Practical work I

Michael J. Reiss, Special Issue Editor

Practical work lies at the heart of school science yet the precise purposes of practical work and how best to assess it remain controversial. Now is a particularly appropriate time for a special issue of *School Science Review* on practical work as major changes are being introduced into how it is assessed in those countries that use GCSE (General Certificate of Secondary Education) and A-level (General Certificate of Education Advanced) examinations for 14- to 16-year-olds and 16- to 18-year-olds respectively.

The articles are spread over two *School Science Review* issues: June 2015 and September 2015. This issue begins with an article by Jonathan Osborne, who argues that the role of practical work in science is overemphasised and misunderstood, and he goes so far as to state that science is distinguished not by empirical enquiry but by the fact that it is a set of ideas about the material world. Osborne maintains that the lack of clarity around the role of practical work in science means that it is often poorly used and that, until its role is clarified, attempts to assess it are of little value.

Rachael Sharpe reports on a study into students' attitudes to practical work. She shows that such attitudes differ according to students' age and the particular science discipline. The implication is that teachers should be more aware of how students' attitudes to practical work change as lessons move further away from a focus on the enjoyment of science towards one that is examination-orientated. Sharpe concludes that doing the same amount of, and adopting the same approach to, practical work is unlikely to foster positive student attitudes towards practical work in all three sciences.

Ros Roberts and Cath Reading concentrate on the new National Curriculum in England, which aims for pupils to understand traditional ideas in biology, chemistry and physics as well as to understand evidence, as specified in '*Working scientifically*'. The new curriculum also instructs that '*Working scientifically… must always be taught through and clearly related to substantive science content*'. Roberts and Reading point out that this requirement could present a challenge to meeting the aims of the curriculum and that teachers will have to plan their use of practical work carefully to overcome this challenge.

Ian Abrahams and I explore how practical skills might best be assessed in school science and introduce two terms: direct assessment of practical skills (DAPS) and indirect assessment of practical skills (IAPS). We conclude that both the direct and indirect assessment of practical skills have their place and that too great a reliance on the indirect assessment of practical skills will lead to assessment that is less valid.

Nigel English and Stella Paes explore some of the ways that examination boards have assessed practical work over the last five decades. They highlight some of the unresolved issues and describe the journey from little or no assessed practical work to narrow and very prescriptive activities.

Peter Canning argues that the recent move by Ofqual to require assessment of investigative skills through terminal examinations, as opposed to coursework or controlled assessment, represents an opportunity to re-examine the role of investigative learning in science. He reports that Pearson's work with teachers and wider stakeholders in the science community often points to a common desire to ensure that students experience science in as real a way as possible. This has often become at odds with the needs of a standardised assessment system for high-stakes assessment such as GCSEs in England. He asks what the education system as a whole needs to do to ensure that teachers can use the freedom provided by the proposed new assessment regime to improve the science learning experience.

Steve Evans and Neil Wade summarise the practical requirements for new science A-levels in biology, chemistry and physics for first teaching from September 2015. They discuss the background to how the new approach was reached and how OCR has seen this taking shape in its assessment models. They maintain that the opportunities presented by this new approach to practical assessment could add value to practical teaching and learning within schools and colleges compared with current controlled assessment regimes.

Sarah Cox notes that there is a shortage of science, technology, engineering and mathematics (STEM) professionals, with too many young people losing interest in the sciences at an early age and choosing to take alternative career paths. Concentrating on the biology curriculum, she argues that changes in science practical work could provide an opportunity to maintain student engagement with science and strengthen the STEM workforce.

Keith Taber examines what might be meant by practical work, and the different purposes we might have for laboratory activities, in teaching chemistry. He points out that one common aim for student practical work is to support the learning of chemical concepts, but both the nature of chemical ideas and the demands of undertaking laboratory work can act as barriers to effective learning. Taber analyses one common chemistry practical to illustrate why learning from student laboratory work can be challenging for students.

Stuart Farmer, William Hardie and Sally Brown examine the findings of a 2014 survey undertaken by the Learned Societies' Group on Scottish Science Education to examine the resourcing of practical science in Scottish primary and secondary schools. The survey was intended to identify barriers to conducting practical work in terms of resourcing for equipment, provision of facilities and technician support. They end their account of the rather worrying findings by asking '*So where do we go from here?*'

Beth Jones and Simon Quinnell describe how seven schools in England improved their science provision by focusing on the professional development of their science technicians. Their article reports the experiences of a project that connected secondary schools with experienced senior science technicians to design and implement action plans aimed at improving their technical service. Schools could claim up to £2,000 but it was the input of an external mentor that had the most striking impact. The outcomes were seen directly in the classroom, with teachers having more confidence and students having a more varied and high-quality practical experience.

Neil Ingram considers the potential for modern developments in ICT to facilitate attainment of the broader aims of practical science. He argues that practical science in schools is considered as a 'sacred space', integral to the development of students with a rounded and reasoned appreciation of science. Ingram presents a model of science practical work where students experience a challenging range of practical activities over their years of formal education, with students recording their observations and reflections as they go along. Integrating ICT into this process will be key to students' development as practising scientists.

It is generally accepted that students enjoy practical work in science and that it has the potential to increase their interest in lessons and in science. In the final theme article in this issue, Helen Darlington discusses an accepted psychological model of interest and then explores how interest development can be supported though practical work by focusing on a number of 'Interest Factors' that she has identified.

The articles in this June issue concentrate on issues that are key to practical work, especially as such work is undertaken in the school laboratory. The articles in the September issue look at how the quality of school practical work can be enhanced, whether by extension activities in the laboratory or by activities that can be undertaken outside of the science classroom or laboratory.

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