



TRICKY CIRCUITRY

Tony Davies uses a magical theme to introduce children to the way electricity works

Figure 1 The light-up ball in action

Teaching children about circuits and the way electricity works is a 'tricky business' because it is invisible, so it may as well be called electrickery. To help you in your quest what about an incredible magic trick to amaze and enthuse your eager pupils? Just imagine all eyes are on you as you produce for your class what looks like a ping-pong ball and then, with a wave of your hand, the incredible happens! This wonderful white sphere begins to glow red and a bleeping noise is heard. What is it? Could it be *electrickery*!

Now I may be a member of The Magic Circle (a British organisation, founded in London in 1905, dedicated to promoting and advancing the art of magic), but I am sure this is one trick we can let you in on because

of course it is not magic at all; surprise, surprise, it is science. These ping-pong marvels are available in all sorts of packaging: I have seen them labelled 'Cosmic Ball' and 'Energy Ball', or even 'Ghost Ball'. They are even marketed as 'light-up plastic eyeballs'! The secret is of course simple: there are two strips of metal on the bottom and by placing your fingers on both of them it makes a connection across your skin, the button batteries inside make a small LED light up and a buzzer sound (Figure 1).

These toys are cheap to buy, surprisingly sophisticated and there are many ways to use them to help children understand how electricity works.

Misconceptions

Children are often asked 'Can you make the bulb light?', and you

find they can do this fairly easily with simple equipment. They recognise that a complete circuit is needed, but will have ideas that can get in the way of later work, such as the colour of the wire making a difference to the circuit (although they may not be clear on what or how it affects it). This can be an opportunity for a systematic enquiry involving a range of coloured wires. Another common problem area to overcome is the children's belief that the electricity comes out of both sides of the battery and, where it meets in the middle, it causes the bulb to light.

Make a magic circle (actually it's a circuit)

Assuming the children can make the bulb light up, we could start to investigate the mysteries of the illuminated ball and how the

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Figure 2 Getting the whole class involved in making the ball light up

Figure 3 The squeezing hands activity to demonstrate a misconception



electricity must be travelling. In fact, it does not flow 'through' us, as the children think, but is passing over the skin. This helps to deal with a subtle misconception, that is that electricity passes 'through' metal when in fact it travels only over and through its very upper surface; this is called 'The Skin Effect' and is why copper-coated steel wires are used in household wiring – steel inner for strength and copper on the outside for the conductivity.

Ask two children to each put a finger on one of the metal strips: nothing happens. But when they hold hands the ball lights up. The electricity is travelling in one direction from one strip to the other. Now let us try increasing the number of children and this will truly amaze you; I mean the whole class! I promised you magic and this is incredible; the children join hands all the way round the room and the electricity will pass and light up the ball (Figure 2).

There are, of course, opportunities for things to go wrong and you can use this to your advantage. In one of our lessons, one of the boys did not

want to hold hands with the girl next to him and pulled the sleeve of his sweatshirt down, covering his hand. This gave us an opportunity to introduce conductors and insulators as well as explore switches:

When someone didn't hold hands properly and got their sweatshirt in the way it cut the power so we started to understand what a switch was and also that electricity doesn't pass through sweatshirts. (Lydia)

Rope trick

You can show the children that when a buzzer is introduced into a circuit, unlike a bulb, it can only be connected one way, showing

that the electricity travels around in one direction and from one side of the battery. The temptation now is to use a pointed finger to show how the electricity moves. The problem with this is that children get the 'idea' that it is a 'blob' of electricity that moves down the wire from the battery, through the buzzer and back to the battery again. To get over this misconception we can try to exaggerate the effect by using a 'rope trick'.

Everybody is asked to hold hands in a circle. You have a card around your neck labelled 'battery' and you choose a child half way around the ring to be the 'buzzer'. Now we play a drama

Figure 4 The 'rope trick' models how electricity actually flows



Figure 5 Using the light-up ball to investigate conductors and insulators



game: you squeeze the hand of the child next to you, they squeeze the hand of the next child and it continues around the ring (Figure 3). When the child who has been chosen to be the buzzer feels their hand being squeezed they say 'buzz!' The game continues until it gets all the way round and you say 'Here!'

After a few goes at this, you discuss with the children whether there is a time lapse between pushing the button on your doorbell and the bell ringing or between switching a light on and it illuminating. To demonstrate that all the electrons in the circuit are moving at the same time we introduce a length of thick string or a skipping rope tied in a loop. All the children cup their hands and hold the string so it will slip forwards and backwards (Figure 4). Now you jerk the string and all the children feel the movement at the same time and of course the child who is the buzzer shouts

straight away. This demonstrates to the children that electricity is travelling through the whole of the circuit so you do not have to wait for the buzzer to sound:

When we used the skipping rope I suddenly realised that electricity must travel very fast because we all felt the pull straight away. (William)

Magic wands

Well this is not quite Harry Potter but we are talking about materials that are either electrical conductors or insulators. The light-up ball is absolutely brilliant for this investigation. Children find them easy to manipulate and it is great fun. You hold the ball in one hand with a finger on a metal strip and, holding the object to be tested in the other hand, touch it on the second metal strip (Figure 5). If the ball lights up you have a connection. Children can be asked to predict and group the items and there is a lot of opportunity for conversation.

X-ray vision assessments

This quirky activity will give you an opportunity for making some assessments. Ask the children to draw and colour what they think may be inside the ball. Children can use their knowledge to show what that they understand, that is, that it needs a battery, light, buzzer and a circuit broken by the metal strips. The children will produce the most intricate drawings and this is a great opportunity for them to talk and for you to ask very open questions: a real opportunity for creative thinking.

Final thoughts

The toy ball may look like a cheap child's toy but has a really creative role to play in helping children with their understanding. Consider also using it to teach

children that if a small amount of electricity can pass around the class holding hands, then high voltages are a real danger, and how we have to be careful with plugs, switches and wet hands and so on.

Perhaps these ideas may help demystify the wonder of electricity.

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