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Are science teachers using experiments as props in lessons?

Pupils generally enjoy carrying out experiments - but do teachers overuse them when they should in fact be teaching more theory, asks **Alom Shaha**

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Tuesday 21 June 2011 11.42 BST

Remember burning magnesium in school? Doing this for the first time as an 11-year-old who has just started secondary school is one of those magical experiences that all students should have. But I'm not convinced that the same is true of all practical work carried out in school science lessons.

Practical lessons are popular with both students and teachers. But their popularity with students may lie in the fact that they are less demanding than theory lessons. The same may be true for teachers - after all, it's easier to check that a child has lit his or her bunsen correctly than it is to check that he or she has fully grasped the particle theory of matter, it's easier to teach a child how to connect an ammeter than teach a correct understanding of electric current. Indeed, a study of student teachers reported in this month's School Science Review found that "most were approaching it as a means of lower order learning objectives such as names of equipment and use of standard procedures".

Many standard school science practicals purport to be experiments when they are nothing of the sort. What we are doing a lot of the time, for example when asking them to "investigate the factors that affect the resistance of a wire", is getting students to carry out practical work with the intention that they discover something which is already known. This approach was described as "intellectually dishonest" by Rosalind Driver in her important essay, The Fallacy of Induction. It is naive and pedagogically unsound to think that all we need to do as science teachers is provide children the opportunity to discover the laws of science for themselves. As Driver wrote, "explanations do not spring clearly or uniquely from data". Yet this approach to practical work persists, according to Professor Robin Millar, due to "the prevalence of the empiricist/inductive view of science... the belief that ideas will 'emerge' automatically from the event itself, if students work carefully enough". As Millar, who has carried out extensive research into what students learn from practical work, points out, "in practice this rarely happens".

I have a simple suggestion to make: perhaps the time we spend doing such experiments could be better spent? Perhaps our students would learn more if we approached doing these practicals in a different way, stopping the pretence that they are doing real science and using the practical to draw out specific teaching points about, say, the limitations of laboratory measurements. Perhaps some practicals would be better done as class demonstrations so that we can spend more time discussing the results and less time

faffing around with apparatus. Millar and others suggest that one of the most valuable things we can do in a practical lesson is to talk about the practical and yet their research shows that this doesn't happen nearly as much as it should.

It is not unreasonable to assume that doing science might be a pretty good way of learning science. But, as my old PGCE physics tutor, Professor Jonathan Osborne, points out, this is a "dangerous assumption". According to Osborne, the role of science education is "to construct in the young student a deep understanding of a body of existing knowledge. In doing so, it needs to show why this knowledge is valued; that it was hard won; and that science is a creative process - that it offers you the opportunity to free yourself from the shackles of received wisdom by creating your own knowledge. However, that is not the same as the doing of science and there is a clear line in the sand that needs to be drawn between the two activities".

Despite the views of Osborne and other senior figures in science education, many people see practical work as an innate part of science education and feel it needs no further justification. Every so often, the media seems to report a decline in the amount of practical work we do in science lessons and there is the suggestion that we ought to be doing more practical work, that somehow, if we could do more experiments we would radically improve the quality of science teaching in this country. These reports seem to ignore the fact that students in the UK spend more time on practicals than their peers in other countries and that "there is limited evidence that practical work actually motivates students, rather than alleviating their boredom with 'theory' by providing a break from listening and writing". Words like "motivation" and "enthuse" are put forward in defence of practical work yet when students were asked to choose the methods that were "most useful and effective in helping them to understand school science" the top two approaches were "having a discussion/debate in class" and "taking notes from the teacher".

Science education in the UK faces a number of challenges, not least of which is the drastic shortage of physics teachers. Those with the power to bring about change would do well to acknowledge the complexity of the situation rather than put forward "more practical work" as some sort of panacea. Energy and resources should be focussed on improving the quality of practical work being carried out in schools rather than simply increasing the quantity of it.

There is a large amount of research relating to the role and value of practical work in science lessons, much of which has been summarised in a review by Professor Justin Dillon of King's College London. Dillon makes a crucial point that is worth repeating here: "there is a danger that the rhetoric surrounding 'practical work' neglects important findings from research and ignores the complexity of several key issues relating to the teaching of science in schools". It would be painfully ironic if we were to allow policy decisions about how to teach science to be made without properly considering the available evidence.

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