MISCONCEPTIONS

Misconceptions are evident in the oral and written work of pupils working at level 6+, GCSE and A level. Indeed as science professionals we should be able to recognise that we too have our own misconceptions! The Qualifications and Curriculum Authority (QCA) uses the evaluation of the National Curriculum Tests carried out by the National Assessment Agency (NAA) to produce posters and presentations which highlight the key implications for teaching and learning (available at www.qca.org.uk/itl). This careful scrutiny of a representative sample of pupils' scripts from the tests indicates that one factor preventing pupils achieving level 6 or better includes the holding of fundamental scientific misunderstandings. For example, in 2006 pupils demonstrated misunderstandings of geological processes and inheritance.

Misunderstandings identified by QCA

In 2006 some pupils had the following misunderstandings with regard to geological and inheritance processes:

- rocks were made with a particular purpose in mind;
- sedimentary rocks are resistant to acid rain;
- rocks that neutralise acid rain will not be weathered;
- oxygen or air plays a part in rock formation;
- size of crystals depends on the amount/shape of space available;
- the child has DNA from both parents so can have features from both sides;
- genes will mix so the child will have some looks the same but not all as genes from both parents are mixed;
- their genes mix so they have differences the dominant gene takes over;
- genes from both parents were fused together in fertilisation so the child can never look identical to one parent because it has genes from both;
- they may inherit what they look like from their ancestors depending on the dominant gene;
- because the child's genes are mixed;
- each egg has different parts of the body the baby would look like but they cannot all be the same.

The Assessing Progress in Science units have activities and guidance that help teachers identify pupils' misunderstandings and misconceptions.

It is important that subject leaders, and therefore teachers within the department, recognise that pupils come to lessons with ideas about the world around them which can often be different to the accepted scientific ideas. It is also important that both teachers and pupils gain some understanding of what these misconceptions are and how they might arise whilst recognising that some scientific explanations can be counter-intuitive.

The word misconception will be used throughout the session and can be taken to mean misunderstandings, 'alternative frameworks' or 'alternative conceptions'. Misconceptions are views held by pupils (and adults) that do not fully coincide with the scientific view. They may be social (held by a large proportion of the population) or personal and are developed from everyday talk and experiences.

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Misconceptions are evident in the oral and written work of pupils working at level 5+ and level 6+. It can be one of the factors preventing pupils making progress. These misconceptions persist into Key Stage 4 and Key Stage 5 with examiners' reports highlighting a number of them year on year. For example in 2006:

- nucleus in a blood cell is used to store food;
- the image forms on the cornea; * a scab is responsible for growing new skin;
- capillaries move nearer to the surface of the skin to cool the body;
- infrared light is responsible for a tan;
- organic is taken to mean 'natural' and not understood in its chemistry context;
- magnetism is thought to be involved in chemical bonds;
- heat rather than hot air is thought to rise.

The everyday use of language could be either specific vocabulary or expressions that are used. This could include words like material, reflection, weight, plastic, pure, force, matter, table and cell which have specific scientific meanings that are different to those used in everyday life.
For example, phrases like:

'He's glaring at me' or 'she's looking right through me' could suggest that light comes from the eye

'Close the door you are letting the cold in' could suggest that cold is an entity

'Birds and animals' which implies birds aren't animals and that often animals are taken to be mammals (except humans)

'I've run out of energy' could suggest that energy gets used up.

Many ideas that pupils hold about the world around them come from sensory experience. They construct a framework from these events that is coherent and fits their experiences but may be very different from the scientific view. The scientific explanation can then seem counter-intuitive. For example, electricity is used or up or heavy things fall faster.

It is worth recognising that in many cases pupils can hold both the 'misconception' and the scientific idea at the same time and may use different ways of explaining events in different situations. However, it is rare for pupils (and adults) to be explicitly aware that they are doing this. Even when presented with new evidence the existing ideas may be resistant to change and pupils may modify the evidence to fit into the existing model, e.g. having demonstrated to pupils that current is not used up in a circuit, their response, a few weeks later, was to say that the ammeters were not working properly!

It is common for people to think that electricity starts at the battery/power pack and goes to each component in turn like a lorry delivering goods. It is then easy to see that by the end of its journey there will be fewer or no goods left on the lorry – hence less or no electricity for the last bulb! This misconception could well arise because of the analogies or models used to explain circuits where the strengths and weaknesses of the model are not made explicit to pupils.

Sometimes pupils have made a series circuit previously using bulbs that look similar butare in fact different voltages. Indeed, the small bulbs used to make circuits can show differences in brightness, even though the voltages are the same, because they are so cheaply produced. This experience can reinforce the idea that one bulb 'gets most of the electricity'.

The concepts of 'current', 'electricity', 'energy' and 'voltage' are often used interchangeably and it is thought that all can be stored, consumed and have movement.

Pupils (and teachers) need to have a clear understanding of, and be able to differentiate between, current, electricity, energy and voltage in order to understand a system where energy transfer depends on current, time and potential difference of the battery. Early in lessons on electricity pupils are introduced to the notion of current flowing so that when voltage is introduced it is seen as flowing the same way as current. Some research suggests introducing voltage as a property of a battery, a precondition for current to flow, and as being present even when there is no current flowing.

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