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simple circuits for special needs children

Francine, Billy, John, Paul and Michael try out their electricity game

Joyce Porter

INVESTIGATES HOW PRACTICAL TEACHING APPROACHES AND RESOURCES CAN MAKE A DIFFERENCE

Although science in the primary school is recognised as one of the most exciting parts of children's and teachers' work (Harlen, 1997), until recently little attention has been focused on the role science can play in the education of children with special educational needs. The ASE has now put forward a plan of action to support teachers working with special needs children (Sandford Smith, 1999). The ASE policy statement, *Access to science education: policy* (ASE, 1997), recognises that *'pupils arrive at science lessons with different levels of physical, sensory, cognitive and emotional development'*. Children with special needs can be isolated by problems in these areas, so it is important to choose an appropriate range of teaching and learning activities which not only makes science accessible to these children but also motivates and stimulates their learning.

This article describes a unit of work on electrical circuits which was carried out over a term with a group of ten 11-year-old children with moderate learning difficulties in a special primary support centre in Merseyside. The children had limited literacy and numeracy skills and some had difficulty communicating verbally. With the help of their class teacher and the learning support assistant, I wanted to find out to what extent the practical teaching

approaches and the curriculum resources chosen stimulated the children and developed their short- and long-term learning of this topic.

Classroom activities

Making and drawing simple circuits

In the first session, we provided the children with batteries, bulbs and wires, organised them into pairs and invited them to make a simple circuit. We encouraged the children to join the components together and observe the result. Important vocabulary was introduced, such as 'battery', 'bulb' and 'circuit', and ideas about circuits were discussed with the class. The children seemed to grasp the idea of a complete circuit being necessary to make the bulb work:

T: *What happened when the wire was not connected to the battery?*
C1: *The bulb won't light.*
T: *Does anyone know why?*
C2: *It doesn't get any electricity.*
T: *Why?*
C2: *The wire is not fixed to the battery.*

In the second session, the teacher introduced the symbols used in drawing circuits and drew a simple circuit on the board. The children repeated the practical work and some were invited to draw their circuits on the board. We gave praise to those who drew the circuits correctly and we encouraged the others to try again. The importance of drawing the connections at the bottom of the bulb was emphasised.

The role of the battery

In the third session the role of the battery was explored:

T: *What does the battery provide to the circuit?*
C1: *Electricity.*
C2: *Energy.*
T: *What happens when the battery runs out?*
C3: *The bulb goes out because there's no energy left.*

The function of the battery was reinforced by playing a game. One child was the battery and a second child was the bulb. The other children carried packets of energy ('e's) from the battery to the bulb in a circle. The bulb did not light until a packet of energy had been delivered. When the energy had been delivered, each child returned to the battery for another packet. When all the packets had been used up, the bulb went out. The remainder of the lesson was spent constructing a switch and putting this in the circuit:

T: *What happens if the switch is open?*
C4: *The bulb doesn't light because there's no energy in the wire.*

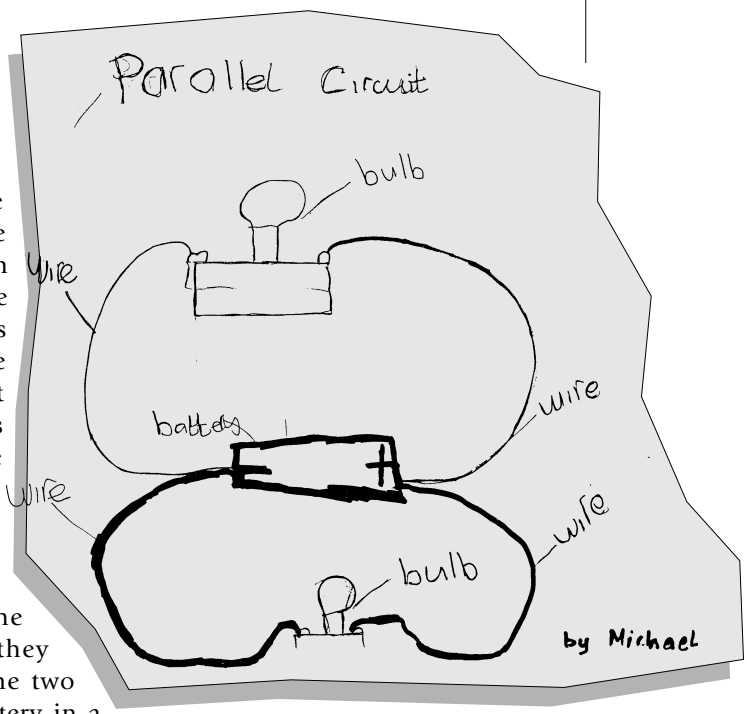
Series and parallel circuits

In the fourth session the children explored the effect of adding additional bulbs to the circuit. The series circuit was made by all the children. The teacher drew it on the board and the word 'series' was discussed. The children saw that the bulbs in this circuit were dimmer than in the simple circuit.

In the next session, the teacher asked the class to see if they could join up the two bulbs to the battery in a different way. Some of the children found this very difficult but four of the class were able to do it. The teacher then pointed out the shape of the circuit. She drew it on the board as a parallel circuit and as a figure-of-eight. The children found it much easier to remember the figure-of-eight. All the class were now able to build the circuit, some with help, and most were able to draw the parallel circuit as a figure of eight. They were able to see that the bulbs were as bright as in the simple circuit.

Reinforcement

In the remaining eight sessions, we spent the first ten minutes revisiting the ideas that the children had already experienced. We questioned them about the concepts underpinning the construction of circuits and each child was invited to draw circuits on the board. In the main body of the sessions, the children constructed models which used the electrical circuits: robots, a house, a car with headlights, a drawbridge on a castle, owls and a power station. Also, I worked with pairs of children using the CD-ROM *Science Explorer I*, which has a good section on series and parallel circuits. The CD-ROM was very effective in demonstrating to the children how much quicker the battery was used up in a parallel circuit with four bulbs than in a series circuit with four bulbs.



Industrial visit

I arranged a visit to the Fiddlers Ferry Power Station at Warrington so that the children could find out how electricity is made for homes and factories, and to show them that it does not come from batteries. At the visitors' centre, a model of how electricity is generated at a coal-fired power

Helen showing her model house with electricity to Vicky and Suzanne

station was demonstrated. Steam from a kettle made a turbine go round quickly. This pushed a magnet in and out of a copper coil and the meter moved, showing electricity had been produced. The visitors' centre is well equipped and the children were able to make bulbs light using pedal-power. Next, the children were taken on a tour of the site, shown the vast stocks of coal, how it is powdered and taken to the boilers. They were given a tour of the operations room and, fitted with the appropriate safety equipment, visited the power hall and felt the power of the generator vibrating.

Assessing learning

I tested the children on their ability to construct and draw circuits at the end of the unit and again four months later to find out whether they had retained the knowledge (Table 1). They made the circuits first and used these to help them draw the diagrams. Most of the children could make series and parallel circuits at the end of the unit, and several months later. Most were able to draw the corresponding circuits, although, after the four month gap, several needed to be prompted about the names of the circuits. The answers to the questions I posed showed they had retained a reasonable understanding of electrical circuits.

Evaluation

The children enjoyed the practical work on circuits and most of them were able to build the circuits successfully. Some of the connections were difficult to make, especially for the models. The construction of the models helped the children to improve their manipulative skills. In the series circuits, the bulbs did not show the same brightness – a common problem (Nott and Wellington, 1995) – but the CD-ROM version fortunately did!

We provided differentiation by giving the children with greater learning difficulties more support in the practical work and by encouraging them to make less-demanding models. We encouraged all the children to contribute verbally to the lesson by asking them questions; we asked for volunteers to draw circuits on the board and make displays for the classroom walls.

The teaching and learning approaches adopted appeared to be successful in helping these children, *'whose senses work well enough but who have difficulty learning and remembering'* (Jones, 1993), retain the information needed to construct and draw circuits.

The language relevant to electrical circuits is difficult for these children; we encouraged and reinforced continually the use of words such as 'circuit', 'series' and 'parallel'. We used the analogies often used with more

Table 1 **Results of tests of children's ability to construct and draw circuits: A at the end of the teaching unit, and B four months later**

Child	Make simple circuit		Draw simple circuit		Function of a switch		Make series circuit		Draw series circuit		Make parallel circuit		Draw parallel circuit	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
C1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓P	✓	✓
C2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
C3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓P	✓	✓P	✓	✓
C4	✓	✓	✓	✓	✓	✓	✓	✓	✓H	✗	✓	✓P	✓	✗
C5	✓	✓	✓	✓	✓	✓	✓	✓P	✓	✓	✓	✓	✓	✓H
C6	✓	✓	✓	✓	✓	✓	✓	✓P	✓	✓	✓	✓P	✓	✓
C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
C8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓P	✓	✓
C9	✓	✓	✓	✓	✓	✓	✓	✗	✓H	✗	✓H	✗	✗	✗
C10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓P	✓	✓

H: help given P: prompt given with name ✓: can do ✗ : cannot do

able children, such as motor racing circuits, the relation to a circle, a series of books or episodes of a serial on television, parallel lines as railway lines. However, these analogies had limited success.

The industrial visit provided an added dimension. It enabled the children to experience the vastness of the power station, to see the small number of people who work there and the large number of computers and wear the safety equipment. Some of the children could remember the basics of the process as demonstrated by the kettle model, after some weeks:

The kettle has boiled and the steam is making the turbine go round and is pushing the magnet in and out of the copper coil.

A large display about the power station, and the models made by the children, exhibited in the school entrance and at a science fair alongside displays from mainstream primary schools, showed the children that their work was valued. The fair was visited by over 500 children and parents. The children benefited greatly from taking part in the science fair. They were able to demonstrate their working models and explain how the circuits worked to children, teachers and parents. They gained self-esteem by demonstrating their practical skills and by talking about the science they had done.

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