Science Teacher Education

No 83 • December 2018

The Association for Science Education
Promoting Excellence in Science Teaching and Learning

An ASE publication for all concerned with the pre-service education, induction and professional development of science teachers

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No 83 ● December 2018

Published by: The Association for Science Education,
College Lane,
Hatfield, Herts AL10 9AA.
Tel: 01707 283000
Fax: 01707 266532
Website: www.ase.org.uk

ISSN: 1756-915X

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Editorial

• Paul Denley

Welcome to Issue 83 (at last)!

I am sorry that this issue is a bit late in publication and is rather shorter than usual. In part, this is due to changeover in editorship and partly perhaps reflecting the pressures of the world around us, with not having a vast reservoir of material to hand to put this together.

Anyway, I would like to say what an honour it is to have taken over as Interim *STE* Editor from Rob Toplis. My thanks to Rob for all he has done in his term of office. I've enjoyed reading some really interesting articles and editorials reflecting the (sometimes crazy) world of science teacher education while he was at the helm.

Many of you will know that ASE is reviewing its services to its members and particularly the content and availability of its journals. There will be a survey of the membership coming up in early 2019 to seek views about this and outline some possible models for future structures. Without going into detail here, one option is to think of some sort of journal that might replace *STE* and include articles not only about science teacher education but also science education research as well, thus potentially drawing on some material that traditionally has been published in *School Science Review.* For this reason, my appointment as Editor is just for one year to allow the consultation process to run and for it to become clearer what the future of *STE* is to be.

So, to this issue. We have an article from **Louisa Aldridge** about routes into teaching from the viewpoint of someone involved from the school side of the partnership. In his final editorial, Rob wrote of one of the aims of *STE* being to provide a forum for discussion. This article invites a response perhaps from someone coming from the Higher Education side. A few years ago, we were being threatened by the then Secretary of State in England (whatever happened to him?!) with his vision of teacher training moving into schools. Louisa's article suggests that, while there might be differences between a more school-based approach such as a SCITT and the 'traditional' model, they may both be fit for purpose and respond to the needs and experiences of trainees.

The other major article by **Kate Andrews, Paul Beaumont, Emma Bissett and Kath Crawford** takes us away from the stress (for many) of the everyday world of initial teacher education, to a summer school designed to improve subject knowledge and confidence in trainee teachers and recently graduating science students. The programme described looks exciting and the evaluation presented shows the success of this event and some factors influencing that. The idea of extending the model geographically and to the primary phase is put forward.

Our **Ask a Researcher** contribution to this issue is based on an interview that Rob carried out with Professor Ian Abrahams about his own activity and reflections on where science education research is or should be going. Some food for thought there too.

We have a couple of **news** items. One is about the eagerly awaited new edition of the *ASE Guide to Secondary Science Education* and the other gives a short report on the ASE Futures Conference held last summer.

Finally, we have a **book review** of *Explaining Primary Science* – an ambitious volume aimed at beginning primary science teachers.

Please look out for and respond to the publications survey when it comes out in the New Year and help us to shape the future!

Paul Denley Interim Editor, STE
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Writing for *Science Teacher Education*

- Have you any research – at whatever stage – that you would like to share?
- Have any of your past students produced assignments or projects that you think would be useful to inform others?
- Have you any comments or views that may promote discussion about current issues in science teacher education?
- Could you write a summary of some published research that has caught your attention?

If so, then we would like to hear from you.

Deadlines

The production schedule is as follows (this may change as a result of the ongoing review of ASE journals):

Final deadline for un-refereed copy	Final deadline for edited copy	Issue date
Mid-December	Mid-January	February
End of March	Mid-April	May
End of August	Mid-September	October

Support

Articles are normally reviewed by the Editor and/or by at least two independent reviewers. Feedback to the author(s) typically may include a text response and/or a tracked version of the article, with suggestions for changes, questions and comments clearly marked for the author(s)' attention. We can provide support for new authors, where a member of the Editorial Board will be allocated to act as coach and provide feedback at an early stage of writing.

Please e-mail the Interim Editor, **Paul Denley** at p.denley@bath.ac.uk with any submissions or comments

The general guidelines are at the end of this issue.

Initial Teacher Training: different routes to becoming a teacher

• Louisa Aldridge

Initial teacher training (ITT) follows a variety of different paths, with school-based programmes such as School Direct, Teach First and Researchers in Schools (RIS) sitting alongside university-based PGCE courses. School-based training programmes follow many different models, of which School-Centred Initial Teacher Training (SCITT) and School Direct training are just two: this article will look at one particular SCITT model of teacher training, alongside the PGCE route.

In School-Centred Initial Teacher Training (SCITT), the learning takes place in a school-based environment, with all the excitement, inspiration and stress that that entails. The PGCE has the feeling of being based in a university, despite two-thirds of the time being spent in schools, lending itself to a reflective, academic approach. The SCITT programme discussed here offers a PGCE as part of the programme; the trainees feel many of the benefits of the PGCE course.

A university environment is conducive to trainees understanding the theory behind the pedagogy and practice, and using this alongside their practice in schools to become reflective practitioners. The challenge on a PGCE course is for trainees to be able to apply the knowledge gained through seminars and assignments in the classroom, so that school students feel the benefit of the trainees' study. University education departments usually participate in academic research and so are in an excellent position to provide the trainees with evidence-based research about methods to teach subjects, as well as theories about how students learn best and are motivated. The challenge here is to ensure that this content is relevant and accessible to teachers at the very start of their careers, when they are not experienced in the classroom. Where this current research is presented in a way that is ready for trainees to build into their practice, their progress towards becoming accomplished teachers can be accelerated.

SCITT trainees have direct access to teachers throughout their training, indeed many of their seminars and lecture sessions are led by practising teachers; this makes the content of these sessions likely to be directly applicable to trainees in schools. Many of the seminars are related to issues that are current in departments, for example, curriculum change, assessment requirements and innovative teaching techniques. These are often very relevant to partnership schools on the programme, and steps must be taken to ensure that there is a breadth of topics covered that will be relevant to any potential NQT post that the trainees may take up. SCITT trainees often talk about feeling immersed in schools, meaning that taking a step back and reflecting can be hard. To compensate for this in our SCITT model, Friday afternoons every week are spent as a cohort of trainees to ensure that teaching practice is reflected upon and developed.

Our SCITT programme provides a school-based mentor for the duration of the course, giving continuity during a year when much change takes place, both externally in terms of school placements and to the trainee as a teaching practitioner. Large amounts of time are spent with mentors, who are practising teachers; this provides trainees with a wealth of knowledge and experience that is directly applicable to classroom practice and the setting of the school. This makes the choice and training of the mentor a vitally important part of any SCITT training. The mentor has a powerful role in embedding trainees' understanding of pedagogy, behaviour techniques and their ability to develop reflective practice. The relationship of the mentor and

trainee can also serve to reinforce their moral purpose and teaching ethos, but can, if poorly chosen, result in misconceptions about teaching and learning and outmoded practices being perpetuated. For example, teachers with a background in teaching modular courses are less used to the practice of interleaving curriculum content to maximise the retention of knowledge required in a linear course.

Some university programmes teach the PGCE in subject-specific groups (biology, chemistry and physics), which leads to an academic rigour tailored to that subject. It is possible to focus in detail on subject pedagogy and ensure that trainees have access to subject-specialised teaching on a regular basis. However, the SCITT trainees, more often being in mixed cohorts, develop a well-rounded view of more subjects, while potentially losing some of the subject-specific focus. For some trainees, often whose subject knowledge is strong, this has the benefit of developing a range of teaching strategies that can be used in a variety of classrooms. This also develops a good understanding of the wider school context and issues broader than curriculum content, mitigating against teachers having a narrow subject-specific focus in schools.

Universities are often able to offer a wider range of school placements than SCITT placements (which draw on local partnership schools); this can lead to a wider variety and diversity of experience. The diversity of experience will ensure that students are fully equipped to teach in any school context following their training. However, SCITT providers are often able to work very closely with their partnership schools, a small number of trainees and mentors in order to provide a bespoke course based on the needs of the individual trainees and the schools in the area. By understanding the strengths and needs of the trainees and the context and issues of the schools, it is possible to match the development needs of the trainee to ensure that s/he continues to develop his/her practice.

Science is a difficult subject to train to teach, due to its combination of biology, chemistry, physics and the scientific skills woven throughout. Often trainees come with an in-depth knowledge of one area: a physics degree, a PhD in microbiology, or experience as an industrial chemist. They then need the training to understand and teach subjects that they may not have encountered since their own schooling. SCITT providers and the PGCE courses tackle this in different and effective ways. Both providers can use the strengths of the trainees to develop others. It is a powerful teaching experience and developmental tool to teach other trainees about a topic that you are passionate about and have studied in depth. It will also always be necessary to audit trainee subject weaknesses and provide a subject knowledge enhancement programme through a variety of methods, including expert input, online resources and training in investigative skills. Universities also have at their disposal faculty expertise that can be drawn upon, while SCITT programmes are able to include their trainees in the CPD programmes run in school. Trainees can also be included as an integral part of INSET days, either to develop as trainees or to get a flavour of continued teacher training.

There are often smaller groups of trainees on SCITT programmes, meaning that these sometimes feel more responsive to the needs of the individual. For example, one recent cohort of science trainees was able to be taught about electromagnetism by a leading scientist in that field, while a practising teacher was able to steer the group in methods that could be used to teach this subject in the classroom.

Teachers, whether they are trainees or experienced colleagues, often struggle to balance

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• Louisa Aldridge

the demands of teaching a practical skills-based subject with the large amounts of content currently needed for GCSE science. These problems become very real when trainees are faced with curriculum planning and exam results at the start of a SCITT course, having started school a week before the term begins. Whenever trainees are in schools, they are able to observe the discussions amongst colleagues about curriculum content and time. This can be further emphasised when they feel part of the institution in which they are working and are planning for a timetable that they themselves might fill in the following year.

In our SCITT model, teachers currently teaching the curriculum deliver subject knowledge sessions. This has the benefit that they apply the knowledge directly to the curriculum and how to teach the content; it can however be difficult to ensure that there is a diversity of subject depth that comes more naturally to a university-based programme. Delivery also needs to ensure that it doesn't over-emphasise the exam board or curriculum that is used in the hosting school.

Science is a very practical subject and the practical sessions are delivered in real classrooms on the SCITT programme. The frustrations that many teachers feel about equipment not working and parts missing are experienced first-hand by trainees. While this can be frustrating for trainees, as it is for students and teachers, when the focus is on illustrating a scientific principle, overcoming and learning from this is a key role in developing the investigative skills needed as a scientist. At university, trainees often benefit from seeing how the equipment would and should work in an ideal situation, and can therefore have a clear understanding of the concept being demonstrated; this may result in a different experience when they take the investigation into the classroom.

Both the PGCE and SCITT models of teacher training have a wide-ranging impact on the schools hosting the trainees, in the form of training for the mentors, an influx of new ideas, a focus on research and not least a potential source of NQTs well trained to hit the ground running. Our SCITT trainees are well integrated into their group of schools, which as a local multi-academy trust means that they can participate and often take a role in CPD throughout their whole training period.

As needs in schools and demands on teachers change, SCITT programmes are in a good position to develop the course to address issues that, as NQTs, trainees will face. This means that the future NQTs understand the needs and driving forces within schools from day one.

The benefits of a SCITT model and PGCE course are mostly dependent on the needs and previous experiences of the individual trainee. It is for each person embarking on his/her teaching career to decide which model best fits his/her approach and desired outcomes. Each course has its advantages and challenges that must be overcome. The definite advantage to potential trainees and schools is that there is a choice of teacher training routes (of which the SCITT and PGCE model are only two) and a model that will suit each aspirational teacher.

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The Scottish Universities Science School

• Kate Andrews • Paul Beaumont
• Emma Bissett • Kath Crawford

For many years the Scottish Schools Education Research Centre (SSERC), in partnership with the Scottish Teacher Education Institutes (TEIs), has delivered a residential professional development event (the Scottish Universities Science School, or SUSS) for secondary science Professional Graduate Diploma in Education (PGDE) students and graduating science/education students across Scotland. Here we explore the aims and structure of SUSS and reflect on feedback from participants and TEI tutors. Feedback has been overwhelmingly positive, with 99% of students reporting their experience as 'good' or 'very good'. Evidence also suggests that SUSS has improved student teacher subject knowledge, confidence and motivation. We also explore the potential for rollout of the SUSS model to other subject areas.

Introduction

The culture of subject-specific professional development is strong amongst the teaching profession in Scotland and this is particularly true for teachers of secondary science subjects. There has been a shift in emphasis from 'one-off' professional development events to those that support career-long professional learning (CLPL). The Scottish Schools Education Research Centre (SSERC) is a local authority shared-service providing support across all 32 Scottish Education Authorities (see https://www.sserc.org.uk/about/). SSERC, with support from a range of agencies (including the Scottish Government, the National STEM Learning Centre, the Wellcome Trust, and the Primary Science Teaching Trust (Shallcross *et al,* 2014)), provides a national programme of professional development in support of science and technology education.

Following discussions with colleagues in the Teacher Education Institutes (TEIs), it was agreed to extend SSERC's involvement with Professional Graduate Diploma in Education (PGDE) students to include subject coverage across the sciences and offer support for practical work in areas outside a student's specialism; thus in 2005 the Scottish Universities Science School (SUSS) was developed.

A series of articles in this journal (Findlay, 2017; Kennedy, 2017; Mulholland *et al*, 2017; Wyn Jones, 2017; Wharf, 2017) has provided details about science teacher education across the British Isles. Findlay, in her article about science teacher education in Scotland, highlighted that SUSS is '*An important and enjoyable part of PGDE science courses across Scotland'.* Here, we explore why SUSS has become established as an important feature in the educational calendar. We also consider whether the SUSS model might be adapted and applied to other curricular areas (e.g. technology, computer science) and sectors (e.g. the primary sector).

Year	Biology	Chemistry	Physics	Total
2013/2014	72	55	38	165
2014/2015	75	57	43	175
2015/2016	88	69	54	211
2016/2017	91	75	60	226
2017/2018	111	86	77	274
2018/2019	110	98	81	289

Table 1. Intake targets for PGDE science student teachers (McLaren *et al,* 2014; Scottish Funding Council, 2017, 2018; Sunderland, 2014).

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The absolute number of secondary science PGDE students in Scotland varies with the annual teacher workforce planning exercise (Education and Skills Committee, 2017) setting out intake targets for the subjects. There has been a noticeable increase in intake targets for secondary science PGDE students over recent years (see Table 1 on page 7).

SUSS Programme

SUSS is a two-day residential event, bringing together biology, chemistry and physics PGDE students and graduating science/education students from across Scotland, and aims to provide participants with:

- experience in a range of activities not usually available during initial teacher education programmes;
- opportunities to develop expertise in teaching topics outside their subject specialisms;
- networking opportunities with other teachers of science from across Scotland;
- an introduction to high quality professional development and information on where and how to access further development opportunities; and
- information on sources of practical support.

SUSS is timetabled into the PGDE year and takes place in January. For most student teachers, this falls between first and second blocks of teaching experience. Attendance at SUSS is voluntary, but typically >95% of the eligible cohort attend from across all ten Scottish TEIs.

The programme includes both subject-specialist and cross-curricular sessions and consists of a mix of hands-on practical sessions, lectures, demonstrations and discussion sessions; all these elements are designed to support aspects of the various Scottish science curricula.

Students work through activities much as their pupils might, with workshop tutors providing guidance on pedagogy and classroom management. Workshop sessions include ample opportunities for discussion with other students and with workshop tutors who are themselves experienced classroom practitioners.

On Day 1 (see Table 2 on page 9), students are split into groups with colleagues from across the universities depending on their subject specialism (biology, chemistry or physics).

Regardless of his/her specialism, each student attends a biology, chemistry and physics session (sessions 2, 3 and 4 in Table 2).

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Day 1		
Session	**Title**	**Notes / description**
1	Keynote address	In this session we engage an external speaker whom we invite to consider the following: ❍ Science teachers have a key role to play in maintaining the supply of scientists/engineers and in supporting the development of a more scientifically literate population. ❍ The role of school science teachers in helping individuals become world-class scientists is key. ❍ Science research in Scottish universities is world-class and in this regard Scotland 'punches above its weight'. ❍ The Government's recently published STEM strategy. Recent keynote speakers have included Professor Bruce Whitelaw (Roslin Institute), Professor Dame Sue Black (University of Lancaster), Heather Reid OBE (STEM Education Committee).
2	Fun with photosynthesis	Delegates are afforded hands-on opportunities to experience aspects of the process of photosynthesis and its relationship to the gas balance of the atmosphere via simple visually illustrative activities. Many misconceptions widely held by student science teachers are addressed in this workshop.
3	Teaching forces and other tricky stuff	You can't see a force, only its effects, so how do you teach such an often-abstract topic? This workshop looks at the main ideas that we are trying to get across to pupils, and the misconceptions that must be tackled. At its core is a series of accessible, fun practical activities that promote deeper thinking and understanding.
4	Salt and battery	Delegates make and investigate a series of electrochemical cells. The topic is familiar to chemists, but is also closely linked to physics. One activity, looking at concentration in cells, also models the way a voltage is produced in nerve impulses, thus connecting biology as well.
5	From Sellotape to fireflies: Things that glow in the dark!	This demonstration lecture, which rounds off Day 1, is one of the activities that SSERC offers to schools and colleges. The lecture covers a range of topics in which light is involved in chemical, physical or biological effects. All the activities explored are transferable to the classroom.

Table 2. Broad programme outline for SUSS (Day 1).

On Day 2 (see Table 3), students work in mixed subject groups with colleagues from across the universities. Each mixed group attends the same sessions throughout the course of the day, including practical hands-on activities, discussion activities and input from the Teacher Support Organisations:

Day 2		
Session	**Title**	**Notes / description**
1	What can SSERC do for you? What additional support is available?	An introduction to the wider work of SSERC and its role as a local authority shared-service. Representation from the Association for Science Education, Institute of Physics, Royal Society of Chemistry, Royal Society of Biology, STEM Ambassadors.
2	Showcase	Meet SSERC Subject Teams and professional bodies.
3	Discussion techniques in the classroom	How various discussion techniques might be used in the classroom, often to explore issues related to scientific developments.
4	What works in science education	Exploration of a range of techniques to support improvements in teaching and learning. Activities covered include Assessment is for Learning, Co-operative Learning, Concept Cartoons and Exploratory Talk.

Table 3. Broad programme outline for SUSS (Day 2).

For most delegates, attendance at SUSS is their first experience of external professional development and we hope that this will be the start of a career-long association with SSERC and the other professional bodies and associations. Such an approach accords well with previous observations (Patrick *et al,* 2010) that:

'…*beginning teachers are at the start of their professional journey, no matter how well prepared they might be by their experiences during initial teacher education'*.

Evaluation

Student evaluations

We report here on cumulative evaluations of SUSS from the period 2013-2018.

From 2013-2018 there were 1048 attendees at SUSS, representing >95% of the eligible cohort.

Students were asked to complete evaluations prior to their departure from SUSS; typically, the response rate is 80+%.

Students are asked to rate their overall experience of SUSS from 'very good', 'good', 'average' or 'poor'. Results were overwhelmingly positive, with 99.1% reporting their experience to be either 'good' (12.4%) or 'very good' (86.7%). Only 7 individuals reported that their experience was 'average' (0.8%) and 1 individual reported the experience as 'poor' (0.1%). The majority of these 'less positive' comments refer to aspects related to the accommodation.

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Students were also asked to rate the individual sessions in providing them with information to use in their teaching and professional development from 'very useful', 'useful', 'of some use', 'of little/no use' or 'N/A' if a student had not attended the session. Results are shown in Table 4 below.

The most popular sessions were the subject-focused sessions, with a minimum of 94% of students finding these to be 'useful' or 'very useful'. Open comments provided further insights into the aspects of each session that students found most useful.

For all subject-specific sessions, it was clear that students particularly enjoyed the practical activities and the ideas that they gained from them. They also appreciated the hands-on interactive nature of the sessions and felt that this format gave them good insights into pupil learning:

	Very Useful	Useful	Of some use	Of little/no use	N/A
Keynote Address (N=850)	48.1%	27.6%	19.3%	4.9%	0.0%
Biology (N=1016)	80.3%	16.1%	3.2%	0.3%	0.0%
Chemistry (N=1018)	72.1%	23.1%	4.5%	0.3%	0.0%
Physics for physicists (N=225)	77.8%	16.4%	5.3%	0.4%	0.0%
Physics for non-physicists (N=773)	88.0%	9.4%	2.5%	0.1%	0.0%
Sellotape to fireflies (N=860)	65.9%	25.2%	5.5%	0.1%	3.3%
What works in science education: making learning better and teaching more inspiring (N=873)	64.8%	24.7%	7.9%	1.7%	0.8%
Discussion techniques (N=874)	58.2%	33.5%	6.8%	0.5%	1.0%
SSERC Showcase (N=871)	61.2%	28.2%	8.6%	0.9%	1.0%
What can SSERC do for you? (N= 433)	40.2%	37.6%	19.6%	1.8%	0.7%
Teacher support organisations (N= 460)	50.0%	35.4%	12.4%	1.3%	0.9%

Table 4. Delegate views on individual sessions at SUSS from 2013-2018. (The lower number of responses for the final 2 questions reflects the fact that these sessions were not introduced into the programme until 2015.)

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'The experiments were great, perfect for the classroom, great resources.'

'Great ideas for teaching science and making science exciting in class!'

'Lots of good activities that are cheap and accessible.'

'Very interesting to do the practical and see what challenges pupils might face.'

Students reported that sessions had improved their subject knowledge, helped to address misconceptions and improved their confidence, particularly in teaching topics that are outside their subject specialisms:

'Learnt a lot! Didn't realise how little I knew about photosynthesis.'

'This session was useful and cleared up a few of my own misconceptions.'

'Fantastic, very useful and helped build my confidence in an area I'm weakest.'

Students also felt that sessions were well delivered and that the enthusiasm and knowledge of all the presenters resulted in many tips and much guidance for improving learning and teaching in the classroom:

'Good practical and reflective advice of classroom teaching.'

'Informative, well presented, excellent resources and ideas.'

'Really interesting to hear from a teacher's point of view.'

Interestingly, this feedback would suggest that sessions may have been useful for developing student teachers' pedagogical content knowledge – the subject matter knowledge for teaching, which consists of the ways in which teachers transform their subject knowledge to enable student learning. This requires strong subject knowledge, but also an understanding of common student learning difficulties or misconceptions and ways to address these (Shulman, 1986).

Students from all sessions commented that what they had learned was likely to have an impact on their teaching practice, with many planning to implement the activities and ideas from the sessions with their classes:

'Photosynthesis session gave us some great new ideas to try in class, and how to do them. I am teaching this next week so will definitely try them out.'

What students enjoyed most about the evening lectures and keynote sessions was that they were inspiring, motivational and entertaining. Students felt that invited speakers were good role models and found their perspectives to be interesting and engaging. Many remarked that the keynote was an enjoyable and appropriate way to start the event and the evening lectures were a good way to end Day 1.

The 'Teacher Support Organisations' and 'What can SSERC do for you?' sessions were particularly useful for building students' professional networks and for providing information about support and further development opportunities:

'Didn't realise there was so much support for teachers.'

'Great to put names to faces for organisations and to build professional network.'

Tutor feedback

Several TEI tutors at SUSS 2018 were interviewed and the feedback that they provided was also very positive. SUSS is held in very high regard by tutors and is seen as a great opportunity to expose their students to high quality CLPL at an early stage in their careers.

We believe that it is this close partnership with TEI tutors that is responsible for SUSS routinely attracting such a large proportion of the available student cohort. Tutors feel that SUSS represents an invaluable opportunity for their students to network with others from around Scotland and to begin to build their professional networks.

SUSS also represents an excellent opportunity for students to improve their subject knowledge, both by revisiting topics covered at university from a different angle, and also by learning from other students from different science backgrounds through both formal and informal networking. Tutors felt that SUSS is particularly good for improving knowledge outside a student's subject specialism, which they felt was important as all teachers in Scotland may be required to teach all sciences to the level of Broad General Education. Tutors mentioned that their students were inspired by the keynote address and the evening lectures and felt that the focus on teachers who had been influential in shaping the lives and careers of the guest speakers was particularly beneficial in boosting student motivation and confidence.

Tutors felt that hosting SUSS in a context away from universities and schools was important, as it changes the tutor/student dynamic and ensures that everyone is treated equally regardless of status. They also felt that the physical location of SUSS was important to make their students feel like valued professionals.

Tutors believed that, since SUSS falls between their school placements, the timing is beneficial, as all students will have some school experience from their first placement to help provide context and frame their learning at SUSS. Additionally, they will all have the opportunity to use what they have learned at SUSS in their following placements.

For tutors themselves, SUSS represents an opportunity to keep up-to-date with scientific skills, curriculum practice and to build their own scientific networks through interacting with the Teacher Support Organisations.

There were very few negative comments received from the tutors. Of these, the only criticisms were that it is an intense couple of days, it is very tiring for the students and that sometimes SUSS coincides with other student deadlines. However, they all stressed that these are only minor complaints and that SUSS is so beneficial to their students that they always find a way to work around any issues.

Success factors

The following represents a list of factors that we believe have been key to the success of the SUSS model:

- Our partnership with TEIs is robust. This ensures that we routinely attract the vast majority of the available cohort each year;
- There is a real opportunity for delegates to network with virtually all their fellow student cohort from across Scotland;
- All workshop presenters are experienced practitioners with relevant practical advice and guidance;
- We focus on experiential activities that are not normally part of the initial teacher education experience;
- The programme is designed to allow participants to develop expertise outside their subject specialism;
- The timing of SUSS in the academic year means that students are able to try out the ideas/activities covered at SUSS during subsequent teaching experience placements;

- Our chosen venue (an out-of-city quality hotel) changes the tutor-student dynamic and ensures that everyone is treated equally as professionals. It also provides an immersive residential experience; and
- Student teachers gain a deeper understanding of the level and variety of professional support that is available to them and are given information on how to access further support and development opportunities throughout their future careers.

The future?

There is no reason, in principle, why the model of SUSS could not be extended to other parts of the UK. In England, because of the absolute number of student teachers, it would probably make sense to bring groups of PGCE providers together on a regional basis and we would be happy to support any groups who wished to put a programme in place. An event such as SUSS would help address some of the recommendations for improving initial teacher training in England as outlined in the Carter review (Carter, 2015). It could help with subject knowledge development, subject-specific pedagogy and provide an opportunity for trainee teachers to learn with others training in the same subject.

In our view, the model and structure of SUSS could also be extended beyond the secondary sciences. Other secondary curriculum areas might benefit from an early 'large-scale' intervention at a national level. In this regard, we can report that the Scottish Government has provided SSERC with funding to run a pilot event (the Scottish Universities Technology School, SUTS) for PGDE students who are following either Design & Technology or Technological Education routes into teaching.

Furthermore, we feel that the primary education sector could also benefit from the SUSS model. We recognise that those following routes into primary teaching often lack confidence and, in some cases, competence, in the teaching of experimental science. Events like SUSS with a focus on the primary curriculum would offer rich opportunities to address some of these issues. A particular challenge in this regard would be the number of PGDE Primary entrants (the target for 2018/19 entry in Scotland is 1200 (Scottish Funding Council, 2018)), although with sufficient resource in place we believe that the quality of learning and teaching in the classrooms of probationer teachers would be much enhanced at a time when the Government's STEM Strategy (Scottish Government, 2017) calls for such change.

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Acknowledgements

We would like to thank the Scottish Government and Local Authority members of SSERC for their financial contributions; without such support SUSS would not be possible. We would also like to thank our colleagues in the TEIs for their ongoing support and for ensuring that their students attend SUSS. We would like to thank all those who, over the years, have been involved in the planning, organisation and delivery of SUSS. Finally, we wish to thank the Primary Science Teaching Trust for their financial support of Emma Bissett's post.

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Ask a Researcher – Professor Ian Abrahams

For this issue, our 'Ask a Researcher' interview was carried out during the European Science Education Research Association Conference in Dublin in August 2017. Ian Abrahams is Professor of Science Education and Head of the School of Education at the University of Lincoln, UK. The interview was conducted by the former STE Editor, Rob Toplis.

Rob Toplis (RT): *Ian, what has been your line of research over the last ten years?*

Ian Abrahams (IA): Over the last ten years I've essentially been interested in practical work and have been primarily interested in how effective it is and its affective value. I take a strong position that what we do in education should be evidence-based, rather than opinion-based. I suppose I'm moving on from that now and the research I've been doing over the last two years has been looking at asymmetric academic peer mentoring, taking undergraduate students, pairing them up one-to-one with students in secondary schools in Year 11 (age 16), where they work with them for a period of twenty-three weeks. What we're doing is seeing how effective this process is and what we're finding now is a statistically significant improvement in their mock GCSEs and GCSEs. So that's the area that I'm working in. I think that would sum up what I'm doing.

RT: *How do you think the undergraduates respond to that?*

IA: Well, interesting, because at the moment – I've moved from institution to institution and where I am at Lincoln we're just setting up undergraduate programmes – mainly at Leeds, York and at UCL with undergraduates, we used some of the findings from the research to illustrate some of the sessions that we were doing. So if we were doing something for instance on the effectiveness of outdoor learning, with the BA Education at York, there was a section for people who were interested in becoming teachers. So I suppose one of the issues there then would be that they heard about that from me specifically, giving examples. And the other way is, if you set undergraduates tasks to write about as part of assignments, it might be one of the suggested readings.

RT: *It's interesting that they're both getting something out of it…*

IA: Yes, I would think so – I would hope so.

RT: *How do teachers get to hear about your research? What messages does your research have for them?*

IA: Teachers get to hear about the research in a variety of different ways. One, whenever we publish work, what I tend to try and do is to publish an academic article and then an article that would go into something like *School Science Review,* because that gets out and certainly when I speak to teachers they've been far more aware of what I've done from a shorter article in *School Science Review* than they would have done from an article in *IJSE (International Journal of Science Education)* or something like that. So they get things that way. A second way that teachers get to hear about research that we've done would be something like the IPWIS Project, Improving Practical Work in Science, where a funding body had taken the research we'd done and that was implemented as a training programme and then, as that was part of a training programme, people had learned where that had come from. So I suppose there are these two ways that people can hear about it, they can hear about it from a project, they can hear about it in journal articles and also there are opportunities to present at places such as the ASE Annual Conference,

where you get interested teachers. We do try to work with our teachers as well, so when teachers come into the university, part of what we try and do as part of outreach is to say 'This is the research we're undertaking at the moment.' And they may not always be interested in it, but sometimes when you're saying that the peer-mentoring project has generated enormous interest in local schools in Lincoln, we've got schools actually coming to us and asking 'Can we do that?' in their schools. They hear about it through a variety of avenues.

RT: *Maybe looking back into the past, just a couple of examples, which two research studies do you feel have had a strong influence on science education, probably in the UK?*

IA: I suppose when you're talking about science education, are you talking about the academic body of people who are working in science education, or are you talking about teachers working in science education? Because, if you look – without drawing on specific articles – at the idea of 'discovery learning' or 'science for future scientists', there was an article by Robin [Millar] which was basically about scientific literacy, and that's had an impact in the sense that teachers seem to...the whole focus moved towards scientific literacy. We had a focus on discovery learning. Now I'm not clear on how that change happened, I'm not sure if a paper went to a policymaker or whether these changes were taken up in schools, but it's hard to see if it's a specific individual paper or whether it's as a research focus that moves to an area and you find that people tend to jump onto that bandwagon. So you have a body of knowledge. You come to conferences like this and you suddenly find that at the previous conference everyone was focusing on practical work. Now at this conference there's a lot about rationality and identity and it could be that those things will change people's perceptions. I don't know that there are specific papers – I don't know that I could name a specific paper which I think has been a significant changer. You can look at the number of times articles have been referenced, but then that tends to be amongst academics, not amongst teachers; it would be quite interesting to go around to schools and say, 'What research have you heard of? What academics have you heard of?' If they all say 'That's really interesting, we've only heard of Malcolm X, Peter Y', you might be thinking 'I didn't think they'd done very much', but for some reason they were known in the teaching community.

RT: *Which leads on very nicely to the next question: which education research areas do you think are in need of focused research at this time? Or maybe the next year or two or three? Where do we go from here?*

IA: One of the things I repeatedly argued for is evidence base. I think we're far too opinion-based at the moment. Someone says 'I think we should be using more discovery or investigative science. We want more students to be, to play out being a scientist in the lab.' We need longer studies. I know that's difficult because funding bodies use three years maximum, but I've been to presentations now where they're saying they're working with primary school children because we want them to be scientists, or we want them to be more able to make change. Now, how long are they doing it? Two-year study. They won't even be out of primary school, so, whatever studies we do, they need to be longer. Even if that means funding bodies actually change the requirements and say 'Well, you're doing a two-year study but part of what we want you or your team to do is to come back in two years', three years', five years' time to actually see.' So if you look at, for instance, scientific literacy, no one has evaluated it; all the time and effort that's been pumped into that – and the millions of pounds – has it

made anyone any more scientifically literate than they were before? In actual fact, we didn't even take a bench-line study before to see if there's been a change. So, we have these ideas – brilliant – where do I think we should be focusing now? I'm not too concerned about scientific literacy, widespread scientific literacy. I would like to be seeing what we could do in generating more science for the future scientist. I would like to see what we could do to accelerate the learning of the more able students who clearly want to do science.

That doesn't mean I don't want broad science, but I think that could be taught very well to the end of Key Stage 3 (ages 11-14), and I would like some research to be looking at what we could put into a changed curriculum that would enable people to make informed choices if it was only taught up to that point, and then let's see what we could do with other students who say 'I know I want to be a nuclear physicist'. What can we do for them?

So there's pretty much two separate focuses to the research: one on science for the future scientists to make it as effective as possible and then another which looks far more realistically at what we mean by scientific literacy and to start saying 'Well, actually, what decisions in our everyday lives do people make using science?' and let's teach the science required for those decisions, rather than us saying 'Well, we think everyone needs to know Ohm's Law' or whatever it might be, when no one's going to use it in their life anyway. So, a realistic approach.

RT: *Teachers are being encouraged to do action research – I don't think this is just coming from universities, I think it's coming from groups of schools. Have you any views on that?*

IA: I think action research has potential. I think for some teachers it is a very good thing to do. I suppose, not wanting to shoot myself in the foot, educational research undertaken at university by academics is there for a purpose and I suppose it's a bit like saying when I'm not very well, I want to go to my doctor who's trained; yes, I could probably undertake a little bit of first aid training myself. I would like to see more collaboration between universities and school. Going back to your previous question, you asked me where I would like to see research going. I would change the question and say, where do teachers *want* science educators to be undertaking research? So, I might say 'Well, we need more research in practical work', but the teachers might be saying 'Well, I want more research into how to deal with unruly behaviour in the classroom and no one's doing anything to tell me about that.' So, at the moment we have academics making decisions about research *they* want and then trying to impose that on the teachers. Part of the solution for that is for teachers to become action researchers and answer their own [questions]. I would like to see a greater synthesis, I would like teachers to be saying 'Well, actually, we want an answer for this, can we work with you together?' That to me would be a far better approach.

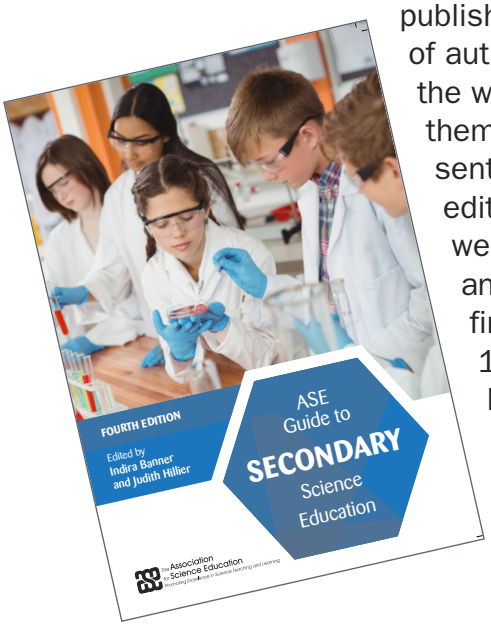
RT: *Thank you, Ian.*

Now available from ASE Booksales!

ASE Guide to Secondary Science Education (4th edition)

Edited by Indira Banner and Judith Hillier
Published by ASE, Hatfield, 2018
ISBN 978-0-86357-458-0

Publishers who have success with a text will often look to a new edition to reinvigorate sales and update the original treatment, but this is not ASE's approach. Each edition of the *ASE Guide to Secondary Science Education* has been produced afresh and reflects the times in which it is published, with a new set of authors to write about the wide range of themes covered. When sent this latest edition, I immediately went to my bookshelf and pulled out the first edition from 1998, edited by Mary Ratcliffe. It is interesting to see the difference between the two books:



So, really quite similar on the surface. A new section on assessing science in 2018, as compared to just a chapter on assessment in Section 2 in 1998, perhaps reflects current emphases and priorities a little more. The chapter on assessment in 1998 does encourage the valuing of formative assessment, but it precedes the transformation of more recent times leading to the orientation towards Assessment for Learning, which gets a chapter of its own in the new edition alongside chapters on using data and another trying to make sense of large scale international assessments.

Although similar issues are covered in other sections, clearly research and practice have moved on in 20 years. Unsurprisingly, chapters in the new edition have been contributed by a completely new set of authors (some of the original authors sadly no longer being with us) to give new perspectives and cover some new topics. The editors have done an excellent job of assembling a team of writers who have been able to present a concise and accessible account of their chosen topics and leave the reader with further readings and reference to take their understanding forward.

On a personal note, I was pleased to find a chapter by Brian Matthews on the role of

Section	1998	2018
1	Setting the scene	Foundations of science education
2	Learning science: concepts, skills and values	Students: all learning science
3	Principles of teaching and learning science	Science teachers: synthesising learning
4	Management and development	Assessing science
5		Science teaching as a profession

emotions in learning science, but it is perhaps unfair to pick out one author when there are so many talented writers included in this volume. It is a very positive acclamation of the strength of ASE that authors are prepared to contribute to these guides.

This short piece is just meant to be an encouragement to have a look at this book for yourself, now that it has been published. The *Guide* is designed for a range of different readers: from those beginning their journeys as science teachers, to those more experienced teachers who want to update and consider afresh how and why we teach science. The intention is to review the *Guide* more fully in the next issue of *STE* from the viewpoint of different stakeholders, particular those working in initial teacher education programmes, professional development and science education research.

I shall not be throwing out my first edition of the *Guide* (or the second and third editions, which I also have), as each stands in its own right. Each represents a position in time and this latest edition carries on a fine tradition.

Paul Denley, Interim Editor of STE.

ASE Futures Conference 2018

The ASE Futures Conference provides a great opportunity to meet with colleagues from across the country who do similar work – often with many schools and a range of partners, but essentially alone. Futures is the ASE group for teacher educators, independent consultants and the last remaining local authority advisers and ITE lecturers with a science specialism – a metaphorical 'staff room' in which to share ideas, experiences and issues, reflect on current policy and research, and develop a sound understanding of effective practice.

This year's Conference at the University of Hertfordshire met all my expectations. I attended keynotes given by key influencers in science education and had time to talk about their inputs with like-minded colleagues. Equally importantly, Futures allowed me to bring my current professional challenges and concerns to share with colleagues working in the same field. Ali Eley, Academic Director of the Primary Science Teaching Trust, and I had carried out a short piece of research to identify the main barriers to developing science practice in primary schools amongst committed and effective teachers – PSTT Fellows and subject leaders from Primary Science Quality Mark-awarded schools. The findings, useful to us, multiplied in usefulness when they were analysed by 30+ expert primary colleagues in a Futures conference workshop. It really was professional development at its best – a sharing of knowledge leading to each of us going back to our professional roles better informed, aware that we shared a joint understanding with colleagues far and wide.

Thank you, ASE Futures.

Jane Turner, Associate Professor for Enterprise and Entrepreneurship,
Director: Primary Science Quality Mark.

Resource Review

Explaining Primary Science

Paul Chambers and Nicholas Souter

Publication: Sage, 2017
ISBN 978-1-4739-1280-9

Reviewed by: Paul Denley, Bath University

It has been a matter of concern for a long time now that many of those embarking on primary phase teacher training do not have much formal science education beyond the end of compulsory schooling at age 16. It is likely that even those who have a science A-level or any equivalent at all will not have studied the physical sciences. Thus, it is unsurprising that, even at the end of their teacher training courses, many of these beginning teachers lack confidence both in their personal subject knowledge of science and how to teach it. Even the most forward-looking teacher training programmes have limited time to spend on developing an appropriate level of subject knowledge in science in a setting where trainees need to be prepared for teaching a range of subjects, and there is still a lot of pressure to concentrate on literacy and numeracy.

In this rather challenging environment, newly qualified and trainee teachers (and those supporting them) are on the lookout for helpful resources and aids to make sense of what can be the daunting prospect of teaching a science lesson. This book takes up the challenge and provides a well-written and accessible summary of primary science. It manages to combine in a helpful way the necessary background subject knowledge for the teacher, with practical illustrations of classroom activities for learners.

Even in a book running to nearly 400 pages, it is difficult to get the balance right. Beginning teachers may just want to know what they should be doing, but that is of limited value if it is not underpinned by the necessary subject knowledge at an appropriate level. This book addresses this issue very effectively by presenting science topics in a way that will be understandable for those without extensive previous study of science and, at the same time, presenting ideas for classroom activities. The latter aspect of the book is strengthened by making links with a companion website (https://study.sagepub.com/chambersandsouter), which contains some useful videos to support (not replace) classroom activities in many of the chapters.

The structure of the book is around 19 chapters covering the most common topics in primary science – seven in the area of biology, five on chemistry, six on physics and one on space (wherever that fits!). All chapters begin with some learning objectives and end with a short summary but, more importantly, some reflection points that pose questions (and give answers) about the sort of issues that often arise in the classroom. The writing is very readable and generally recognises the level of previous knowledge of the likely reader and the need to not over-complicate explanations without losing too much in terms of scientific accuracy. In any book like this, the chapter on energy is often scrutinised. In this case, the account given balances everyday understandings about energy with the scientific view. Some might quibble about the presentation of different 'forms' of energy or the idea of energy being 'used', but these are perhaps subtleties that might be left for further study in secondary school. It is perhaps more important to bring into the open some of the misconceptions that pupils might bring to lessons about energy and prepare their teachers with appropriate responses.

The book takes an interesting stance about linking its presentation of science topics to curriculum models. Rather than make direct reference in the main text itself, there are two tables at the start of the book that provide references to specific learning outcomes within the English and then the Scottish national curricula. These tables just give links to particular chapters and an indication of which school years

the outcomes relate to. Thus, without reference to the relevant table, it would not be immediately obvious to the reader of any chapter at what age of learner across the seven years of primary education particular content was aimed. It might be seen as a limitation that more directly accessible information about curriculum coverage is not included in the chapter itself. However, it could also be seen as a strength, in that, seen from the teacher's viewpoint, a clearer picture of the topic as a whole is being built and knowledge developed, which can then be applied as appropriate and according to the national curriculum requirements. The danger of tying content too closely to curriculum requirements runs the risk of missing the wood for the trees and so, on balance, this book's approach might be seen as the preferable one. I would have appreciated an introduction to the book from the authors to explain their rationale for why they decided to present the book as they have.

The one limitation that perhaps time and/or space did not permit would have been to have included more references and suggestions for further reading about both the science knowledge itself and pedagogical issues. Perhaps this just reflects the pressure on primary teachers and the reality of their working lives, which must leave very little time for further reading.

Overall, a book to be recommended for both the main intended audience of teachers in training, but also to newly qualified teachers who wish to get a good overview of the subject.

General guidelines for authors

Some aspects may change as a result of the ongoing review of ASE journals.

There are five types of article in STE:

- Articles on pedagogy and professional learning in science education – ITE and CPD
- Articles from early career teachers that are developed with the support of a mentor, either from the ITE/Masters/PhD/EdD tutor, or provided by ASE
- Action Research and Practitioner Research section
- CSci/RSci learning journeys, or mentor-learning journeys, or PGCE/SD/TeachFirst learning journeys
- Reviews of CPD programmes, resources & books on professional learning

For main articles, we are looking for more than just descriptions of practice. Pieces should be between about 1500 and 3500 words. A good article will have the following features:

- A clear and catchy title that expresses what the article is about;
- A very short abstract (about 100 words) that outlines the main points it makes;
- An introduction about what was done (if about research or evaluation of methods), in the context of what is already known about the area (just a few references to other work could be given, but not too many!). It is always useful to refer back to articles that have appeared in *STE*;
- A short section that outlines the methods used to collect data and the sample or the focus of evaluation;
- The key findings or outcomes;
- A discussion of the findings and what they mean for teacher educators;
- A conclusion that points to implications for practice and policy in science teacher education – please don't just repeat the findings again;
- An e-mail address for the main author – where you can be contacted;
- A list of references in the ASE house style – see back issues of the journal and the examples that follow;
- Typed, double-spaced as one single Word document, with diagrams, tables and figures arranged in the text as the author wishes to see them. Colour photographs can be included in the word document or sent as separate JPeg files.

Documents should be sent by e-mail to the Interim Editor, Paul Denley, at **p.denley@bath.ac.uk** at least three months ahead of an issue for an item to be considered. The Editor has the right to decide on the exact issue in which accepted publications should appear. Final copy for publication must reach the Editor at the dates in the *Deadlines* section earlier in this issue.

Guidelines for style and referencing

For a paper from a journal:
Clough, M. & Olson, J. (2004) 'Nature of Science: Always part of the Science Story', *The Science Teacher,* **71,** (9), 28–31

From a book:
Harlen, W. (2010) *Principles and Big Ideas of Science Education.* Hatfield: Association for Science Education

From a chapter in a book:
Harlen, W. (2006) 'Assessment for learning and assessment of learning'. In Wood-Robinson, V. (Ed.) *ASE Guide to Secondary Science Education.* Hatfield: Association for Science Education, 173–180

From an electronic source:
Eisenkraft, A. (2003) *Expanding the 5E model.* Available from http://www.its-abouttime.com/htmls/ap/eisenkrafttst.pdf Accessed 17.10.09