but hadn't used the idea to thrash out those scientific principles that had eluded us for years, or to bounce ideas off each other, gaining a deeper understanding as a result. The PGCE science surgery gave us the chance to do just that. There we were, four science students and a tutor, all giving our version of how tides work. We had just heard (in the video) about how the Moon's gravity pulls the water into a bulge giving high tides, and how it also pulls on the Earth more than it pulls the water on the other side of the Earth, giving another bulge on the other side because the water effectively gets 'left behind'.

This didn't seem a bad explanation, especially considering that, overall, the Moon's gravitational pull is the most important factor. So it all seemed OK – until someone mentioned the Sun. Surely the Sun must affect the tides, because it also has gravity? We could see that in principle the Sun may have an effect, but (we agreed) it can't be a big one because, after all, we'd only been taught about the Moon at school and what we are taught at school must be right ... right? Or had we in fact only acquired a partial view back then, and been robbed of a full understanding, growing up

instead with questions unanswered (and unasked) and a view of science as something that never really made sense?

Musing together about the Sun opened the floodgates to other theories, made up of bits and pieces we had heard here and there. Once one of us had begun questioning, the rest of us felt confident to follow:

What about the centripetal force caused by the Earth's rotation, you know, it like pushes the water around?

Isn't the Moon in an elliptical orbit around the Earth, so when it's closest it pulls more and you get higher tides?

Do you mean that the Earth actually gets pulled out of its orbit a bit towards the Moon, leaving the water on the other side of the Earth 'behind'?

Our discussion – like the tide – was in full flow, with each of us trying to explain and justify our ideas and being forced to question them in the light of someone else's thoughts. Each of the theories seemed reasonable but we couldn't quite work out which was 'the right one'.

And what does the book say?

My curiosity had been aroused, so on arriving home I turned to one of my favourite astronomy textbooks. I realised that we had been like the blindfolded wise men looking at the elephant. One feels the trunk and decides it must be a snake, one feels the legs and is sure it's a tree, one feels the tail and is adamant it's a broom, and one feels the thick, rough skin and confidently reports that it is a brick wall. Each of them has a part of the 'right explanation', but none can put these parts together to see the whole picture. Yes, I read, the Sun does affect the tides. When the Sun, Moon and Earth are in line with each other, the force of gravity from the Sun and Moon reinforce each other, giving particularly high (spring) tides. When they are not in line, at right angles, then the combined force is weakest, resulting in unusually low (neap) tides. And, yes, the Earth's rotation does cause (centripetal) acceleration of the water. Because the Earth rotates and the water is on the Earth, the water is experiencing a slight change in direction from one second to the next resulting in its acceleration. It is rather like when you turn a teacup, the tea inside it moves slightly. It is not exactly that the Earth is pulled towards the Moon, but rather the Moon's gravity gives rise to 'body tides' in the Earth that cause the land (including the bottom of the sea bed) to rise by several centimetres. The Moon is in a circular orbit around the Earth, so we don't need to worry about its closeness to or distance from the Earth.

Bringing it all together

The following week, I met my fellow students and tutor on a visit to the Norman Lockyer Observatory in Sidmouth, Devon. After a night looking at the Moon, planets and stars, we congregated in the pub where we put together our thoughts and observations, and arrived at a much fuller and more satisfying explanation of how tides work. Not only am I now much more confident to teach about tides in school, I also feel much more able to handle those tricky questions that may be raised by my class, even if I don't intend to go into all these details in my teaching.

But how can we do this practically in the classroom? One of the ideas we came up with is to begin with the phases of the Moon. Put 28 chairs in a circle and label them 'day 1' through to 'day 28'. Stand a sponge ball in the middle of the circle and shine the light of a projector on to it. Keep the ball and the projector in one place and ask the children to move gradually from one chair to the next. They will be able to see the different phases of the Moon, see that it depends on their position as to which phase they see and that they only see it because it is lit up by the 'Sun' (the projector). You can then reverse the experience: let a child stand in the middle, and move the ball from chair to chair so that they can see how its appearance changes. After this, ask the children to do a daily 'Moon-watch' at home, and then colour in the phases of the Moon on a sheet. Over a month, they will correspond with the phases they saw on the sponge ball in the classroom.

Then you can move on to the tides. If you live by the coast, take children to the beach to observe where the tide has reached each day. Obtain tide tables for your part of the coast. (If you live in urban areas, children can access websites that give live pictures of the tides and the times: www.ukho.gov.uk/tideprediction.cfm or www.pol.ac.uk/ntslf/tides/?port=0001).
They can then compare the heights of the tides with their daily Moon-watch, which should show them that spring tides coincide with the new Moon and full Moon, while neap tides coincide with the half Moon (first and third quarters). This approach of sensory experience before abstract concepts will help them to see the link between the Moon and tides, enabling you to fill in the rest in the classroom.

You could fill in these details by extending the idea of 'concept cards' (Kibble, 2002), but instead of only one card giving the true explanation, three or four cards could each give a part of the explanation, each being partly 'right'. This is a great way of stimulating discussion and, as my friends and I discovered, discussion leads to questioning, further research and the thrill of greater 'discoveries'. Isn't that the goal of science education in the classroom?

Reference

Kibble, B. (2002) Misconception about space? It's on the cards. *Primary Science Review*, **72**, 5–8.

Jenny Hatley, PGCE Primary Science, University of Exeter