GOODBYE SCHOOL SCIENCE EXPERIMENTS?

Feedback, September 2011

Thank you to everyone who responded to Keith Taber's *Endpoint* in issue 4 (http://bit.ly/j0m8JX).

We received detailed letters from Neil Barker at Leggott College, Wendy Pitt at The King's School, Ely and Pauline Winn at Loretto College, which are printed here in full. You are welcome to continue the debate on **Talk Chemistry** (http://bit.ly/pAvIR3 – free registration required).

I was interested to read Keith Taber's views on 'school science experiments' in *Endpoint* in the June 2011 edition of *Education in Chemistry*.

I agree that practical work has a limited effect on the motivation of students and that it is often difficult to demonstrate key ideas in practical work. Students are often so fully occupied by trying to follow instructions and manipulate equipment that they have little space left in their minds for interpretation and linking to theory.

Keith points out that teacher demonstration may be a better route to success in these areas. He goes on to make a case for authentic enquiry with extended periods of work to allow students to design, critique and refine experimental approaches. While I have sympathy for such a high ideal, I have some concerns.

Before a student can engage with practical work at a high level there needs to be some training in observation and measurement. Although observation seems a simple skill it is clear from my recent experience with A-level chemistry practical assessments that this is far from the truth.

Students need to see for themselves what substances do at close hand. They need to acquire the language of science and link it to experience eg they need to be able to distinguish the a few bubbles of trapped air from the production of gas in a reaction. They need to be able to use the word precipitate and distinguish it from the insolubility of a pre-existing solid.

There is also the matter of when to take practical work very slowly in order to see subtle changes and when things can move along with more pace to get through a body of work in the time available.

I do not think that it can all basic practical work can be done by demonstration. Indeed if someone was attempting to teach me in such a way I would be thinking 'when are they going to let me have a go!'. This is to say nothing of measurement which requires a lot of training, practice and repetition to get right.

Without time taken on these fundamentals, it is impossible to go on to 'authentic enquiry'. Indeed it may be argued that at GCSE and even A level the students do not have enough experience to make such an enquiry worthwhile. Perhaps they would benefit most from understanding, at first hand, that there is no science without careful observation and measurement.

Neil Barker, *John Leggott College*

I feel I must respond to Keith Taber's *Goodbye school science experiments?* in the June 2011 issue of *EiC* which provided stimulating reading.

It was, however, disappointing to note the absence of any reference to Score or the ASE's *Getting Practical*, perhaps the most recent works on this topic. There is also no mention of the different learning styles, VAK [visual, auditory and kinaesthetic], which teachers acknowledge to be important in planning activities for learning and of which one is practical in nature.

I wonder what Keith's reaction would be to the all too often question from sixth formers on entering my chemistry laboratory: 'Are we getting the Bunsen's out today, miss?'. This speaks volumes of the paucity of science practical work carried out in High Schools.

The reality is that many of my students do not recognise simple pieces of apparatus or techniques and are certainly not skilled in taking accurate measurements or careful observations, all of which are required in the practical assessment at A-level and then at university. In two years I have to teach them all this as well as a body of chemical knowledge in order to equip them with the skills needed for progression.

I agree that real science does not usually equate with school science and that it would be wonderful to have the time to allow pupils to do real science in school. However, it is not the case that practical work in schools or colleges is only valid if it emulates how science works.

There are many different views on the purpose of practical work and, indeed, a consensus on purpose is lacking, but Keith only seems to consider one kind of purpose. There are all kinds of activities which require students to solve a problem, find a numerical answer through quantitative analysis or to experience new phenomena first hand and ask questions about how and why.

His suggestion that demonstrations should replace pupil practical work is absolutely fine if all we want is for pupils to pass examinations and have an intellectual relationship with science. But, given that our country will still presumably need some wet chemists amidst all the instrumentation and computerisation of the subject, who is going to do the important synthetic and analytical laboratory work if school pupils never get their hands dirty in a school laboratory? Who will make accurate measurements for drugs and engineering, if pupils never take readings?

Objections on the grounds of cost and safety are valid but not unique to science practical lessons. The way in which science practical work is organised can leave a lot to be desired but practical lessons can be managed effectively such that pupils do not spend ages washing up or setting up and that technical help is deployed appropriately. Streamlined efficiency is great and should be encouraged.

I have taught in the third world where practical resources were scarce; carrying out practicals hugely improved pupil understanding. A well planned practical lesson will engage students' minds as well as their hands and both will be active. Science educators are encouraged to plan for this.

At all costs we must avoid having scientists who are homogeneously theoretical. Ideally theory and practical go hand in hand; sometimes one leads and sometimes the other. We cannot and should not exclude pupil practical work. It is, when done properly, largely about learning. Demonstrations are more about teaching.

I want my students to become responsible learners and I consider one of the best ways they can do this is through practical work.

Pauline Winn, *Loreto College, Manchester*

I read with interest, Keith Taber's *Endpoint* in the June 2011 issue of *EiC* with the title *Goodbye school science experiments?* The title certainly made me uneasy as did a few of the statements that followed. The piece made many valid points and some, perhaps, controversial ones too so I suspect it provoked discussion amongst many science teachers.

Accurate terminology

Keith's statement that 'the notion that school science should be organised around a series of experiments has been eroded, and perhaps it is now time to recognise that they have little to offer in modern teaching' made me sit up. How can anyone pass on the excitement and joy of chemistry without the experiments? I read on. I had misunderstood, falling into the colloquial use of the term experiment, erroneously seeing it to be synonymous with science practical work. Yes Keith, I will certainly take time to ensure that my students learn the difference so that the question, 'Are we going to do an experiment?' will most likely in future be gently corrected with 'No, but we will be doing some practical work'.

But, does a series of experiments have little to offer in modern teaching? My unease is back. Surely it is important that our students learn 'the scientific method' and they do so with practical work accompanying the theory? ....some of which should involve leading the student through a series of experiments and guide them logically towards an appropriate end?

Teaching scientific method

I must admit my relief by the end of the article. Keith is right that if we wish to use practical work to teach scientific method, it must be allocated an appropriate amount of time and should be based on authentic enquiry. Students must learn first how to handle the apparatus correctly, observe and record etc. This is surely best done through demonstration followed by hands on experience. Only then can true experiments be performed.

I continued on to Keith's final lines. Yes, 'working over extended periods to allow students to design, critique, and refine experimental method, by doing a real experiment in school science' is the way.

By the end of this thought provoking article I was nodding, almost in complete agreement. I don't actually care if, by some, practical work is seen as gimmicky or to avoid boredom of theory. I just know that my students' enjoyment and understanding are enhanced by it and that in the real world practical skills are very valuable.

Real science is a practical subject. If we are to prepare our students for science based careers, surely they need hands on experience? Demonstrations have a part to play in that the students can see how to manipulate the equipment before doing so for themselves.

Congratulations Keith for making us think about what we are doing and why.

When I saw Keith's more controversial comments, 'School science practical work, involving acids, high voltages and animals sacrificed in the name of education..?' and 'makes science an expensive curriculum subject', I could not suppose that people really believe that this is what we do in the school laboratory? It is money well spent if it helps our students to not only understand but to also enjoy the subject.

A final comment, 'raises serious safety issues...' surely this is why our science teachers must be well trained and must pass onto their students the correct methods of assessing risks and ensuring a safe environment. Dare you lift the bonnet of your

car for fear of the battery? Be careful with the vinegar! I must check the biology labs. I do not recall a sacrificial altar.

I also read Keith's review of Ian Abrahams's *Practical Work In Secondary Science; A Minds-On Approach* (http://bit.ly/l4Ejhn). My initial unease abated when I re-read Keith's final lines in his both his review and *Endpoint*: 'None of this is a reason to abandon practical work, but the teacher who reads this book might well decide it could be more judiciously used' and 'the need to work over extended periods to allow students to design, critique and refine experimental approaches. Only then will they get a feel for the experimental method, by doing a real experiment in school science.'

Wendy Pitt, *King's School, Ely*