Letters

Ethics and science education

■ The December 2004 issue of *SSR* raised many interesting issues. Space only permits me to take up those raised by two of the contributions, Eric Hall's and Jerry Wellington's. Eric Hall (*SSR*, **86**(315), 25–28) claims that there are those who seek to suggest that science can be a source of moral values without a single reference. I am not aware of any authors who claim this to be so. Rather science is a social practice and, therefore, must operate internally with a set of values – what Hall chooses to call '*methodological rules*'.

Hall's attempt to argue that these are not values is simply not acceptable, for what are methodological rules if not the values that the community chooses to abide by when faced with making decisions for which there is no empirical base? And, likewise, if 'honesty' and 'integrity' are not two of the fundamental values of the social contract that we all hold in general as members of society and, in particular, as members of a scientific community, then what are they? Why else would Rom Harré, one of the most outstanding English philosophers of his generation, write that '*the scientific community must be seen as a moral order, a body whose internal structure is based on a network of trust and faith*' such that '*when one enters the community, one commits oneself to its fiduciary act*' accepting the values of the community. Likewise, Occam's Razor – the belief that when confronted with two competing explanations we pick the simplest – is simply a value that the community holds dear. There is no objective evidence for it.

More fundamentally, Eric Hall's belief in the objective nature of scientific knowledge is too a value that has been contested ever since Bishop Berkeley introduced his solipsistic notions about human thought. And, if this is not enough, contemporary scholarship has shown that the development of biological ideas is riddled with theories that were a product of the cultural values people held rather than the 'facts' they observed. This is not to argue that it is impossible to distinguish between facts and values as Jerry Wellington (*SSR*, **86**(315), 33–38) would suggest – rather that there are many instances where the distinction cannot be so easily made. So the idea that the acceleration due to gravity is 9.81 m s^{-2} is a piece of consensually agreed knowledge that most would accept is relatively value free (although not totally value free – see for instance, Hilary Putnam (2002), a leading philosopher on the collapse of the fact–value distinction).

The consequence is two-fold. First, as much as Eric Hall would like to, it is impossible to keep values totally out of science. Even if we were to attempt to maintain a hermetic seal between science and its applications, the issue of the internal values of science will arise at some stage in the classroom. More seriously, though, who can seriously imagine teaching about reproduction/genetic modification or energy use without discussing the moral and ethical values that such issues raise? Moreover, to deny pupils any opportunity to explore such issues in the context in which they are raised is to make school science look odd, if not absurd. Why? Because in everyday life, the exploration of such issues is part of common discourse. To exile the moral and ethical dilemmas raised by the application of science as themes to be addressed in citizenship or RE seems simply perverse to most students. In short, as much as the world would be a simpler and easier place if the science classroom never raised issues of values, try as hard as you can, such issues will inevitably seep in. Rather than muddle through in a confused manner, isn't it better that as a community we learn how to address such issues with clear goals and an effective pedagogy – something that many of the articles in this issue were attempting to do.

The second point with which I take issue with Eric Hall is that he is wrong to think that there is any argument that pupils' views should be a determinant of the science curriculum. Rather, we have to face that, for the vast majority of school pupils across the globe, there is a problem with school science. Why else do the numbers studying it voluntarily continue to decline, evoking political panic in governments? Confronted with such a problem, surely it makes sense to ask those who experience it daily what is unappealing and at least consider their views in its reformulation? That is all I would argue.

Finally, Hall also demonstrates a confusion that has existed ever since the days of Nuffield between learning science and doing science. The two are not one and the same thing. To offer pupils the experience of being a 'novice scientist' would require teachers to permit pupils to (a) determine the question they wished to investigate; (b) choose the methods and data to collect to determine their own answer; and (c) submit their results to their peer community for adjudication. The reality is that nearly all school practical work requires teachers carefully to constrain the first and second of these, and the outcomes, the third of these, are judged solely by the teacher. Moreover, there is considerable evidence that the kind of experience that Hall would have offered to pupils leaves them with naive ideas about the nature of science, unable even to evaluate critically newspaper articles about science. Arguments for teaching 'about science' explicitly have simply been an argument to redress the balance in science curricula. Just as you can't teach process without content so you can't teach about science without some well-defined content – content that the society considers is worth knowing. Hence, the *21st Century Science* course, for example, has two major components: science explanations – the 'facts' of science – and a set of 'ideas-about-science'.

As somebody who has constantly espoused the value of argument as a means of clarifying our thinking, Hall's article has the value of articulating commonly held views. I hope this response demonstrates why I believe them to be erroneous.

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Reference

Putnam, H. (2002) *The collapse of the fact/value dichotomy and other essays*. Cambridge, MA: Harvard University Press.

Einstein Year

■ As we celebrate the 100th anniversary of Einstein's first papers, *SSR* readers may be interested in the following response published in the *Guardian* newspaper's 'Notes and Queries' section (11 January 2001) resulting from my submission of the question:

Albert Einstein received a Nobel prize for his 1905 explanation of the photoelectric effect but no such recognition for his work on special and general relativity, the theories on which his fame is now based. Why not?

'Einstein was nominated for the Nobel prize in physics every year from 1910 to 1922 except for 1911 and 1915. In most cases he was nominated for his work on both special and general relativity. Historians of science have given two reasons why Einstein never received the prize for this. First, these theories were so revolutionary that the scientists on the awarding committee didn't understand them well enough to pass judgement and were concerned that not all his predictions had been experimentally verified. Second, it is said that certain anti-Semitic members of the Swedish Academy of Sciences awarding committee were influenced by the lobbying of the German physicist Philipp Lenard, who later became a Nazi. He claimed that relativity was a counterintuitive, non-Aryan and Jewish theory.

'However, the spectacular confirmation of Einstein's general theory in 1919, when light from distant stars was shown to be deflected by the gravitational influence of the Sun, made him the first scientific superstar and the Swedish Academy could no longer ignore him. His 1922 Nobel prize citation read: *"For his services to theoretical physics and especially for his discovery of the law of the photoelectric effect"*. The letter to Einstein from the Secretary of the Academy added, *"but without taking into account the value which will be accorded your relativity and gravitation theories after these are confirmed in the future"*. Einstein was awarded the prize for his quantum theory explanation of the photoelectric effect, published in 1905. The irony is that this phenomenon was discovered by Lenard, for which he was awarded the 1905 Nobel physics prize. Lenard's virulent anti-Semitism prevented him from ever accepting Einstein's quantum explanation for the effect.'

Pete Severs
Sheffield

Teaching relativity

■ I would like to add a clarification or caveat to my Science Note 'Teaching relativity to 10-year-olds' in the March 2005 issue (*SSR*, **86**(316), 34–35). Readers may realise that the activity, in which photons bouncing off a clock are observed, is essentially a simple Doppler shift model and does not quantitatively model time dilation. However, if the suggested teacher prompts are used to describe qualitatively how the role play pertains to fast space travel and black holes, then 10-year-olds should not be led astray! Furthermore, with an older group of pupils the activity might lead on to a discussion of how classical Doppler theory fails adequately to explain relativistic time dilation (for example, if the teacher walked in the opposite direction, the moving clock would appear to run fast).

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Using interactive whiteboards

■ I read with interest the article published by Gary Beauchamp and John Parkinson entitled 'Beyond the 'wow' factor: developing interactivity with the interactive whiteboard' (*SSR*, **86**(316), 97–103). As a science teacher who firmly believes that ICT, when embedded into our practice, enriches our pupils' learning, I would take this opportunity to discuss further some points that the authors raise. The article's purpose was '*to raise the issue of how teachers can maintain motivation through the use of the IWB [interactive whiteboard] by increasing pupils' engagement with learning*'. However, I suggest that, almost without exception, the authors' examples can be achieved by either projecting an image from a data-projector on to a normal whiteboard or using a wireless mouse and keyboard (at a considerably reduced price).

Examples of the advantages of projection on to IWBs provided are '*annotation capability and the ability to move freely and easily between flipchart pages revealing an infinite range of pre-prepared resources ... and the direct use of the Internet*'. If we consider these points in turn we will see that they can be achieved without using an IWB. Resources (e.g. photographic images) that have been inserted into MS *PowerPoint* (or a similar program) can be surrounded by a light-coloured background and projected on to a normal whiteboard. Teachers or pupils can then annotate the surrounding light part of the image using a normal whiteboard pen. Brainstorming or mindmaps can be effectively created in this way. Also, contrary to the authors' suggestions, the ability to move freely between pre-prepared resources and direct use of the Internet can both be achieved without an IWB.

The authors further state that IWBs can be used to allow students to 'drag and drop' matching or sequencing activities and brainstorm text. This can be achieved by using a wireless mouse and keyboard respectively. The authors do mention the use of wireless technology, in that '*[it enables] the teacher to work from the body of the class rather than the front of it*'. They do not extend this point to suggest that it can be used equally as interactively as an IWB to promote pupils' learning. The only advantage that IWBs seem to have in this regard is the manipulation of the resources from the front of the class.

The authors also mention a number of further advantages that come from developing interactivity using the IWB: '*use of a digital camera*', the ability to '*portray strong images and rich information sources*' and also to '*display work undertaken on other computers*'. Again, all of these can be achieved by simply using a data-projector without an IWB. When the monetary difference between IWBs and wireless mice and keyboards is around £1000, this is surely a point worth further consideration.

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Myths roll on – not quite as it seems!

■ I was shocked to see *Chemistry for you* quoted as an example of a school chemistry textbook that perpetuates the idea that you can calculate the percentage of oxygen in the air using a candle, beaker and trough of water. As author of the book, I was fully aware of the debates about the experiment and the arguments as to why the experiment cannot be used for this purpose.

On reading the letter 'Myths roll on' from John A. Barker in the March 2005 issue (*SSR*, **86**(316), 17–18), I was sent scurrying for my version of the original 1996 edition of the text to check that I had not in fact encouraged the misconception referred to in the article.

I was relieved to find that Experiment 22.1 on page 274 makes no claims that the activity will allow the pupil to work out the percentage of oxygen in the air. It does ask pupils to explain their observations as the night-light goes out but does not ask pupils to make any measurements that could lead to erroneous calculations. The text does ask what is produced in the combustion of a hydrocarbon such as wax (page reference provided). This is aimed at highlighting the fact that one of the products is carbon dioxide, that is another gas, which is produced as oxygen gas is being used up in the combustion. This stimulates pupils to challenge a simplistic explanation, such as '*The flame goes out because all the oxygen is used up*', and shows that there is no point making quantitative conclusions about the percentage of oxygen in the air from this experiment.

This is one of my favourite demonstrations, asking pupils to observe very carefully what happens as the beaker covers a night-light floating in a trough of water. Some pupils notice bubbles escaping at first from the beaker – as the gas inside warms up and expands. Then there is the difficulty in deciding exactly when the flame is extinguished. As the proportion of oxygen decreases in the beaker, there will also probably be some carbon monoxide – another gas – produced by incomplete combustion. Not surprisingly, the evidence mounts as to why this experiment can't be used to calculate the percentage of oxygen in air (great for practising balanced equations though).

Other points that come out in discussion involve the solubility of carbon dioxide in water, as well as its high density – which could cause the gas to accumulate at the bottom of the beaker, extinguishing the flame and hence leaving unreacted oxygen in the upturned beaker. Then there is the volume occupied by the candle to consider.

As an exercise in evaluation it can't be beaten – but to actually work out the percentage of oxygen in the air – certainly not! Why not try Experiment 22.3 '*How much oxygen?*' at the bottom of page 274?

Lawrie Ryan
Author of 'Chemistry for you'

Reply from John A. Barker

■ I am sorry that Lawrie Ryan feels aggrieved that I have misinterpreted the intentions in his book *Chemistry for you*.

He refers to the investigation of burning a night-light floating in a trough of water and under a beaker. I accept that if the three investigations on that page are taken together there is a valid progression towards discovering the amount of oxygen in the air. Taken all together, I have plainly been too negative about his procedure. However, if only the first investigation is considered, explaining why the level of the water rises, the answer to the question '*Explain why this happens*' will surely be that all the oxygen has been used up.

I am sure that when he teaches this topic pupils will understand completely the correct situation. I am interested in his comment that when he carries out the procedure some pupils observe that bubbles of gas escape from under the beaker when it is placed over the night-light, due to expansion of the air. I have carried out this operation as a class practical many times with postgraduate science trainee teachers and it is only once in a blue moon that one of them makes that observation. I suspect that they have been so firmly indoctrinated into the 'correct' answer that they see nothing!

John A. Barker

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