



Science in health care



# Supporting your fieldwork needs



We've identified the best ways we can support teachers and ensure students benefit from vital fieldwork experiences this term:

- **day courses** at our centres, which have been transformed to operate in a fully Covid secure way;
- visiting schools to deliver **outreach** in their grounds or local area;
- a range of new **digital packages** where face-to-face is not possible.

[www.field-studies-council.org/biology](http://www.field-studies-council.org/biology) **FSC**



*Editor* **Geoff Auty**

*Joint Executive Editors* Martin Payne and Andrew Welsh

*Assistant Executive Editor* Helen Johnson

*Book Reviews* Miriam Chaplin

*Websearch* David S. Moore

*Editorial contact ASE* Jane Hanrott

*Design/typesetting* Andrew Welsh

*School Science Review* is published in March, June, September and December as a benefit of 11–19 membership of the Association for Science Education. It is also available on subscription from the ASE.

Authorisation is granted by the ASE for items from *SSR* to be photocopied for personal use or for the use of specific students. Permission is needed to copy or reproduce for any other purpose and requests should be addressed to the ASE.

The contents of this journal do not necessarily represent the views or policies of the ASE, except where explicitly identified as such.

© Association for Science Education, 2021

ISSN 0036–6811

## **The Association for Science Education**

Address College Lane, Hatfield, Herts AL10 9AA

Telephone 01707 283000

Fax 01707 266532

Email [info@ase.org.uk](mailto:info@ase.org.uk)

Website [www.ase.org.uk](http://www.ase.org.uk)

Advertising Rebecca Dixon-Watmough, [rebecca@ase.org.uk](mailto:rebecca@ase.org.uk)

Printing Holbrooks Printers Ltd, Portsmouth, England

# Contents

**School Science Review** March 2021, 102(380)

- 5 Editorial
  - 6 Letter
  - 9 Science notes
    - 9 **Law of flotation** *Iain MacInnes*
    - 10 **STEM project to investigate conductivity using student-constructed probes interfaced with a BBC micro:bit** *Steven Weir*
    - 13 **Newton's laws of motion – science that emerged during the Great Plague of 1665–1666** *Geoff Auty and Tim Watson*
  - 15 **Physics is useful – especially in medicine!**  
*Elizabeth M. Parvin*  
Demonstrations of medical physics are a useful way of linking school physics with modern medicine; this article describes some simple, fun and mostly low-budget demonstrations for use in schools
  - 21 **A heartfelt experience, part 1: the recognition and treatment of a heart problem**  
*Geoff Auty*  
A personal account of the treatment of a heart problem from first-hand experience
  - 25 **A heartfelt experience, part 2: an explanation of MRI scanning and a patient's experience of the process**  
*Geoff Auty*  
How MRI scanning works and the author's personal description of the process
  - 31 **Introduction to audiology**  
*Ann-Marie Hawkins*  
The role of the audiologist including how we hear and the causes of hearing difficulties
  - 34 **High school students produce a biosensor: glucose strips are made using electrochemistry, biomimetics and enzymatic reactions**  
*Stefano Cinti*  
High school students fabricate and employ an entire enzymatic biosensor
  - 40 **Using the ability of certain insects to 'revive' as a vehicle for inquiry projects in science**  
*Manuel Vidal López, Miguel Ángel Yebra and Pedro Membiela*  
Using the phenomenon that certain insects can be revived after being submerged in water for hours as a means of motivating students to carry out scientific inquiry projects
  - 46 **Measuring the circumference of the Earth**  
*Keith Gibbs, Geoff Auty and Stuart Farmer*  
Three ASE members collaborate to measure the circumference of the Earth, following an initiative from the National Schools' Observatory
  - 50 **What enables successful open-ended practical investigative work in the sciences post-16?**  
*Lynda Dunlop, Maria Turkenburg-van Diepen, Kerry J. Knox, Judith Bennett, Aba Adebajo, Simon Moore, Martin Hampshire, Tanya Hunt and Simon Poliakoff*  
Incorporating open-ended investigation into post-16 science: ways of making this work count for teachers and students, with attention to key learning outcomes associated with investigation
  - 58 **In praise of the textbook**  
*Phillip Murphy and Elizabeth Murphy*  
Using a textbook can still have a place in the classroom and can help with the transition to higher education
  - 60 **Engaging with STEM through engineering design challenges**  
*Maeve Liston*  
Providing authentic STEM learning experiences using the engineering design process
  - 67 **On the stairway to competence in scientific inquiry**  
*Cornelia Stiller, Andreas Stockey, Stefan Hahn and Matthias Wilde*  
A one-year science course rationale that focuses on scientific literacy by increasing students' autonomy in experimentation as an alternative to regular statutory curricula in Germany
  - 75 **3D science – theoretical model or potential classroom reality?**  
*Gareth Price and Stuart Bevins*  
3D science – could this new model of science provide a way to develop more personally significant and motivating STEM courses for students aged 11–19?
  - 82 **Reviews**
  - 85 **Science websearch**
  - 88 **SSR special issues; Advertisers index**
- 2 **SSR** March 2021, 102(380)



## Important notice for all UK individual ASE members – new opt-in for paper copies

With the increasing appetite for digital content, and to further reduce our environmental impact, the ASE has been considering reducing the number of paper journals that it sends out. We had intended to commence this process over the coming year but, in light of the continuing COVID-19 situation, and following on from similar processes being followed by a number of fellow organisations, we have decided to change the way in which we distribute our journals from next term.

From the **end of May 2021**, our three 'paper' journals, *Education in Science (EiS)*, *Primary Science (PS)* and *School Science Review (SSR)*, will be issued online only, by default, to individual members (institutional members, e.g. primary schools and secondary science departments, will not be affected).

Any individual members wishing to continue to receive hard copies may do so, free of charge; just log in to your account on the ASE website and update your preferences here: [www.ase.org.uk/my-preferences](http://www.ase.org.uk/my-preferences). Alternatively, please log in and go to 'My account' and select 'My preferences' from the left-hand menu. Please do so before **30 April 2021**.

This means that the last paper copies of journals being produced under the old system will be March/April *PS*, March *SSR* and May *EiS*.

We very much hope that you understand the reasons behind this change and that you continue to enjoy the wide range of material offered to you through our journals.

## Health & Safety

For all practical procedures described in *SSR*, we have attempted to ensure that:

- the requirements of UK health & safety law are observed;
- all recognised hazards have been identified;
- appropriate precautions are suggested;
- where possible procedures are in accordance with commonly adopted model risk assessments;
- if a special risk assessment is likely to be necessary, this is highlighted.

However, errors and omissions can be made, and employers may have adopted different standards. Therefore, before any practical activity, teachers and technicians should always check their employer's risk assessment. Any local rules issued by their employer must be obeyed, whatever is recommended in *SSR*.

Unless the context dictates otherwise it is assumed that:

- practical work is conducted in a properly equipped laboratory;
- any mains-operated and other equipment is properly maintained;
- any fume cupboard operates at least to the standard of CLEAPSS Guide G9;
- care is taken with normal laboratory operations such as heating substances or handling heavy objects;
- good laboratory practice is observed when chemicals or living organisms are handled;
- eye protection is worn whenever there is any recognised risk to the eyes;
- fieldwork takes account of any guidelines issued by the employer;
- pupils are taught safe techniques for such activities as heating chemicals or smelling them, and for handling microorganisms.

Readers requiring further guidance are referred to:

*Safeguards in the School Laboratory*, 12th edn, ASE, 2020.

*Be Safe! Health and Safety in School Science and Technology for Teachers of 3- to 12-year-olds*, 4th edn, ASE, 2011.

*Topics in Safety*, ASE, latest version on the ASE website: [www.ase.org.uk/resources/topics-in-safety](http://www.ase.org.uk/resources/topics-in-safety) (login required).

*Hazcards*, CLEAPSS, latest version, and other relevant publications, on the CLEAPSS website: [www.cleapss.org.uk](http://www.cleapss.org.uk) (almost all schools, colleges and teacher training establishments in the UK outside Scotland are members, as are many overseas).

*Hazardous chemicals database*, SSERC, latest version on the SSERC website: [www.sserc.org.uk/health-safety/chemistry-health-safety/hazchem\\_database-2/](http://www.sserc.org.uk/health-safety/chemistry-health-safety/hazchem_database-2/) (schools, colleges and teacher training establishments in Scotland).

*Preparing Risk Assessments for Chemistry Project Work in Schools & Colleges*, SSERC, 2020.

# Editorial Board and Associates

## Editor

**Geoff Auty**

## Editorial Board

**Miriam Chaplin** science education consultant

**James de Winter** Universities of Cambridge and Uppsala

**Maria Kettle** University of Cambridge

**David S. Moore** Oxford

**Dave Pickersgill** Sheffield

**Michael Hal Sosabowski** University of Brighton

**Bernard Tedd** King Edward VI High School for Girls, Birmingham

**James Williams** University of Sussex

**Janet Williams** Mayflower High School, Billericay

## Editorial Associates

*The Editorial Associates support the Editorial Board in advising the Editor on the suitability of submitted articles.*

**Damian Ainscough** independent education adviser

**Jeremy Airey** National Science Learning Centre, York

**Maria Bateson** The Charter School, East Dulwich, London

**Richard Boohan** London

**Ian Carter** ecology consultant, Alderney

**Anthony Clowser** Ysgol John Bright, Llandudno

**Stuart Farmer** Education Manager, IOP (Scotland), Aberdeen

**Alastair Fleming** Oban

**Mary Frost** Appleton School, Essex

**Rory Geoghegan** Irish Science Teachers' Association, Dublin

**Keith Gibbs** Schoolphysics, Taunton

**Randal Henly** Dublin

**Jon Heywood** University of Leicester

**Stephen Hoskins** Torquay

**Sue Howarth** Worcester

**Michael Inglis** University of Leeds

**Ruth Jarman** Queen's University Belfast

**Susan Judge** Marlow

**Ian Kinchin** University of Surrey

**Vanessa Kind** Durham University

**Chris King** Keele University, Keele

**Ian Lancaster** Cheshire

**Dawn Leslie** Davenies School, Beaconsfield

**Roger McCune** Northern Ireland

**Robin Millar** University of York

**Andy Newsam** National Schools' Observatory, Liverpool  
John Moores University

**Jonathan Osborne** Stanford University, California

**Alan C. Pickwick** Manchester

**Michael J. Reiss** UCL Institute of Education, London

**Keith Ross** Villembits, France

**Sarah Sephton** Brampton College, London

**Dom Shibli** University of Hertfordshire, Hatfield

**Nicky Souter** University of Strathclyde

**Keith Taber** University of Cambridge

**Christopher Talbot** St. Joseph's Institution, Singapore

**Alaric Thompson** Ulverston Victoria High School

**Neil Walker** Westfield School, Newcastle upon Tyne

## ASE Health and Safety Group Representatives

**Peter Borrows** science education consultant, Amersham, Buckinghamshire

**Phil Bunyan** Oxhill, Warwickshire

**Joe Jefferies** Everton, Nottinghamshire

# Contributing to SSR

We welcome contributions for all sections of *School Science Review*. For reference, a full page of A4 text in the journal is about 800–850 words; including two small figures on a page would bring that down to about 600 words. Articles should be no longer than 4000 words in total.

These can be emailed to The Editor, [ssreditor@ase.org.uk](mailto:ssreditor@ase.org.uk), or posted to The Editor, *School Science Review*, ASE, College Lane, Hatfield, Herts AL10 9AA. Detailed advice on the submission of articles and Science notes is available on the ASE website at: [www.ase.org.uk/submission-guidelines](http://www.ase.org.uk/submission-guidelines).

Readers will soon discover that there is more input from me than usual. About 4 years ago, we had discussions about a theme on the science in health care. I put out several enquiries but we did not find a guest editor who could seek out possible contributors, so I began the search. I tried Café Scientifique meetings in two local towns and two presenters at ASE conferences when the topic seemed appropriate. On each occasion I received an enthusiastic positive response, but no follow-up came. It seems that speaking 'off the cuff' with the support of images on *PowerPoint* is a much easier task than writing. However, I had personal experiences that could provide two articles and obtained another from a contact working in health care. A member of the editorial board found another contact and a submission from Italy was suitable for inclusion as a healthcare topic.

The edition opens with a letter from Keith Ross offering ideas on teaching about gravity in response to Philip Johnson's article in the previous edition. Unusually for a letter, it is illustrated with diagrams. In *Science notes*, Iain MacInnes suggests a reconsideration of the wording of Archimedes' principle. It is possible for heavy objects to float on very little water. Steven Weir offers ideas on electronic methods of testing electrical conductivity.

It might be expected that a healthcare theme would focus on biology (for the human body) and chemistry (particularly for medicines), but only one involves chemistry, and it is also for detection, not cure. The remainder involve uses of physics, with detection again being at the forefront of the topics described.

Elizabeth Parvin takes us through the history and some uses of X-rays, including the risks of overuse, and a neat optical simulation is described. Doppler ultrasound methods are shown to be valuable for checking blood flow, while the use of endoscopes is illustrated using simulations. The final part describes pulse oximeters, which can determine blood oxygenation levels by measuring the relative transmission of red and infrared light through the fingertip.

I decided to share the experience of a heart operation, with X-rays playing an important part in the surgery. This was followed by volunteering for MRI scans that would check on the effectiveness of the methods being used, and I was given the privilege of studying the results briefly with the researchers.

Ann-Marie Hawkins is an audiologist who studies hearing defects and how to give the most effective treatment. She explains a number of tests and methods for providing improvement. Often there is not a cure, which makes the job of finding the best outcome very difficult.

The last item in this set arrived individually from the authors, as most of our articles do. This one came from

Italy and is a useful addition to this theme. The author explains that after giving a talk to post-16 students, some of them had the opportunity to produce biosensors that can give very quick results and enable patients to do regular self-testing for control of conditions such as diabetes.

A year ago, we hastily produced a discussion article about coronavirus, which was a fairly new word in our vocabulary. At the time, I guess we all believed that the pandemic would be over by the end of the summer, but it has proved to be otherwise. Since then, we have featured some items on home schooling, but not many. Teachers have had to be continually creative in moving this forward, and a few have shared their efforts with us. Hopefully, such work will not be needed again, but perhaps it would be sensible to archive it in case of a resurgence.

I was alerted to one activity initiated by the National Schools' Observatory on the 'longest day', which in 2020 fell on 23 June. The plan was to ask children to help to replicate the measurement of the circumference of the Earth by Eratosthenes. Keith Gibbs and I said we would try it, and we enlisted Stuart Farmer as backup. We are no longer children, but longstanding ASE members. The results were reasonably accurate when compared with modern measurements, and more detail is on the NSO website.

The remaining content is a selection of individually offered articles, which I hope will include something for everybody. A group from Spain describes investigations in which they show that some insects can revive after apparently being dead. A group of teachers with researchers at the National Science Learning Centre in York describe a study of the advantages of giving students open-ended practical investigations. This is a good way to develop skills and confidence, which will be useful in tackling the assessed practical work that students have to cope with. Phillip and Elizabeth Murphy remind us of the value of textbooks when their use appears to be diminishing.

Maeve Liston from the Republic of Ireland makes use of engineering design projects to develop practical skills. This is perhaps the next stage to consider following the suggestions from the NSLC. Engineered items have to work successfully. A group from Germany considers teaching science subjects through inquiry – challenging students to seek answers rather than load them with ready-made information. The final article from Price and Bevins explains a different educational method they describe as '3D science'. It is necessary for students to absorb knowledge in education. For science subjects, this requires management of evidence and the application of mental energy to evolve a structure.

**Geoff Auty**

Editor, *School Science Review*