

Science Council Submission

House of Commons Science and Technology Committee Inquiry Practical experiments in school science lessons and science field trips inquiry

Background

The Science Council is an umbrella organisation of over 30 learned societies and professional bodies in the UK¹ drawn from across science and its applications: a list of member organisations is attached. In addition to providing a mechanism for the sector to work collectively, the Science Council develops and leads collaborative projects working with member bodies and the wider community, including the Future Morph web site that is designed to provide information for young people, their parents and teachers about careers from studying science and mathematics. The Science Council awards the professional qualification of Chartered Scientist (CSci) and is now leading an initiative which aims to raise the profile and aspirations of technician and graduate scientists by developing new professional registers at these levels. Collectively our member bodies represent more than 350,000 individual members, including scientists, teachers and senior executives in industry, academia and the public sector.

The Science Council has a keen interest in enhancing the level and quality of science education, knowledge and skills in the UK and welcomes the opportunity to contribute to this inquiry. The Science Council's strength comes from its multi-disciplinarity, enabling us to draw from the breadth of science and types of scientists in responding to complex issues in science and education.

Key Points

1. Practical work plays a key role in enhancing understanding and improving engagement
2. The practical and technical are skills integral to science and vital for science employers
3. Practical activities and field work provide a valuable real life context for multi-disciplinary learning
4. Hands on experience of science can help young people develop their career preferences
5. Enhancement and enrichment activities can help provide additional opportunities for practical work

Understanding and awareness of the breadth of science

Practical enquiry provides the opportunity to develop knowledge and understanding of key concepts in science and this is central to all teaching and learning in science. In addition to facilitating awareness of science in practice, practical experiments and field work can provide an excellent opportunity to show how biology, chemistry and physics interact, the connection to other sciences and the multidisciplinary nature of science. The major challenges facing the world, for example, food security, climate change and water scarcity will demand a multi-disciplinary approach to seek solutions. In addition a host of new areas promising future innovation, such as bioengineering or biophysical chemistry, require an interdisciplinary approach that combines fields. Learning outside the classroom yields valuable real life examples of the interplay between science disciplines; teachers need to be supported and resourced to make the most of these opportunities.

¹ Appendix 1 List of Science Council Member Organisations

Future scientists

Experimentation is of central importance to the practice of science and it is hard to imagine a quality school education in the subject which does not incorporate experience of practical experiments for all learners. The inclusion of practical work is of particular importance for those learners who may consider a future working in science as there is widespread concern amongst science employers with regard to a lack of practical and technical skills at all levels, including graduates. The Science Council recognises that this is an important issue in the education and training of professionals in science at all levels. This is illustrated by the view of the Institute of Biomedical Science:

“The development of practical skills based on interactive teaching of the core sciences is key to the assimilation of technological advances.”

The UK’s growing economic need for a workforce with science skills includes a demand for those utilising technical and practical skills at technician level with the UKCES Working Futures report² identifying that the number of associate scientific and technical professionals is set to rise by 6.5% between 2007 and 2017. Practical and field work play a key role in helping to raise awareness of the value of technical skills and the employment settings in which they can be applied.

Enjoyment and engagement

Practical and investigative work can enhance engagement in science and be a motivating and effective style of teaching and learning. NESTA’s 2005 Real Science report looked at the value of science enquiry, which often involves practical work, and stated;

“The potential of science enquiry to engage and motivate learners is clear from the outcomes from NESTA projects, those projects funded and supported by other organisations, and from the broader research literature.”³

Attainment alone will not attract increased numbers of young people to science, therefore, it is important that there is opportunity and imperative for teachers to utilise practical work in the classroom.⁴ Research studies^{5 6} have shown that there is lack of connection between young people enjoying science and visualising a future for themselves as a scientist. Practical experiments can enable young people to experience a taster of the processes employed by scientists in their work and assess their enjoyment of such activities.

Support for practical work

Many of the Science Council member organisations seek to ensure that practical work is of high quality by providing a wide range of support for teachers through provision of resources, support for the delivery of projects and activities, continuing professional development and support networks. The Institute of Physics, Royal Society of Chemistry and Society of Biology all support websites making available examples of high quality practical activities⁷ and offer CPD courses. The Society for General Microbiology⁸ and Royal Society of Chemistry have both looked at safety issues and provide guidance to alleviate teachers’ concerns and illustrate techniques. A more detailed list of some of this

² UKCES (2009) Working Futures 2007-2017

³ NESTA 2005 Real Science http://www.nesta.org.uk/publications/assets/features/real_science

⁴ SCORE 2010 Practical Work in Science <http://www.score-education.org/policy/wider-learning-experience/practical-work-in-science>

⁵ Edgar, Nelson Important but not for me 2005

⁶ Public Attitudes to Science, Ipsos Mori, Dept. for Business, Innovation & Skills 2011

⁷ www.practicalphysics.org, www.practicalchemistry.org, www.practicalbiology.org

⁸ <http://www.microbiologyonline.org.uk/teachers/safety-information>,

work can be found in Appendix 1. The extensive work undertaken can only be effective if teachers know how to access the assistance and have time and resources to do so: this is obviously an area where the Department for Education can assist.

There are a wealth of hands on science enhancement and enrichment initiatives, including many delivered by our member organisations and partners, whose evaluation has shown that such activities can raise the aspiration and engagement of young people. Many of these take place outside of school, one such activity is the annual Big Bang: UK Young Scientists and Engineers Fair, led by Engineering UK. The evaluation for the 2010 event⁹ shows increased understanding, enjoyment and awareness of career options for science and engineering. The Government funded after school STEM Clubs provide a further opportunity for practical experience and the evaluation of the precursor scheme¹⁰ provides evidence of increased enjoyment and aspirations to become a scientist or engineer.

As a former member of SCORE¹¹ the Science Council supports its detailed work on the issue of practical work in science education. SCORE is currently undertaking research to explore the resourcing requirements of practical laboratory and field work, including laboratory facilities, consumables, equipment and technician time. This work will help to inform the evidence base for policy matters on the factors that enable good quality practical work.

The Science Council
11th May 2011

⁹ http://www.thebigbangfair.co.uk/db/documents/The_Big_Bang_2010_Evaluation_Summary.pdf

¹⁰ After-school Science and Engineering Clubs Evaluation, DCSF Oct 2008

¹¹ Association for Science Education, Institute of Physics, Royal Society, Royal Society of Chemistry, Society of Biology <http://www.score-education.org>

Appendix 1

Some examples of the ways in which Science Council Member Organisations support practical work

Association for Science Education

The Association for Science Education has been a strong voice in promoting excellent practical work to support science education from its inception in 1901. More recently, our efforts have focused on the Department for Education funded “Getting Practical” project which incorporated research into professional development and made real progress in improving practice. We believe that authentic practical experiences in science are essential to engagement with the subject. From our members we understand that support for practical science in schools is currently in some difficulty. We have concerns about the provision of school laboratory technicians (many of whom are members of ASE), about laboratory design and about sufficient emphasis during initial teacher education on the management of practical lessons.

Getting Practical www.gettingpractical.org.uk

A programme of professional development designed to support teachers, technicians and high level teaching assistants at primary, secondary and post 16 levels consider the way in which they teach practical science with a view to improving the quality of their teaching.

The programme aims to improve the:

- Clarity of the learning outcomes associated with practical work.
- Effectiveness and impact of the practical work.
- Sustainability of this approach for ongoing improvements.
- Quality rather than quantity of practical work used.

Bringing together these aims will develop a teacher’s ability to assess the way they teach practical science at all levels and increase their confidence in producing good quality lessons for the benefit of the learner.

Geological Society

Code for Geological Fieldwork <http://www.geolsoc.org.uk/page2542.html>

Gower Field Guide <http://www.geolsoc.org.uk/gsl/education/resources/page2544.html>

A field guide to the solid geology of the Gower Peninsula.

Institute of Materials, Mineral and Mining

Schools Affiliate Scheme – Connecting teachers to the world of materials, minerals and mining <http://www.iom3.org/sas>

Membership of the Scheme allows access a range of resources which will support and enhance teaching. Contained within the site there is information to help bring the materials, minerals and mining topics in the 11 to 19 curriculum to life. Previous newsletters and support literature can be downloaded, and in the near future it will be possible to gain access to the presentations given at the

Institute's conferences for teachers and find out about how to borrow one of the Institute's resource loan boxes.

Institute of Food Science and Technology

Ideas for lesson plans <http://www.ifst.org/learninghome/helpforteachers/>

These lesson plans include ideas for practical work on topics including [Cereals](#), [Supply Chain Management](#), [Milk](#), [Fruit & Vegetables](#) and [Food Texture](#)

Institute of Physics

The Model Project: The resource provides ideas for practical physics activities, student instructions and worksheets plus guidance for teacher and technicians. The practical activities are supported by video sequences showing how some people use physics in the jobs they do. The activities were designed for 14-16 year olds and the resource includes links to the relevant UK specifications. See: http://www.iop.org/education/teacher/resources/model/page_41554.html

Practical Physics website. The website includes notes on apparatus, procedure, and teaching notes, together with general guidance on teaching approaches. See: <http://www.practicalphysics.org/>

General CPD support, for example, supporting for non specialists through the Stimulating Physics Network to with guidance for teachers and technicians on setting up and using apparatus.

Videos on practical work available through talkphysics website and the National STEM Centre site (see: <http://www.nationalstemcentre.org.uk/elibrary/search?term=videos+institute+of+physics>)

Institution of Chemical Engineers

12 exciting hands-on experiments

<http://www.whynotchemeng.com/uk-and-ireland/teachers/teacher-resources/key-stage-2-and-3-resources>

12 exciting hands-on experiments, developed by Dr Mark Biddiss, are designed to be safely used in the classroom. Each experiment is accompanied by instructions, shopping list and useful information, and are taken from Dr Mark's Magical Science 1 & 2 Books and CD Roms.

Water Boxes

Since 2004, IChemE's Water Subject Group have been donating a limited number of 'water boxes' to schools both in the UK and overseas. The boxes contain 21 water-based experiments and are currently supplied by Three Valleys Water.

Royal Astronomical Society

The RAS offers support for the teaching of astronomy and geophysics in schools in a variety of ways, from putting teachers in touch with astronomers who can assist with practical outreach to managing the legacy of the 'Telescopes for Schools' project which gave telescopes to 1000 schools during the International Year of Astronomy in 2009. Simple equipment such as a pair of binoculars or one of these 1000 small telescopes is enough to see many celestial objects, from craters on the Moon to the clouds of gas and dust where stars form.

<http://www.ras.org.uk/education-and-careers/for-schools-and-teachers>

Royal Meteorological Society

MetLink Website <http://www.metlink.org/>

MetLink is an educational website of the Society with weather and climate resources aimed at primary and secondary school teachers, students, teenagers, children and the general public. Resources include lesson plans, experiments and demonstrations and after school club activities.

Royal Society of Chemistry

11+ Resources

Practical Chemistry Website <http://www.practicalchemistry.org/>

This website provides all teachers of chemistry with a wide range of experiments to illustrate concepts or processes, as starting-points for investigations and for enhancement activities such as club or open day events.

Video Clips

<http://www.rsc.org/Education/Teachers/Resources/Practical-Chemistry/video-clips/index.asp>

Downloadable clips produced by Teachers TV in association with the RSC. This material was sent to schools in the Autumn of 2006 on a DVD.

Demonstration Videos

<http://www.rsc.org/Education/Teachers/Resources/Practical-Chemistry/Videos/index.asp>

The RSC commissioned a series of video demonstrations providing guidance for some fundamental, and some very exciting, reactions. Accompanying notes from Classic Chemistry Demonstrations are provided for the demonstration videos.

Making Measurements and Manipulating Experimental Results

<http://www.rsc.org/Education/Teachers/Resources/Practical-Chemistry/Experimental.asp>

This online resource provides a clear and concise summary of a topic that both teachers and students often find confusing.

Investigate Chemistry

<http://www.rsc.org/Education/Teachers/Resources/InvestigateChemistry.asp>

In 2009 the Royal Society of Edinburgh and the Royal Society of Chemistry recognised a need for exemplification of the Chemistry "experiences and outcomes" in a Curriculum for Excellence. Through this project three resource packs were created. The resources have been designed in line with the Scottish Curriculum for Excellence but could be easily adapted for teaching elsewhere.

16+

Discover LabSkills

<http://www.rsc.org/Education/DiscoverChemistry/DiscoverLabSkills.asp>

The Discover LabSkills Project was launched in January 2009 through collaboration of the RSC / Pfizer education programme, Discover Chemistry, with the University of Bristol and Learning Science Ltd.

The aim of the project was to improve access to the LabSkills Dynamic Lab Manual (DLM) to allow teachers and student to develop and improve their practical laboratory skills.

Practical Chemistry for Schools and Colleges

<http://www.rsc.org/Education/Teachers/Resources/practical/index3.htm>

Video footage of standard experimental techniques including assembling apparatus.

Chemistry for Non Specialists

<http://www.rsc.org/Education/Teachers/CPD/ChemNonSpec/index.asp>

Society for General Microbiology

Basic Practical Microbiology for Secondary Schools - Accredited one day course for secondary school teachers, technicians and PGCE science students providing basic training in the techniques needed to carry out interesting microbiology investigations safely in schools.

Advanced Practical Microbiology for Secondary Schools – Measuring microbial growth

One-day, practical based course for secondary teachers and technicians deals with a variety of suitable methods.

Basic Practical Microbiology: A Manual

Manual for teachers and technicians explaining basic techniques necessary to carry out microbiology experiments safely and effectively.

Practical Microbiology for Secondary Schools

21 safe practical investigations suitable for KS3 & 4/GCSE and equivalent Scottish qualifications. Many of the experiments also meet the needs of the AS/A2 specifications and can be adapted for project work.

Online safety/ practical information: <http://www.microbiologyonline.org.uk/teachers>

Video portal streaming practical techniques: <http://www.microbiologyonline.org.uk/what-s-hot/podcasts-and-vodcasts>

Society of Biology

Practical Biology

<http://www.practicalbiology.org/>

Practical Biology provides teachers of biology at all levels with experiments that demonstrate a wide range of biological concepts and processes. Each practical may be used alone or as a starting-point for open-ended investigations or enhancement activities, such as clubs or open-day events. Experiments are placed within real-life contexts, with links to carefully selected further reading, enabling teachers to show relevance and illustrate the key principles of How Science Works.

Society of Dyers and Colourists

The **Colour Experience** includes a range of supported activities to introduce young people to hands on experiences with colour.

<http://www.sdc.org.uk/en/education/colour-experience/index.cfm>

Appendix 2

Science Council member organisations

March 2011

1. Association for Clinical Biochemistry*
2. Association of Neurophysiological Scientists
3. Association for Science Education**
4. British Computer Society*
5. British Psychological Society*
6. Chartered Institution of Water and Environmental Management*
7. Energy Institute*
8. Geological Society of London*
9. Institute of Biomedical Science*
10. Institute of Brewing and Distilling
11. Institute of Clinical Research*
12. Institute of Corrosion*
13. Institute of Food Science and Technology*
14. Institute of Marine Engineering, Science and Technology*
15. Institute of Materials, Minerals and Mining*
16. Institute of Mathematics and its Applications*
17. Institute of Physics and Engineering in Medicine*
18. Institute of Physics*
19. Institute of Professional Soil Scientists*
20. Institution of Chemical Engineers*
21. Institution of Environmental Sciences
22. London Mathematical Society
23. Mineralogical Society
24. Nuclear Institute*
25. Oil and Colour Chemists' Association*
26. Royal Astronomical Society
27. Royal Meteorological Society
28. Royal Society of Chemistry*
29. Royal Statistical Society
30. Society for General Microbiology
31. Society of Biology
32. Society for Cardiological Science and Technology
33. Society of Dyers & Colourists

* Licensed to award Chartered Scientist – CSci

** Licensed to award Chartered Science Teacher - CSciTeach