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Science Teacher Education

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Editorial

After the temporary suspension of *News, Research Roundup* and *Resource Reviews* to make way for extra articles in our October 2014 ‘special issue’, *STE* 72 contains a bumper crop of top quality articles and review items. We start with a response to the **Carter Review** by one our longest-serving members of ATSE, Keith Ross, who reminds us that, although he might have retired from daily involvement in teacher education, he is still active with his pen and computer! His response to Carter’s question on ‘what models there are to equip intending teachers with skills and knowledge to become outstanding’ draws on years of experience with the Gloucestershire Initial Teacher Education Partnership (GITEP). Ross clearly shows the benefits of a strong HE partnership with schools, where different teaching experiences are reflected upon and used to move student teachers’ skills and knowledge forward in both the subject and how best to teach it. Reading his article, one wonders whether we will see such exemplary practice in the future.

Our second offering is the first of two emerging from the highly successful joint ATSE-NAIGS Conference held in July 2014. Don’t forget to sign up for **this year’s Conference,** which promises to be a crucial opportunity for debate and information-sharing. Len Newton and Pete Sorensen from Nottingham describe Project ‘MaSciL’ (*Mathematics and Science for Life)*, aimed at promoting the widespread use of inquiry-based science teaching in primary and secondary schools in Europe, by connecting mathematics and science education to the world of work. The Project involved the provision of a professional development toolkit that can be used with pre- and in-service mathematics and science teachers. **Newton and Sorensen** describe how this toolkit can help to support professional learning communities (PLCs) of science teachers.

Our second article from last year’s Conference is by a team of authors from Bath Spa University, led by **Dan Davies**. Their article begins by reminding us of some of the trials and tribulations of assessing using the National Curriculum levels and new possibilities emerging in the ‘post-levels’ world. Data from the Teacher Assessment in Primary Science (TAPS) Project at Bath Spa suggest that many teachers have developed a mentality in which ‘levelling’ through measurement is seen as a more valuable assessment tool than just plain old ‘good judgement’. As part of post-TAPS work, the research team came up with a sort of ‘energy pyramid’ model, showing types of assessment used in schools and what processes and outcomes are operationalised at each ‘level’ (of this pyramid). The model is a very pragmatic, bottom-up explanation for the values and contributions of formative and

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diagnostic assessment. When I saw this at the ATSE Conference, I thought that it had great potential for our teacher education students to understand what assessment should be all about *(but given that this might be difficult, to influence what our school partner tutors might provide).*

Our final article is by **Pauline Hoyle**, Associate Director of the National Science Learning Network (NSLN). It is now some time since we published an article from what was once the NNSLC (National Network of Science Learning Centres). Pauline updates us on how the National and Regional Centres have changed to form a network responsive to local and individual requirements for professional development (PD). Using evidence on what makes effective PD, the article describes how the NSLN is responding in the changing environment for ITE and CPD and with its wider remit for STEM (involving Engineering, Technology and Mathematics), rather than the more limited remit, for just science, that existed in the old NSLC.

Our ***Research Roundup*** section features a review of an article continuing the assessment theme (from the Bath Spa piece). In this case, the value of peer assessment by students in chemistry classes is researched and reviewed. Paul Denley's *Research Roundup* contribution reminds us that the CASE project lives on. He prefaces his review with some experiences from his recent work with an audience of International Masters' students, who could not believe that, with evidence from CASE evaluations, the UK did not make more changes to its National Curriculum, or to science teaching more generally. I think that many of us working in UK education for the last few decades could provide many reasons for this and Denley reviews some of them.

Finally, Paul's ***Resource Review*** (*Teach Now! Science: The Joy of Teaching Science* by Tom Sherrington) shows that there might be a worrying new trend for books emerging from the new regimes of School Direct and the like that, while being useful for teaching tips, skate rather superficially across the more complex landscapes of learning psychology or pedagogical content knowledge (PCK).

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Please note that the opinions expressed in this Editorial are those of the Editor and do not necessarily reflect views of ASE or ATSE.

Editorial

Future issues of STE

Articles, letters for publication, research ideas and reviews of published material are welcomed.

Deadline for the June 2015 issue is **Friday 15th May 2015**

Deadline for the October 2015 issue is **Friday 18th September 2015**

Deadline for the February 2016 issue is **Friday 18th December 2015**

All correspondence and enquiries about journal content should be sent to the Editor, Martin Braund, at the University of York. E-mail: **martin.braund@york.ac.uk**

Please make sure that full contact details including your position, affiliation, job title and e-mail address are included on all material submitted, thank you.

Science Teacher Education, the ASE's first electronic journal, is available on subscription. ATSE and NAIGS members receive *STE* as a benefit of membership, ASE members for £15.00 per annum for three issues. The cost to non-members is £30.00 per annum.

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Quality learning in science ITE takes time and some effort!

• Keith Ross

Keith responds to questions posed by the Carter Review, response dated 22nd September 2014.

Your question Q1a) asks:
Delivering effective ITT provision – What practical strategies, models and practices do ITT providers and schools deploy to equip trainees with the skills and knowledge to become outstanding teachers?

I worked for many years as the science subject tutor for the Gloucestershire Initial Teacher Education Partnership (GITEP), a partnership between the University of Gloucestershire and the Gloucestershire Association of Secondary Heads.

Four to six trainees with different subject specialisms were placed in each 'parent school' under the guidance of a *Training Manager* (a Deputy Head), who undertook all the professional studies side of ITE – classroom management, learning theory, behaviour management, assessment, etc., loosely following a course text developed jointly by all participating schools and the University.

However, the unique value of GITEP is the way that it deals with the subject-specific part of an intending teacher's education. Every Thursday afternoon, the intending teachers met with their subject tutors, so I met with 20-25 science graduates, each from a different school with different experiences. I developed a course that re-activated their knowledge and understanding of science through examples of teaching approaches.

One afternoon we created a timeline from the Big Bang, through the formation of the solar system, the evolution of life and humans on the planet and through the recent history of the development of science and technology. Each pair of graduates would research the last 10, 100, 1000, 10000, 100000, etc. years, then we described the whole story on a logarithmic timeline. This illustrates a teaching technique through which pupils can research parts of a scientific story and they then present it to the whole class. It also fills in some major gaps in the trainees' science knowledge.

The point I am making is the huge value in getting all 20 trainees together for the three hours on those Thursday afternoons. We begin with their own tales of success (and failure) from their week's teaching and observations, enabling them to obtain advice from me, or their peers. Then, we

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● Keith Ross

share teaching ideas (such as I exemplify above) with pedagogical and science input. I did not normally get involved with their day-to-day lesson planning – that was the job of their science mentor (and, to a lesser extent, their Training Manager) in school – however, I ran a website enabling them to comment on each of our Thursday sessions and also to put up questions relating to their lesson planning, to which I, or others, could respond.

Student teachers who are stuck in one school, however well prepared the school might be, with little chance to meet other science trainees, miss out on this opportunity to broaden their subject knowledge and introduce a great variety of teaching approaches.

So, as we consider your statements *[with my comments in italics]*, you can see the huge value of running ITE from an HE centre, as long as it is part of a partnership with schools.

Training that takes place in an isolated individual school is not only inefficient (I deal with 20 science students at a time), but also does not provide the variety of exposure and experience needed by intending teachers:

- Trainees finish ITT with strong subject knowledge. *[Enabled by the Thursday meetings – my course was planned so that most of the difficult subject areas are tackled];*
- Trainees finish ITT with a strong grasp of and ability to apply effective subject-specific pedagogy. *[In school, they see just a few examples of teaching approaches but, when 20 trainees are gathered together, a full range of teaching approaches can be explored];*
- Trainees are critically reflective, research-literate and feel confident and are effective in taking an evidence-based approach to their own practice. *[Few classroom teachers have time to keep up with educational research findings – until teachers are given sabbatical terms (every 5 years?), we will continue to have teachers who may be excellent in their own schools but will be unaware of the developments made elsewhere. This awareness cannot be formed in the initial teacher education year, but it starts there, and it needs science tutors who are given the time to research and read research findings];*
- Trainees can deal confidently and effectively with challenging pupil behaviour. *[This is best done in school by the Training Manager or*

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other teachers as incidents occur; even so, we deal with critical incidents that can happen in science lessons, especially in the lab and, with 20 teachers from 20 schools, their stories can be shared – especially useful if some trainees are in schools where the pupils (nearly) all show a general positive approach to learning];

- Trainees can support pupils with a range of special educational needs. *[Much easier to do this if you are in contact with trainees from 20 different schools, sharing experiences and learning about different disabilities and different approaches to supporting the learning];*
- Trainees can assess and support pupil progress effectively. *[Many schools suffer under the need to get a high percentage of 'C' grades and above for GCSE, which skews the way that assessment is used. Ideally, science lessons will enable students to understand their world better, so we teach for understanding and examinations will follow naturally. Freed from the assessment constraints of individual schools, we can explore the real value of assessment for learning];*
- Trainees can differentiate effectively to respond to individual and collective pupil strengths and needs. *[The question of how to differentiate is taken up by the Training Manager, but we exemplify this in our Thursday sessions too, again drawing on the experience from 20 different schools].*

GITEP gives trainees 4.5 days in their 'parent' school per week (they went to a 'twin' school in the Easter term, to provide variety), along with a group of 3-5 other student teachers of different subjects, and half a day with their same-subject colleagues with a dedicated subject tutor. This seems to me to be the best and the most efficient way to develop excellent teachers for the future. And this system requires the grouping of schools linked with a centre of educational research, which, in the case of science, was provided by my university.

My approach to teaching science, after many years in secondary schools in the UK, but also in India and Nigeria, after a brilliant year doing a Masters degree at Leicester University, and after working for many years with my Gloucestershire trainees, is contained in our book ***Teaching Secondary Science*** written with my colleague Liz Lakin and one of our school science mentors, Janet McKechnie. My doctorate (from Bristol) was undertaken entirely in my own time whilst teaching,

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and has led to many talks and journal articles relating to people's understanding of what happens when fuels burn and when we respire food.

Although I am now retired, I have recently completed my work on the 4th Edition of *Teaching Secondary Science,* have guest-edited the **September 2014 issue of School Science Review** and also am co-creating 4-minute animated science videos (examples at **bit.ly/1sBbmHT**) with the Fuse School, which are free to students and teachers worldwide (see **www.youtube.com/fuseschool**).

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Preparing science teachers for assessment without levels

• Dan Davies • Christopher Collier • Sarah Earle
• Alan Howe • Kendra McMahon

Introduction

Assessment is primarily a matter of judgement rather than measurement, yet for too long we have been pretending that we can measure pupils' attainment and progress in increasingly fine detail (one APS 'point' being one sixth of an original National Curriculum level). The lack of validity and reliability of this approach becomes obvious when we try to assess something as multi-dimensional as practical work in science (Roberts & Gott, 2006), yet the current 'bonfire of the levels' in the new National Curriculum in England (DfE, 2013) has left schools and teachers feeling vulnerable and reluctant to discard the 'comfort blanket' of numerical tracking systems. Data from our Teacher Assessment in Primary Science (TAPS) Project suggest that very few primary schools have yet adapted their assessment approaches to the 'post-levels' world, and that most will continue levelling pupils during 2014-15 – as indeed they are required to for Years 2 and 6 (ages 7 and 11) – whilst possible alternatives are explored. We suspect that the situation is similar in most secondary schools, particularly as they prepare for the introduction of the *Progress 8 school performance measure* (DfE, 2014), which aims to track the progress of pupils from the end of Key Stage 2 (age 7-11) to GCSE. On our primary and secondary PGCE programmes at Bath Spa University, we have in the past introduced beginning teachers to a number of formative strategies for science assessment, yet saved the summative process of 'levelling' to the end of the course, since this is one of the areas that they find most difficult.

So, we should see the loss of levels as an opportunity rather than a threat, to bring formative and summative assessment closer together and ultimately to find more valid ways of assessing what it means to be a scientist. The TAPS Project, based at Bath Spa University and funded by the Primary Science Teaching Trust, aims to develop a system for assessing science that will support teachers to use the full range of pupil information available in the primary classroom to assess and develop learning. The research questions we are seeking to address are:

RQ1: What approaches are primary teachers currently using to assess children's learning in science?

RQ2: How valid, reliable and manageable are these approaches?

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RQ3: Can an approach be synthesised from existing good practice and ongoing development over the course of the Project, which meets the requirements of the revised National Curriculum, implements Nuffield recommendations, and which is valid, reliable and manageable for teachers?

RQ4: What is the potential role for ICT in enhancing validity, reliability and manageability of teacher assessment in primary science?

RQ5: What model(s) of CPD can support teachers in developing their skills to make valid and reliable assessment judgements in science whilst retaining manageability?

Our findings to date are based on analysis of two principal data sources:

- The submissions to an online database of science subject leaders in all 91 English primary schools who worked towards the Primary Science Quality Mark (PSQM) in Round 4 (April 2012 to March 2013). Data consist of written reflections in Spring 2013 regarding current school practice in science and developments over the past year.
- Visits to TAPS Project schools undertaken in November 2013, January and March 2014, involving interviews with science, assessment and ICT co-ordinators; observations of science lessons from Years 1 to 6 (ages 6-11); collection of school science and assessment policies; collection of examples of assessment tools, annotated pupil work, tracking grids, reports to parents, etc.

The model of teacher assessment developed through the TAPS Project

A working group of science assessment experts convened by the Nuffield Foundation (2012) recommended that the rich formative assessment data collected by teachers in the course of ongoing classroom work in science should also be made to serve summative purposes (reporting to parents, teachers of the following age group, government) through synopsis at the end of academic years or key stages. They developed a pyramid model for the flow of assessment information through a school, using the analogy of energy flow through a pyramid of numbers in an ecosystem. The TAPS Project aims to operationalise the Nuffield working group

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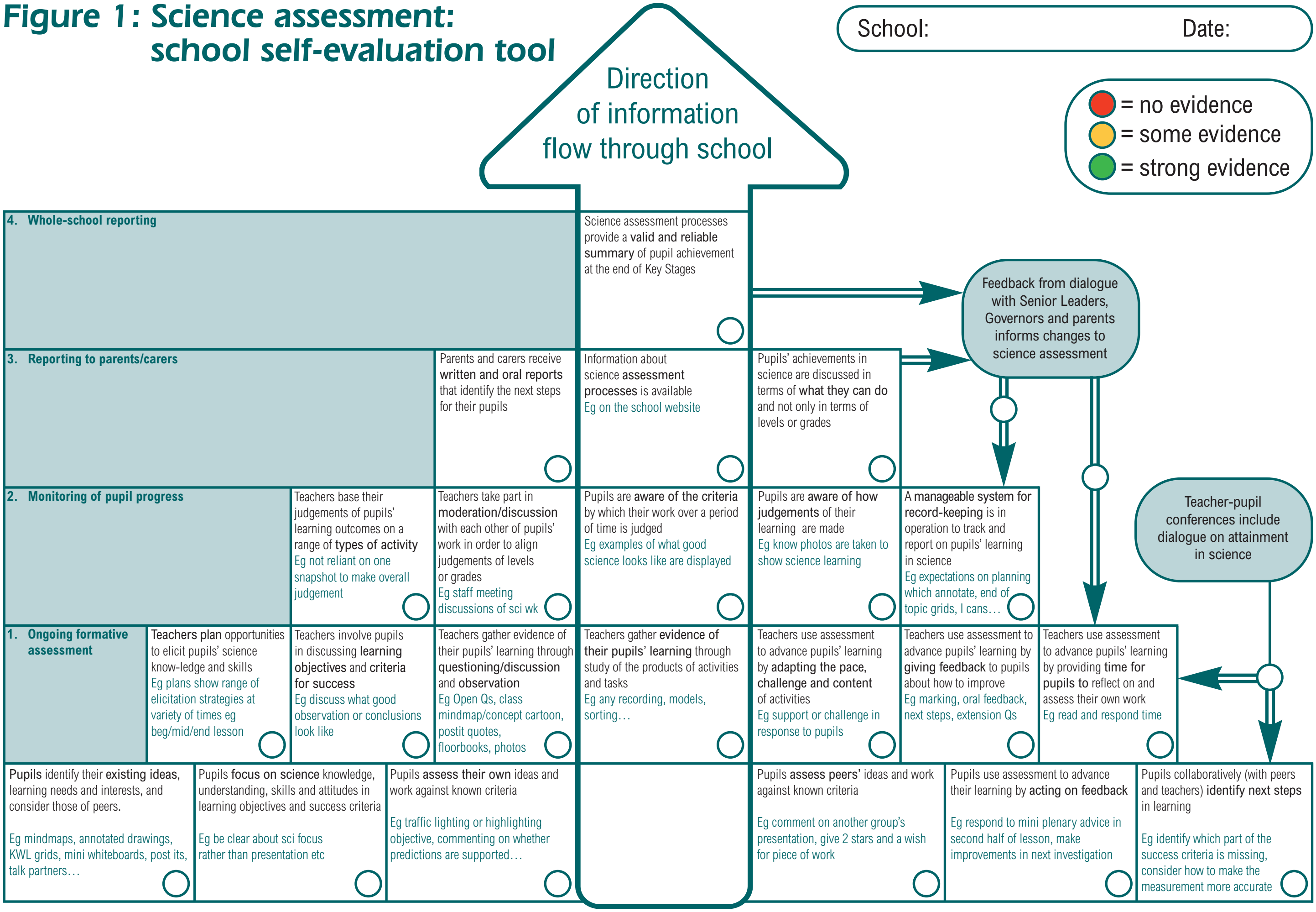
Figure 1: Science assessment: school self-evaluation tool



Produced by the Teacher Assessment in Primary Science Project, Bath Spa University, developed from the Nuffield Foundation (2012) and Harlen (2013)

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recommendations by developing this pyramid model into a whole-school evaluation tool (See Figure 1 on p.11, also available on www.pstt.org.uk), to support schools in identifying strengths and weaknesses in their assessment systems and provide an exemplified model of good practice. Assessment information feeds up from the ongoing formative assessment layers, with the actions of pupils and teachers in the classroom being the basis of later monitoring or reporting. In the same way that feedback loops within an ecosystem affect populations in the layers below, feedback from summative assessment, tracking and reporting can influence how teachers and pupils make use of formative evidence.

To exemplify the layers and cells within the pyramid tool, we have gathered examples from Project schools, published as a series of case studies in Davies *et al* (2014). For example, in one school, children are involved in discussing learning goals through the collaborative process of constructing a 'Learning Wall' as a whole class (see base layer of Figure 1). Individuals or groups develop KWL grids (What do I *K*now? What do I *W*ant to know? What have I *L*earnt?) or Mind Maps that identify relevant prior knowledge that the children have and what questions they have about the topic. A 'Learning Wall' is a display board in the classroom that is used to document the development of a topic for the whole class, using children's drawings and writing and photographs, annotated by the teachers for younger children.

In another school, *teachers involve children in discussing learning goals* and the standards to be expected in their work (see second layer of Figure 1). At this point, teachers take care to ensure that the children understand the meaning of key words that will be used during the lesson, giving them an opportunity to discuss them with each other. Once the lessons are under way, *teachers gather evidence of the children's learning through further questioning/discussion* by using a range of strategies. This might be in the form of partner 'buzz-time' discussions, to respond to searching questions such as *'what do batteries have inside them?', 'what do you notice (about the batteries)?'*

Teachers will note where the children need to be reminded to focus on learning objectives, and intervene appropriately: *'It's important to explain …', 'Why?', 'Let's predict what is going to happen',*

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'What are you going to measure?'. Opportunities for dialogue might be planned throughout the lesson. *Teachers gather evidence of the children's learning through observation* by planning to work with groups to assess progress, or making use of teaching assistants to make observations on specific children as they monitor the remainder of the class. The teacher might say *'I'm going to eavesdrop on your group'* as she listens in, and might make a *Post-it* note of a key utterance to be used later to assess an individual's learning.

In relation to the third layer of Figure 1 (monitoring progress), another school's approach to *gathering a range of evidence to inform judgements* includes paying heed to children's responses to feedback. The assessment co-ordinator explained that feedback to Key Stage 1 (age 5-7) children is given immediately, whereas with older children time is given for pupils to respond to comments made on their work during science lessons. From the range of information gathered, scientific knowledge and enquiry skills are assessed against statements on a tracker grid that is included in children's exercise books. The approach demonstrates how the child can be fully involved in the assessment process to the extent that s/he is aware of the criteria used in making judgements. The statements are expressed in the first person and in a language that makes sense to primary-aged children. In another school, the science subject leader set up a series of 10-minute science moderation slots that take place within staff meetings across the year: *'Moderating regularly in small manageable chunks helps us to maintain a high profile for science, gives teachers confidence and means we have super evidence of children's attainment'* (Subject Leader). This moderation has led to the creation of a school portfolio of assessed work in science.

At the level of reporting to parents (level 4 in Figure 1), in one school, children's achievement is discussed in terms of what they can do, not only in terms of levels or grades. For most year groups, reports to parents are not based on a level of attainment in science, and attitude is an important focus. In relation to the top layer of our pyramid (whole-school reporting – Figure 1), the presence in another school of detailed science attainment data held electronically on a database such as SIMS enables key staff to manipulate and interrogate these data to monitor progression rates for different groups of children, particularly in a school with a high turnover. Extensive statistical analysis of assessment data held in numerical form needs to be undertaken with caution, since the apparently fine-grained nature of such data is only as reliable as the original teacher judgements that underpin it; however, the school's painstaking approach to evidencing and moderating such judgements provides a level of reassurance on this point.

Overall, whilst differing in the tools used and the ways in which children's progress is tracked, science assessment in the schools we have visited displays some common features that our evaluation tool would suggest exemplify good practice:

- A strong emphasis upon formative assessment (AfL) as lying at the heart of the teacher assessment process and which leads or drives the summative judgements made. The use of 'Learning Walls', KWL grids, 'buzz' groups, exemplification of objectives and IWB discussions all have high validity as assessment strategies, though recording them more formally raises manageability issues for teachers.

- A concern to involve children as much as possible in assessing their own science progress, providing feedback to each other and responding to the interactive feedback of their teachers and teaching assistants (TAs).

- A separation between the assessment of procedural and conceptual components of scientific attainment. This increases the manageability of the assessment process, but arguably compromises its validity, as scientific process skills may be concept-dependent so need to be assessed in relation to a range of conceptual content.

- A rigorous approach to evidencing teacher judgements. Clearly, evidencing every judgement with a piece of children's work, an observation or quote, can create an unmanageable system, but a light sample of evidence can provide assurance of the consistency (reliability) of teachers' judgements and the validity of assessment activities, particularly if hyperlinked using an electronic system.

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- A focus upon moderation of teacher judgements as part of the transfer of evidence gained from formative assessment to quantitative tracking systems, thus increasing the reliability of those judgements.

One final feature of these schools' approaches to assessment of children's scientific learning is the commitment to staff development to enable all colleagues – teachers and TAs – to gain a good 'feel' for what it means to be a scientist. At present, some aspects of this 'feel' have been for 'levelness', so there is a job to be done to relate this to 2014 age-related expectations or performance descriptors.

Implications for Initial Teacher Education

Although we have not reached the stage of the PGCE programmes at Bath Spa University where we introduce our beginning teachers to the mysteries of summative assessment, we are conscious that this needs to be done in quite a different way from previous years, in order to avoid inducing in them the fear and confusion currently affecting many schools. By introducing them to the principles of good practice in teacher education through the pyramid model, exemplifying each layer and cell for them and inviting them to use it as an evaluation tool in their own classroom practice, we aim to develop a new generation of teachers who are confident in their exercise of assessment judgements and who are not reliant on computer-based, quantitative level-tracking software to validate their professionalism.

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Making 'better STEM' happen: The role of the MaSciL project

• Len Newton • Pete Sorensen

Introduction

'Too often in secondary schools, science has seemed to students, parents and teachers to be quite separate from the rest of the curriculum and from the realities of everyday life; it has often seemed remote, clinical and inaccessible. The unique and distinctive features of science have, perhaps, been emphasised to such a degree that they have served to isolate the subject, making it difficult for all but a minority of students to gain much pleasure or satisfaction from its study' (Secondary Science Curriculum Review (SSCR), 1987, p.1).

This paper describes aspects of Project 'MaSciL' (*Mathematics and Science for Life*), which is aimed at promoting the widespread use of inquiry-based science teaching in primary and secondary schools in Europe by connecting mathematics and science education to the world of work. MaSciL is one of several recent European Community (EC)-funded projects aimed at promoting a widespread use of inquiry-based science education (IBSE). Here, we explain the broader context in which the MaSciL project is located. Next, we examine the particular focus of the Project on the 'world of work' (WoW) and describe the development of a professional development toolkit for use with pre- and in-service mathematics and science teachers. We describe how the toolkit can help to support professional learning communities (PLCs) of science teachers and, finally, we consider how the MaSciL project can serve to support developments in science teacher education in England.

Background

The European Community's commitment of resource to projects designed to research, develop and disseminate novel approaches to science teaching followed the publication of the so-called Rocard report in 2007 (Rocard *et al,* 2007). That report called for a shift from typically deductive teaching approaches towards more exploratory, inductive science pedagogies. Two further pertinent exhortations in the report were to support connections between wider communities of 'actors' with interests in school science education and, secondly, to connect teachers in ways that would support professional engagement and learning.

The attention given to these issues in Europe was also reflected internationally in order to address perceived crises in shortages in a STEM-educated

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workforce. Thus, whilst in 2004 the EC produced a report entitled *Europe Needs more Scientists*, in the United States a significant group of learned societies produced a report, *Rising Above the Gathering Storm* (2007), which raised similar concerns. Overlaying these policy-focused reports, international research such as that for the 'Relevance of Science Education' (RoSE) (Sjøberg & Schreiner, 2010) revealed worrying international discrepancies in young people's views and experiences of learning science in secondary schools. More recently, research for the Aspires Project (2013) reveals worrying detail of young people's aspirations for careers in STEM subjects. Given these issues, the recent report by England's Ofsted (2013) addressing the need to maintain students' curiosity in science education is a welcome development.

Once gained, now lost expertise?

In the UK, there is long, but perhaps now forgotten, history of innovative, inquiry-oriented curriculum development in science education. Such developments, supported for example by the Schools Council and Nuffield Curriculum Trust, had their roots in debates in the US. Writing in the 1960s, Rutherford asserted:

'We stand foursquare for the teaching of scientific method, critical thinking, the scientific attitude, the problem-solving approach, the discovery method and, of special interest here, the inquiry method' (Rutherford, 1964, p.80).

By the 1980s, elements of a more inquiry-orientated curriculum could be discerned in some schools. However, progress was slow and the concerns quoted at the start of this article, from *Better Science: Making it Happen* (SSCR, 1987), provided the impetus to the establishment of the Secondary Science Curriculum Review (SSCR). In his foreword to the *Better Science* report, Jeff Thompson, who went on to chair the Science National Curriculum Working Party, stressed the need to connect science with *'the wider community of teachers, parents, LEA officials, government officials, higher education, the world of work, and the students themselves, in creating the means whereby changes can be made in the improvement of science teaching in the secondary schools, for the benefit of all'* (SSCR, 1987, p.iii).

Most recognised the need for change and many of the teachers and other stakeholders involved felt empowered to make a difference. Thus it is ironic,

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even tragic, that the curriculum reforms in England over the 25 years or so since SSCR and the introduction of the National Curriculum have led to the position where there is now required a flurry of activity to reinvigorate and refocus science education in directions that were once to the fore in UK curriculum development.

Nevertheless, such a shared history lends an advantage to those working in the UK context and the potential contribution of expertise to the wider EC. Having said this, we need to approach the area of IBSE with a degree of caution. Understandings of what is meant by IBSE are multiple and varied. Given this, it is no surprise that some of the research evidence in terms of outcomes is mixed. For example, Minner *et al* (2009) published a research synthesis of 138 studies and argued that some of the defining features of IBSE did serve to support students' conceptual learning.

However, intensive use of inquiry instruction did not *necessarily* improve student outcomes. The MaSciL Project seeks to develop the application of IBSE in a manner that draws on the features that are most supportive of developing students' conceptual understanding of science, as well as contributing to aims concerned with developing scientific skills and an understanding of how science contributes to society.

Engaging science teachers

Whilst the number of European projects focused on building knowledge and understanding of IBSE grows, a question remains about the wider reach of such projects for the community of STEM educators, especially schoolteachers. Thus a challenge remains to engage classroom practitioners in projects so that there is a realistic chance that the fruits of such projects can influence and shape the development of classroom practice.

Too often, teachers are positioned as receivers of research and, somehow, expected both to know about research and to make use of its fruits in teaching. In the context of the increasing demands on teachers, reliance on such a passive approach is unrealistic. There is no doubt that professional associations like ASE, learned societies and other agencies have a critical role to play in disseminating research and supporting teachers' use of it.

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In England, the MaSciL Project has at its core a view, in common with some other projects, that teachers should be partners in research as members of PLCs with researchers, teacher educators and other stakeholders (e.g. workplace representatives). Thus the MaScIL Project has a rationale for professional development that aims to be sustainable and scalable and which is locally situated in schools and contextually appropriate.

Bringing actors together

In line with the previous discussion, the MaSciL Project has adopted a Participatory Intervention Model (PIM) designed to *'integrate theory and research in the development of culture- or context-specific interventions, and to promote ownership and empowerment among stakeholders who are responsible for sustaining and institutionalising the intervention after the support provided by the interventionists or consultants has ceased'* (MaSciL, undated). The PLCs form part of the PIM, reflecting the concern to take into account the social dimensions of learning and the evidence that collaborative models are a critical component of effective professional development.

The MaSciL Project has also set out to bring together the characteristics of IBSE in learning contexts that are meaningful and can be seen as having purpose to learners. In particular, MaSciL seeks to support learners' inquiry-orientated experiences of science and mathematics in workplace contexts, which we term the 'World of Work' (WoW).

It is fair to say that WoW is an elusive construct. Project MaSciL sets out to exemplify WoW in a wide range of contexts for learners at both primary and secondary levels. Thus, these examples offer representations of WoW that serve different purposes in the classroom. Examining the range of WoW contexts helps to identify some defining features of WoW tasks that give the construct meaning and purpose in relating to classroom tasks. These defining features of tasks can be summarised as:

- **Context:** that can be strong (i.e. rich context) or weak (i.e. 'task wrapping');
- **Activities:** those which have a similarity to authentic work practices;
- **Professional role:** authenticity – learners stepping out of school role into another; and

Making 'better STEM' happen: The role of the MaSciL project

• Len Newton • Pete Sorensen

- **Product:** task outcome – similar to workplace 'products'.
  [Source: MaSciL re-design guidelines (no date). Available online at **http://bit.ly/1z8N9eR** Accessed 01.12.2014]

The Project has produced some new materials as exemplars, but this has not been a main concern. Curriculum innovation phases over many years have produced a vast array of relevant resources to draw from. The national organisations mentioned earlier provide ready access to this heritage through the Internet, and these bodies, together with a variety of other organisations and individuals, continue to add to the resource base. Thus, the emphasis of the Project is on the approach to the use and modification of existing resources as part of furthering the emphasis on Inquiry Based Science Learning (ISBL) and the WoW.

The PLCs are supported by a 'toolkit for professional development'. Two versions of this exist: one for pre-service, another for in-service. Each toolkit, developed and piloted with the support of teachers across Europe, is a flexible resource designed to enable teachers to improve their teaching by adopting IBSE practices that connect to the WoW. The flexibility allows for prioritisation of particular aspects according to the needs of particular individuals and PLCs. The toolkit consists of three domains: 'Ways of Working', 'The World of Work' and 'Inquiry Learning'. The initial focus on 'Ways of Working' is crucial, as it sets the framework in which the PLCs can develop.

In order to develop the PLCs, a pyramid model has been adopted. In this model, particular interventions, be they at national, regional or local levels, introduce the Project and toolkit to participants who can then go on to act as 'multipliers' or facilitators in their PLCs. The availability of the toolkit online allows for all members of the PLC to have access to all the materials. The MaSciL site provides links to the broader learning community, supporting networking across Europe.

The English context and MaSciL

In England, the aspirations of *Better Science* (SSCR, 1987) have proven to be elusive targets. Other pressures, notably in relation to assessment and accountability, have seemed to work against

IBSL approaches and their application in authentic contexts like the WoW. However, the current climate would appear to provide grounds for some optimism. In particular:

- the new National Curriculum for England stresses 'Working Scientifically', with a focus on inquiry and the applications of science. This is expected to be at the core of teaching about concepts. Moreover, the requirement to use levels in the assessment processes, seen as difficult to apply in IBSL, has been removed;
- the national inspection body, Ofsted, is putting a strong emphasis on the findings reported in *Maintaining Curiosity* (Ofsted, 2013). This document states that the best teachers *'put scientific enquiry at the heart of their teaching' (p.5).* It also notes that the best science leaders in schools *'allowed students to see the purpose of science learning and its enquiry-based skills within a wider context applicable to future careers'* (p.34). It is clear that Ofsted will be expecting to see evidence of IBSL and WoW in their inspections;
- more priority is being given to the provision of subject-specific professional development, supported, in part, by the National STEM Centre (**www.nationalstemcentre.org.uk**) and National Science Learning Networks (www.sciencelearningcentres.org.uk), as well as the various subject associations;
- more opportunities are being provided for teachers to take a lead on research and development in school. In some cases, this has been linked to performance management expectations, with a renewed focus on professional development; and
- a range of new groupings have developed in recent times, including teaching school alliances, academy chains and school partnerships with higher education institutions, all including an emphasis on supporting professional development. Such local structures are being supported through various regional partnerships and the national centres. The Mascil Project, with its focus on PLCs, is designed to be able to support these local, regional and national networks in a flexible manner.

Concluding comments

The MaSciL Project aims to make a contribution to science and mathematics teacher education across Europe. For science teachers in England, it has the potential to support and empower them to make a difference to the learning and aspirations of their students. The history of science education in England is a rich one. In developing the MaSciL Project in England, we draw on this legacy and seek to learn from it, in support of 'Better Science' and, more broadly, 'Better STEM'.

Footnotes:

To get involved with the Project, please contact: **peter.sorensen@nottingham.ac.uk** or **mary.oliver@nottingham.ac.uk**

The MaSciL Project website is at: **www.mascil-project.eu**
The in-service toolkit can be found at: **www.mascil.mathshell.org.uk**
The pre-service toolkit can be found at: **www.mascilite.mathshell.org.uk**

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Biographical notes

Len Newton and Pete Sorensen have each worked in science education in schools and universities for over thirty years. They share a common interest in inquiry-based approaches to teaching and learning science. Between 2009 and 2014, Len Newton edited *Research in Science and Technological Education.* Pete Sorensen’s interests include collaborative approaches to teacher development, Nature of Science and teacher education.

The National Science Learning Network: supporting effective and impactful professional development and learning

• Pauline Hoyle

In this article, we examine the evidence for what makes effective professional learning and development for teachers; the need for subject-specific continuing professional development (CPD), particularly in science/STEM (science, technology, engineering and mathematics) subjects; and the drivers for engagement with it by teachers, technicians and schools. We outline how the National Science Learning Network[1] supports teachers' professional learning and development through a range of face-to-face, online and in-school activities, with proven, positive impacts on teachers, schools and young people.

Background

Over the last five years in England, there has been a significant shift towards a self-improving school-led system, with groups of schools working together, led by expert teachers and leaders, to develop and improve practice. The Department for Education has designated over 500 outstanding schools as Teaching Schools, with a remit including growing their capacity and expertise to support other schools. Both within Teaching Schools and beyond, this shift has led to more teachers being involved in school-based professional learning, using evidence and research to improve their teaching and hence improve outcomes for young people through networks and other activities.

However, no effective professional system can be entirely self-reliant, with doctors, lawyers and engineers, as well as teachers, knowing the value of drawing on expert, external sources of subject knowledge and skills to complement peer-to-peer support. This applies across all subjects and disciplines, but most notably to subjects that change rapidly or require teachers to teach beyond their specialism, such as can happen often within STEM.

The question then becomes one of how do teachers and schools identify their professional development needs and, once identified, work out how to identify and access the internal and/or external support that will have most impact on them and the young people they teach?

[1] The National Science Learning Network comprises the National Science Learning Centre funded by Project ENTHUSE, and the network of Science Learning Partnerships, funded by the Department for Education.

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What makes effective CPD?

There have been several reviews and analyses of the available research evidence about teachers' continuing professional development and learning. In particular, CUREE (2012) presented the evidence from a series of meta-analysis studies and reported that the models of professional learning for teachers that are more likely to improve student outcomes are:

- collaborative – involving staff working together, identifying starting points, sharing evidence about practice and trying out new approaches;
- supported by specialist expertise, usually drawn from beyond the learning setting;
- focused on aspirations for students – this provides the moral imperative and shared focus;
- sustained over time – professional development sustained over weeks or months had substantially more impact on outcomes for students than shorter engagement; and
- exploring evidence from trying new things to connect practice to theory, enabling practitioners to transfer new approaches and practices and the concepts underpinning them to practice multiple contexts.

From these meta-studies, CUREE concluded that the characteristics of the most effective CPD approaches are:

- collaborative enquiry – peer-supported, collaborative, evidence-based learning activities taking place over an extended period, coupled with 'risk taking' (experimenting with new, high leverage, high demand approaches) and structured professional dialogue about evidence;
- coaching and mentoring – a vehicle for contextualising CPD and for embedding enquiry-oriented learning in day-to-day practice;
- networks – collaborations within and between schools depending upon and propelled to success by CPD. The effective networks draw on internal and external expertise, and are clearly focused on learning outcomes for particular student groups; and
- structured dialogue and group work – practised in pairs and small groups, providing multiple opportunities for exploring beliefs and assumptions, trying out new approaches and giving and receiving structured feedback.

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These studies support the notion that the most effective professional development is that in which teachers are involved with sustained professional learning, working with and learning from each other but, also very importantly, drawing on and learning from external expertise as necessary. Bell and Cordingley (2014) reported that there was some evidence that exceptional schools may also make more regular and more specific use of external expertise on a more sustained basis than 'one-off' inputs at INSET days.

Drivers for teachers

Like other professionals, teachers understand that professional development is a key part of continuing to be effective, and is crucial throughout their careers. Recent changes to performance management processes and inspection frameworks reinforce the importance of continuing engagement in professional learning, and teachers in English state-funded schools are now required to demonstrate the link between their teaching, professional development activities and improved outcomes for young people.

This is intended to provide a significant driver for career-long engagement with high impact professional development, including updating of subject and pedagogical knowledge to improve pupils' learning.

This driver should also work to increase schools' willingness to support teachers in high quality and high impact professional development activities. In England, the Ofsted framework requires the leadership and management of a school to demonstrate the 'golden thread' between performance management, continuing professional development, quality of teaching and pupil outcomes. In theory, therefore, schools, teachers and technicians should be more motivated than ever to identify their professional development needs and engage with appropriate support. Indeed, in many cases this is happening. However, in too many instances, this combination of drivers is also making schools reluctant to release teachers for appropriate CPD, since they feel time in the classroom is more important. Whilst understandable on one level, this is false economy – particularly when that means that the teacher is not engaging with professional development with demonstrable pupil outcomes. It is also likely to have negative impacts on teacher motivation and morale; like all professionals, teachers regard CPD as an important part of their professional life, and evidence shows its positive impacts on teacher retention and enthusiasm (Wolstenholme, 2012).

Why engage with science/ STEM-specific CPD?

STEM subjects are some of the school subjects that change most rapidly. Content knowledge in science develops rapidly, particularly in areas such as genomics and biochemistry. In addition, in many secondary schools, science and technology departments simply do not have staff with expert subject content knowledge across the whole curriculum and so it is vital that these staff have opportunities to upskill their subject knowledge. In many English primary and middle schools, there may be no staff with a STEM qualification above grade C at GCSE and, yet, in most instances, all staff are expected to teach at least 10 subjects across the curriculum. In STEM subjects, these teachers need to be able to build on children's natural curiosity to develop their scientific thinking skills, so vital for future study, and to know how best to use the available resources to encourage practical and investigative skills.

With rapid changes to initial teacher education, with in-school routes potentially leading to a lack of time to develop subject-specific content and pedagogical knowledge, it is possible that newly qualified teachers may meet the current standards for QTS without actually spending any substantive length of time on these key areas. These teachers and their schools need time and opportunity to learn from each other, but – just as importantly – also need to draw on the expertise and specialisms of others experienced in science teaching beyond their own institution. This includes colleagues in other schools, including local secondary schools, through networks and collaborative projects but, vitally, should involve engagement in wider professional development opportunities specialising in STEM, such as those available through the National Science Learning Network. This ranges from support to those in training, newly qualified teachers and those beginning their careers, right through to those aspiring to lead science teaching and school leaders themselves.

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It is vital that, even in an era of a school-led system, schools and teachers remain outward-looking, constantly challenging their own practices and beliefs as well as supporting others.

It is only through this that our education system will be truly informed by research and expertise, and all teachers receive the professional development and support they require to be world-class.

From the network of Science Learning Centres to a National Science Learning Network

As the school system has developed, so has the infrastructure to support science-specific professional development. Over the past eighteen months, the National Science Learning Network has transmuted from that originally established in 2004, of nine regional Science Learning Centres and the National Science Learning Centre, to a much more agile, flexible model comprising fifty local school-led Science Learning Partnerships working alongside the National Science Learning Centre, which remains at York.

This move has been made specifically to support the new school-led model of school improvement, ensuring that it can draw on a range of high quality, evidence-based subject-specific expertise around the teaching of science and other STEM subjects. The National Science Learning Network is dedicated to supporting the needs of individual teachers, technicians and schools within a framework that also supports national priorities around encouraging more young people to pursue STEM subjects beyond compulsory education and into the world of work.

The Network ensures that teachers, technicians and schools have access to appropriate subject and pedagogical expertise through local Science Learning Partnerships and the National Science Learning Centre, supplemented by resources of the National STEM Centre.

By utilising excellent physical facilities, including those of former regional Science Learning Centres, and combining this with local practitioner-led professional development, the Network is ensuring that all teachers and technicians have convenient access to a range of relevant, inspiring and effective opportunities, covering practical and theoretical aspects of teaching science. This support provides a range of ways of engaging with CPD, in-school bespoke support, network

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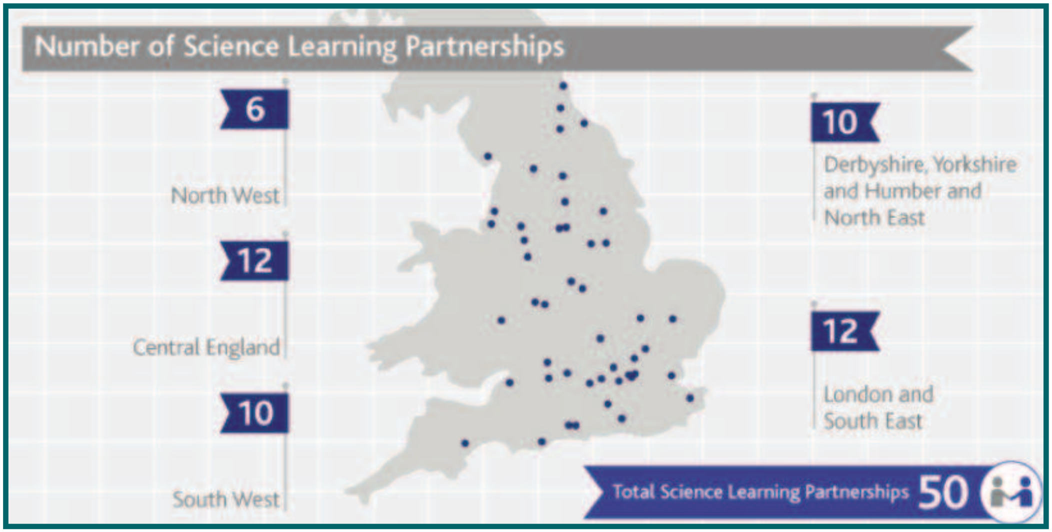

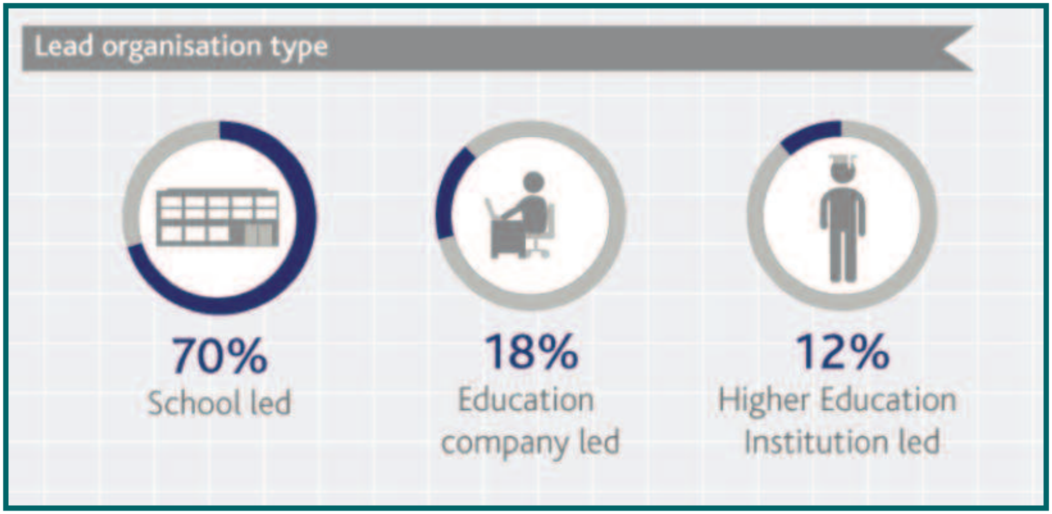

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meetings, mentoring and online networking, alongside short courses, thus providing the sustained, joined-up, knowledgeable and active CPD that teachers and technicians require.

Key successes include:

- continuing high levels of reported impact from teachers and technicians engaging in Network professional development, with significant emerging evidence of impact on staff knowledge, skills and practice and on wider sharing of learning across the school. Importantly, teacher-reported impact from network CPD is significantly higher than that reported for other CPD providers, both in the UK and internationally, according to the well-respected TALIS (2013) report;
- successful establishment of 50 Science Learning Partnerships, so ensuring convenient, local access to support and complementing efforts towards a self-improving school-based model;
- continuity of science CPD support to schools throughout the transition;
- significant increase in the training and use of teacher-presenters in CPD delivery; and
- improved quality assurance across everything the Network does.

What is special about the National Science Learning Network?

Evidence shows that the model of professional development provided by the National Science Learning Network is effective for teachers, technicians, schools and the young people they teach. As such, it is a crucial component of the STEM support infrastructure within the UK that is helping develop a world leading science education for all young people.

Independent evaluation[2] shows that continuing professional development provided through the Network is unique in:

- having proven impact on staff performance and motivation, and student achievement; and
- consistently being of the highest quality, in terms of provision, participation and impact, combining Government and national priorities around STEM with locally-identified school needs.

Specifically, independent evaluation and the Network's own evaluation[2] repeatedly shows impact on student outcomes through:

[2]Summary of external evaluation can be found at https://www.sciencelearningcentres.org.uk/impact-and-research/impact/impact-reports/

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- improving teachers' science subject knowledge and science pedagogy;
- closing the achievement gap and widening participation in science for underperforming groups of students (including students from disadvantaged backgrounds and girls in physical sciences);
- improving subject leadership, including supporting science subject leaders to become Specialist Leaders of Education (SLEs);
- preparing teachers for implementing new curricula and qualifications;
- increasing teachers' exposure to and understanding of cutting edge science;
- integrating information about STEM careers into the curriculum and teaching approaches; and
- promoting the effective use of practical work to enhance and extend learning in science.

The programme is continually evolving as local and national needs change, but always remains firmly focused on impact, underpinned by appropriate science and education research.

How does the Network support teacher progression?

The Network's programme of professional development is designed to underpin participants' entire professional journeys, from trainee teachers to those leading science within and across schools, or for technicians from those beginning work within a school to those leading others. Planned together with the support offered through the National Science Learning Centre programme, it provides options for routes that individuals might take, including, where appropriate, the National Science Learning Centre's more intensive, often residential provision leading to yet deeper impact on pupil outcomes. There is particular focus on, and additional bespoke support for, schools with the greatest need to transform science teaching, including the availability of intensive Impact or ENTHUSE Award bursaries (www.slcs.org.uk/about/bursaries) to help fund the cost of additional help.

Embedding of National STEM Centre resources and support across the programme promotes effective sharing of quality resources and helps develop communities of practice to maximise sharing of experiences and sustained ongoing support.

A relatively recent addition to the portfolio of Network support is online CPD, including webinars and, in Autumn 2014, its first MOOC-like course (Massive, Open, Online Course), an online

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behaviour management course, which attracted over 2,800 participants. This is an area that will inevitably grow over the next few years.
The Network offers several accredited courses for teachers at primary and secondary level, along with technicians. It also recognises the commitment of individual teachers and technicians to CPD, through the Network Teacher and Support Staff Recognition Scheme, which supports individuals in assessing further and recording the impact of their involvement in CPD on themselves, their colleagues and their students. This evidence can be used to support applications for professional recognition as a Registered Technician status (RSciTech) or Chartered Science Teacher (CSciTeach).

What impact does engagement with the National Science Learning Network have on young people's learning?

As mentioned above, teachers and technicians participating in Network professional development continue to report extremely high levels of positive impact on knowledge, skills and confidence as a result of their experiences. Indeed, levels of self-reported impact on such areas far outstrip those reported via the recent TALIS (2013) report, both in terms of international comparison and for other UK professional development (see chart on p.34).

In addition, external evaluation[2] and evidence pinpoint a range of impacts on teachers, technicians and the young people with whom they work, specifically:

- **for teachers**
  - improved confidence and classroom practice
  - enhanced subject knowledge and understanding
  - improved job satisfaction, progression and retention
- **for young people**
  - improved achievement in STEM subjects
  - a better understanding of 'where STEM can take them', including careers
  - enhanced engagement in lessons and extra-curricular activities

The Network is now developing its approach to ensure participants' understanding of how to

[2] Summary of external evaluation can be found at https://www.sciencelearningcentres.org.uk/impact-and-research/impact/impact-reports/

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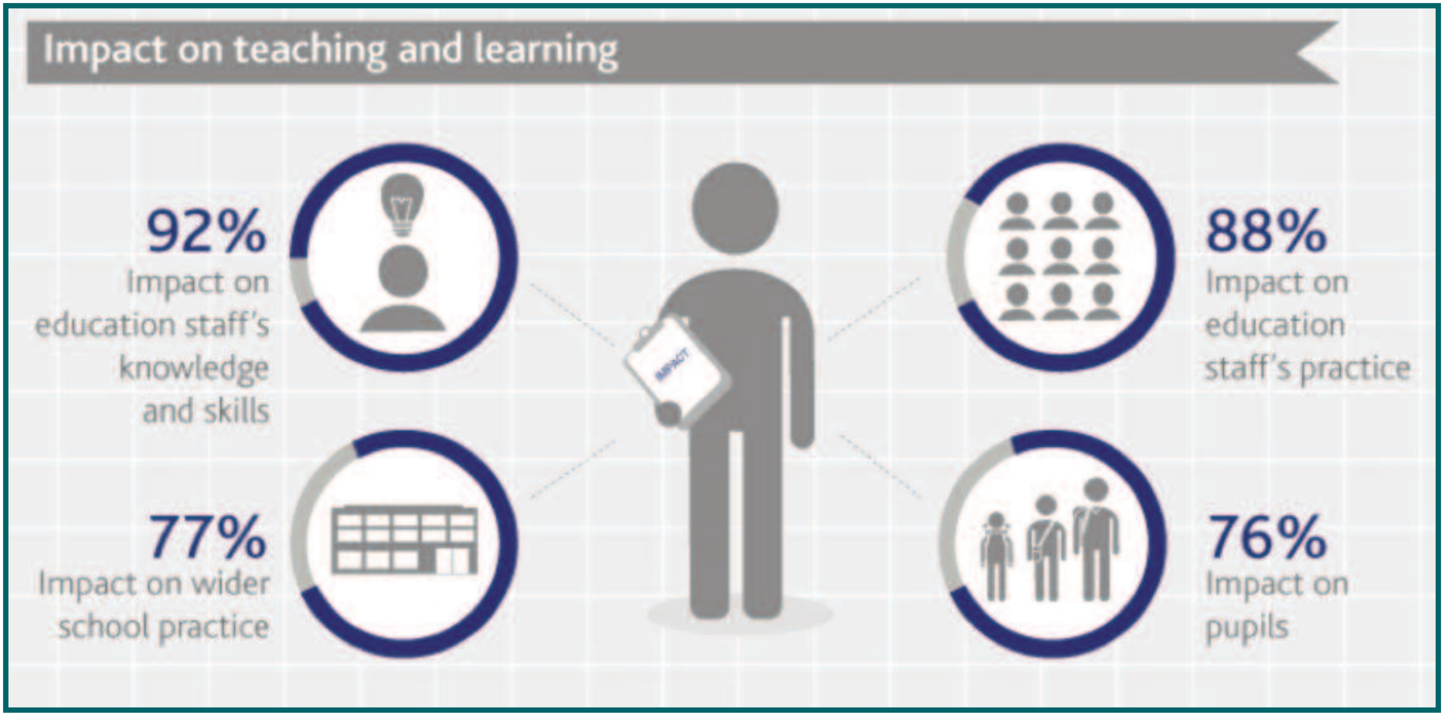
Evidence of impact from across the Network based on Impact toolkit data from 2013/14



identify and, where appropriate, measure impact on pupils, using 'embedded evaluation' and 'action research/reflective practices'.

This draws on research (Kudenko & Hoyle, 2013) that demonstrates how the embedding of specific instruction on identifying and measuring impact is critical in ensuring that teachers are able to provide clear evidence of the impact of their professional development upon their pupils. Building on the Guskey model (2000) of evaluating the impact of professional development, this provides a practical approach to assist teachers and schools in developing this important area.

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Making professional development affordable and accessible

In addition to providing professional development with very high levels of impacts on participants, schools and young people with whom they work, the Network is also unique in providing financial assistance, which ensures that professional development remains affordable to all those working within state-funded schools and colleges.

Such teachers and technicians engaging with professional development activities provided through the National Science Learning Centre are eligible to apply for ENTHUSE bursaries, which contribute significantly towards the costs of participation, including those of supply cover. Similarly, those working with the wider Network, through Science Learning Partnerships, are often able to access Impact Awards, which assist with the costs involved.

ENTHUSE Awards are possible thanks to the generosity of Project ENTHUSE, a unique partnership of Government, Charitable Trust, employer and professional institution funders, who share our view of the importance of subject-specific professional development. Project ENTHUSE was launched in 2008 with £27 million from the Wellcome Trust, the Department for Children, Schools and Families, AstraZeneca, AstraZeneca Science Teaching Trust (renamed Primary Science Teaching Trust in 2013), BAE Systems, BP, General Electric Foundation, GlaxoSmithKline, Rolls-Royce, Vodafone and Vodafone Group Foundation, and received further funding of over £22 million from 2013 from the Department for Education, the Wellcome Trust, BAE Systems, BP, Rolls-Royce, Institution of Engineering and Technology and the Institution of Mechanical Engineers.

Impact Awards, provided by the Department for Education, enable all schools, colleges, teachers and technicians to benefit from the Network's 'core offer', which specifically supports curriculum and other priority areas for the Government.

All Awards are easy to apply for, using the Network's impact toolkit to record learning objectives and reflections on the professional development experience, with participants developing an action plan and – following their experience – reporting on its impact back in the classroom.

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The future

The Network is looking ahead to an exciting future, with the Department for Education recently confirming continued financial support for 2015/16 and the National Science Learning Centre funded via Project ENTHUSE until at least 2018.

In the immediate future, priorities include developing the Science Learning Partnerships, and supporting teachers, technicians, schools and colleges in preparing for new curricula and new challenges as the school-led model develops. We will be developing our range of online and bespoke support, alongside a targeted 'core offer' addressing immediate and emerging needs and concerns. We will also be working with ASE and others to develop further the links between the Teacher and Support Staff Recognition scheme and professional recognition, so providing excellent development opportunities and pathways for teachers of all stages.

The future is exciting, with much work to be done. Together, we will continue to develop teachers' professional learning in science, so benefitting them, their schools and colleges and, most importantly, all young people across the UK.

For additional information on the National Science Learning Network, please visit: **www.slcs.ac.uk**

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News from ATSE

• Caro Garrett

Much of the last edition of *STE* was focused on the future of science teacher education, and our response to the call for evidence by the Carter Review, which of course has not yet appeared. So we find ourselves in a little bit of a lull, preceding the publication of the Carter Review (although I have heard a rumour that it might not appear at all!) and the outcome of the general election. This is an opportunity then to look inward and forward.

Welcome to new Committee members, Anne Cullen (Middlesex), Deb Heighes (Reading) and Catherine Reading (Durham). Massive thanks to retiring members Keith Ross and Alan Goodwin, (who have both been sort of retiring for some years!) and John Oversby, all of whom have made huge contributions to the ATSE Committee and Initial Teacher Education (ITE) in many ways over many years. I know they are all still active and interested, so I am sure we have not heard the last from them. There does seem to be a bit of a gender imbalance developing here and we would welcome any interested new members whose gender might restore the balance (am I allowed to ask that?).

Members of the ATSE and NAIGS Committees have reflected on our joint conference last summer and, following the success of this, are now planning another similar event for summer 2015. Details, as far as we know them, are given below – please put in your diaries and consider responding to the Call for Papers.

As the models of and routes into ITE have been changing, we have had to adapt and innovate, including embracing the requirement to be more involved with our Newly Qualified Teachers (NQTs). This draws us further into the world of NQT induction and Continuing Professional Development (CPD), which clearly overlaps with the remit of NAIGS and its members.

Consequently, we are discussing possibilities of an amalgamation of these two ASE interest groups, ATSE and NAIGS. I will write more on this in the next *STE* in May.

Wishing you all a very Happy New Year, and all the best for you, your institutions and students and the schools, mentors and pupils with whom you and your students work.

Caro Garrett, Chair of ATSE
E-mail: **c.garrett@soton.ac.uk**

News from ATSE

• Caro Garrett

ATSE/NAIGS

Joint Summer Conference 2015

8th – 9th July 2015
Hatfield, Hertfordshire, UK

We welcome papers on any aspect of science teacher education from all those involved as teacher educators or mentors.

In the first instance, an abstract of 500 words should be sent to Caro Garrett at
e-mail: c.garrett@soton.ac.uk

ATSE – Association of Tutors in Science Education

NAIGS – National Advisers and Inspectors Group for Science

News Roundup

As usual, we include a mix of recent announcements and hotlinks on several topics that you might find interesting to pass on to your colleagues and students. Don't forget that readers can send items they think would be of interest to the Editor, Martin Braund at: **martin.braund@york.ac.uk**

Awards

Sue Verdeyen, Education Officer at the Three Counties Agricultural Society, has been given top honours at a national education awards ceremony. The Awards for Outstanding Contribution to Learning Outside the Classroom honour individuals and teams of people who have had a significant impact on the lives of children and young people through inspirational learning outside the classroom (LOtC) opportunities.

Sue won the award in recognition of the work that she has done to develop the educational programme offered by the Three Counties Agricultural Society. As well as planning and delivering workshops on site at the Three Counties Showground and in school grounds across Herefordshire, Worcestershire and Gloucestershire, she also acts as a local champion for learning outside the classroom. She organises the Society's educational activity in and around its main shows throughout the year, and is responsible for field studies, educational workshops and school visits run by the Society in its role as an educational facilitator within the local community, enabling many young people to experience the world beyond the classroom walls.

Talking about her belief in the value of learning outside the classroom, and the importance of getting children outside, Sue said, *'Gardening has been my passion from a very early age – I always loved being outside and enjoying natural surroundings as a child. As I've become older, I have felt increasingly that today's little ones are not getting outside, and that many of them are leading a fairly sedentary lifestyle, which is not only unhealthy, but also means that they are missing out on the fun which comes with the great outdoors and all its treasures, not to mention the fresh air! I also became concerned that children didn't seem to know where their food came from.'*

The Chief Executive of the Council for Learning Outside the Classroom said, *'Sue's passion and* *enthusiasm for her work ensuring that more children can experience the world beyond the classroom walls is outstanding, as is her work building long term partnerships with schools to help them embed regular learning outside the classroom opportunities across the curriculum. I would like to congratulate Sue on this well-deserved accolade.'* Other Award winners were: Emma Schofield, LOtC Educator, Hugh Fearnley-Whittingstall, Celebrity LOtC Champion, and Kate Allies, Lifetime Achievement in LOtC.

The Council for Learning Outside the Classroom is a national charity, which works with educational establishments and providers of LOtC to ensure that more young people can access high quality educational experiences. Find out more about the charity's work and access free online guidance at: **www.lotc.org.uk**

Reports

Universities UK

Universities UK have released their fifth report, *The funding environment for universities 2014*, focusing on those universities in England that provide initial teacher training (ITT). The report examines the recent changes affecting English universities' delivery of ITT, analyses of recent trends in recruitment following the implementation of these changes and, finally, discusses the specific impact on institutions and implications for current and future provision in this area. The **report** can be downloaded from the Universities UK website, but your institution must have a members' login.

Wellcome Trust report on primary science and maths leaders:

Primary Science: Is it missing out?
Reinvigorating primary science is a key priority for the Wellcome Trust. ***Primary Science: is it missing out?*** considers how some of the issues uncovered in the Trust's latest study and other work can be addressed, and makes recommendations for the future.

Research grants

In collaboration with the Education Endowment Foundation, the Wellcome Trust has announced **six projects**, which will investigate the effectiveness of educational interventions and classroom practices that have been informed by neuroscience. With neuroscience continuing to further our understanding of the mechanisms of learning, Wellcome is interested in how this knowledge can be applied to improve education.

Resources

New animations from 'Fast Plants'

'Plant Biology' animation shows three key processes in living organisms – respiration and photosynthesis, growth of plants, and the transport of sugar and water.

Developed in conjunction with scientists and educationalists, this animation has a particular value in reminding students that the different processes taking place are interrelated. Designed to enable teachers to explain, pause and discuss the processes while students are watching in class, there are also student notes to enable the animation to be used for revision purposes as well.

The animation can be viewed in its entirety or in parts, and is viewable across multiple devices as well as being downloadable as videos:

New animation - Growth in Plants with teachers' and students' notes
Respiration and photosynthesis - with new teachers' and students' notes
Transport of water and sugar in plants - with new teachers' and students' guide

Thanks go to Richard Needham and Howard Griffiths for their work on this project. We'd be delighted to hear what you think of these resources and how they work for you in your school or college.

Online resource

Brain: the inside story, a new teaching resource developed by Parkinson's UK, has been created to engage 16-18 year-olds with our most complex organ – the brain. The online resource takes students on an interactive journey through the brain. While fitting in the A-level biology curriculum, *Brain: the inside story* brings to life this complicated, but fascinating, area of human biology.

The online hub contains interactive tools including 'You be the Doctor', where students have the opportunity to diagnose real people's conditions, revision quizzes, and teachers' notes to help with lesson planning.

Secondary school science teachers from across the UK have been involved in the development of the resource to ensure that it is engaging and relevant for A-level students. The resource will improve young people's understanding of Parkinson's, which affects one in 500 people in the UK. Currently, over three quarters of people in the UK have little or no knowledge of the condition.

This free, interactive resource is available at **www.braintheinsidestory.co.uk**

Research Roundup

The aim of *Research Roundup* is to keep readers of *STE* in touch with recently published research and articles in teacher education. The articles might be of interest to readers' own research and/or scholarly activity or to their students.

In each issue, members of the Editorial Board of *STE* and other readers choose articles from recent issues of prominent journals in the fields of teacher education, INSET/CPD and science education.

Of course, our selections are subjective, but we have tried to choose articles that we think have general relevance in teacher education, that resonate with some of the current issues faced by the readership or that might be useful to our students and colleagues.

The bibliographic details are provided so you can trace the full versions of articles or journal issues if you are interested in them. The Editorial Board would like to encourage and invite readers to submit their own selections of recently published articles that might be of interest for the next issue of *STE* (deadline for our next issue is Friday 15th May 2015).

Review of Scott (2014)

Provided by Morag Findlay
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Scott, F.J. (2014) 'A simulated peer assessment approach to improving student performance in chemical calculations', *Chemistry Education Research and Practice,* **15**, (4), 568–575 Doi: 10.1039/c4rp00078a

Simulated peer assessment initially seems like an odd concept. We know that learners generally like peer assessment, although they can also have concerns about the quality of the feedback that they receive and the possible impact of friendship upon this.

We also know that learners studying chemistry can have difficulties caused by lack of mathematical skills, rather than by lack of chemical understanding.

Scott (2014) tackled both of these problems by asking learners to find deliberate mistakes in teacher-provided chemistry calculations by using peer assessment. He calls this process 'simulated peer assessment (SPA)'.

The work reported in Scott (2014) was a revision activity, carried out with three National 5 Chemistry[1] classes (GCSE-equivalent) and three Higher Chemistry (AS-level-equivalent) classes in Scotland in the run-up to external examinations.

In consultation with colleagues, Scott identified common types of chemistry calculation at each level. He then wrote three simulated answers for each topic. Each answer reflected a different common student mistake in that type of calculation. The students worked in groups of two or three to identify the mistakes and to correct the calculations.

The effectiveness of the intervention was gauged by using a pre- and post-test on the same topics. Students were also asked to reflect on their attitude to using simulated peer assessment. The analysis used the students' working grade from the mathematics department as an indication of their mathematical ability. At both levels, all students improved their scores in the post-test, but the highest gains were made by students with intermediate mathematical ability. The students with 'A' grades in mathematics scored very highly, so it was difficult for them to improve their numerical scores, although the simulated peer assessment process would have consolidated their understanding of the chemistry involved. The students with 'D' grades in mathematics lacked the basic mathematical skills to improve their scores significantly. In general, the students enjoyed the activity and preferred it to actually marking other students' work.

Overall, the results in this paper suggest that simulated peer assessment in chemistry has the potential to provide an enjoyable and worthwhile revision activity for pupils. Although the evidence base is currently restricted to six classes in one subject in one school, I feel that the simulated peer assessment technique reported here begins to provide research evidence for a technique that teachers may already use.

Simulated peer assessment is potentially a useful addition to the teaching toolkit across STEM subjects, and possibly beyond, because it draws on teachers' knowledge of the mistakes that their own classes typically make.

[1] Unlike GCSE Combined Science, students in Scottish secondary schools study separate rather than combined sciences in Secondary 3 and 4 (equivalent to Years 10 and 11).

Research Roundup

Review of McCormack, Finlayson & McCloughlin (2014)

Provided by Paul Denley
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McCormack, L., Finlayson, O. & McCloughlin, T. (2014) 'The CASE programme implemented across the primary and secondary school transition in Ireland', *International Journal of Science Education,* 36, (17), 2892–2917

I was recently working on a Masters unit on learning with a group of international schoolteachers (not scientists). In one session, we looked at cognitive development and the development of children's thinking. I used the Cognitive Acceleration through Science Education (CASE) programme as an example to illustrate the Piagetian notion of formal operational thinking and how important this type of thinking is for children's learning, particularly in subjects like science and mathematics. I introduced some of the CASE activities and discussed the principles of CASE through the 'five pillars' structure (described in this article). I outlined how the development of the CASE materials was preceded by the curriculum analysis in the 1980s (before the National Curriculum) by Shayer and Adey, as published in their book *Towards a Science of Science Teaching,* which showed how much of 'upper secondary' science was dependent on formal operational thinking that was unlikely to have developed naturally for many pupils – hence the need for cognitive acceleration. We also discussed the impact of the CASE intervention in terms of improvements some years later in GCSE grades in science and the transfer to improvements in grades in mathematics and English.

Two things surprised the group:

- First, that having analysed the science curriculum pre-National Curriculum, why did the first versions of National Curriculum Science still have a similarly high level of conceptual demand?
- The second surprise was that, having strong empirical evidence of impact through longitudinal research studies, why was the CASE programme not used more widely in UK schools?

I could not help them much with the first question – we are probably still making what are unrealistic demands of many 15-16 year-old students. Even a concept like density is difficult to understand in any true sense of the word without formal operational thinking, yet this and many other concepts are still common in the science curriculum. The timeframe for the implementation of the National Curriculum was so short that nothing was possible beyond a damage limitation exercise by the Science Working Group, even though many of the group were quite familiar with Shayer and Adey's work.

The second question was also difficult to answer. The CASE materials were first published at the same time as the National Curriculum and the confusion around at the time prevented any rational debate about a wider dissemination programme, particularly with government support. To use the CASE materials effectively (i.e. to get the predicted gains in GCSE grades) required an intensive (and expensive) professional development programme. Although a quite sophisticated model had been developed for this, resources at the time (in all parts of the UK apart from Scotland) were largely directed towards National Curriculum implementation. Since the late 1980s, there has been a strong network of CASE schools and many local authorities (when they were able to do so) have supported professional development and implementation but, despite the evidence, it has never been possible to get UK government support. There has been some significant activity in Scotland and in many other parts of the world. Now, the scope has broadened to other subject areas and phases (see http://www.letsthink.org.uk/).

The Education Endowment Foundation is now supporting these programmes, as it recognises their effectiveness (http://educationendowmentfoundation.org.uk/projects/cognitive-acceleration-through-science-education-case-lets-think-forum/).

So, (eventually!) we come to this research paper, which presents work that has been going on in Ireland not only to introduce CASE interventions for purposes of cognitive acceleration but also to attempt to use this intervention to improve primary-secondary transition, which is perceived to be an issue in Irish schools. (The original CASE materials were designed for use with lower secondary pupils.) In this study, the activities were split, with some being done in the final year of primary school and others in the first year of secondary school. The study adopted a quasi-experimental design involving eleven primary and six secondary schools, with several hundred pupils in both phases across intervention and non-intervention groups. In many respects, the research design mirrored the approach used by Shayer and Adey in their original research, using the same Science Reasoning Tasks for pre- and post-testing in each of the two years.

Overall, for those pupils who had experienced both the primary and secondary interventions, gains in their learning were comparable to Shayer and Adey's results – at best, nearly one SD above expected performance. These data are presented in relation to effect sizes and to John Hattie's assertion that an effect of this magnitude could be seen as advancing learning by two or three years.

Aside from the fact that part of the programme was delivered in the primary school and part in the secondary, there is little information about how this was used to address transition issues other than in the general way that secondary teachers would have some awareness of work done in the primary school through this programme and presumably some performance data from the pre- and post-tests.

The article does not mention how this research study was funded or otherwise supported, but it did involve a substantial commitment from the research team to collect and analyse the data, to provide the professional development programme to the teachers and, in some cases, to be directly involved in teaching the intervention lessons. The longer-term implications of this study and whether the programme will be taken up more widely in Irish schools is not clear. It is also unclear if there is any intention to follow the intervention pupils through their secondary school years to see if the enhancement is sustained.

Resource Review

Teach Now! Science: The Joy of Teaching Science

Author: Tom Sherrington
Routledge
ISBN: 978-0415726900
RRP: £14.61

I am not sure what I think about this book. It is part of a series consisting of a core book *(Teach Now! The Essentials of Teaching)* and then a number of specialist subject books such as this one for science. The series is intended to share the secrets of great teachers with those just coming into the profession as secondary teachers, either through school-based training or PGCE routes.

Many books aimed at this target audience are written by those working in university departments on PGCE programmes. They often reflect the subject 'method' courses in those institutions and the particular research interests of the writers.

This book aims to provide trainee teachers with an introduction to teaching their subject from a different direction. It is written by a Headteacher, who still teaches science and clearly does have a love of his subject. It aims to distil the author's experience into a form that is accessible to them and which will provide practical suggestions for them to develop their own practice.

It deals with issues such as behaviour management and differentiation, as well as more science-specific issues such as practical work and what it describes in one chapter as 'classic teaching methods'. It is surprising that in a book of this sort there is very little mention of learning in science and little by way of introduction to the difficulties children experience in understanding many science concepts, although it does recognise the importance of teachers having sound subject knowledge.

Several areas (beyond the issues about learning in science) are not dealt with in detail, such as the use of ICT or laboratory safety. Some of the discussion about issues it does address is rather limited. For example, in considering the use of analogies in relation to water models in teaching about electricity, there is nothing about the limitations of the analogy and how it might reinforce or introduce misconceptions in learners' minds rather than improving understanding.

In general, the book is easy to read and does contain a lot of sound advice and practical suggestions for classroom activities. So, what is my reservation? Well, I suppose it centres around the assertion that the book is based on a ‘grounded, modern rationale for learning and teaching’ (of science, I assume). It may well be, but my concern is that this rationale is not made explicit and therefore not communicated to the reader. There are a few references to supporting sources or further reading in the text itself and the bibliography at the end consists of sixteen sources, three of which are by Richard Dawkins and only one directly relating to science teaching.

From this book alone, the beginning teacher will have little insight into the vast amount of academic and research literature on which current practice is based and no means beyond their own initiative to follow up issues raised.

This would perhaps be more acceptable if we were living in an age when the development of subject-specific pedagogy continued beyond the training year and took place through a coherent programme of professional development, but this is not the case, at least not in the English context.

The training year, particularly for those on PGCE courses, is the one opportunity we, as science teacher educators, have of exposing the research base for teaching science and giving our trainees some insight into how the curriculum came to be as it is today. It is also our one opportunity to try to get them not only to be reflective about their practice but also to critically engage with current debates in the teaching of their subject.

The book is heavily anecdotal, which is both a strength and a limitation. It is a common experience for trainee teachers to try to model themselves on experienced and successful teachers and finding that what works for the teacher might not work for the trainee; they need to develop their own approach grounded in their own understanding of what they are trying to do. Reading the book brought to mind Eric Hoyle’s distinction from the 1970s about the ‘restricted’ and the ‘extended’ professional.

The ‘restricted professional’ is in no sense a ‘poor’ teacher. He or she may be highly effective in their own setting (able to deliver an ‘outstanding’ lesson) but who values above all and is heavily reliant on experience. The ‘extended professional’, on the other hand, takes a wider view and values the theory underpinning the pedagogy at the same time as recognising the inter-relationship between theory and practice.

I do not like the simplistic dichotomy of 'school-based' and 'university-based' models of teacher training, but it seems that this book is at the 'school-based' end and reflects (whether or not this was the intention) contemporary political views that teacher training should be grounded in classroom practice and that universities just fill trainees' heads with unrelated and unnecessary theory.

To the trainee teacher, I can see the attraction of a book of this sort. It is clearly grounded in the successful practice of a committed science teacher; it is readable (without the distraction of all those pesky references!); and seems to present tried and tested ideas for planning and delivering science lessons.

My overall feeling is that, while it may seem to be helpful in the short term, it presents a rather limited vision for the beginning science teacher of the profession that they are entering. It is good for providing a clear view of current practice, but needs to be seen as the starting point for that journey, not a definitive road map. It will be for colleagues to decide whether it warrants a place on their reading lists.

Paul Denley
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E-mails from the Edge

To: Dr. Brown (Education)
CC: Head of Biological Sciences

Subject: Your students' nutrition

Dear Dr Brown,

After reading some advice from Birmingham City University, and bearing in mind what the VC tells me is your students' very poor showing in sessional examinations, I am minded to pass on some food tips that are said to impact students' revision potential and examination performances:

- *Don't be a food snob*
- *Don't go shopping with the 'Cookie Monster'*
- *Bulk it up!*
- *Cook slowly*
- *Take a packed lunch to the uni*
- *Get food parcels from your mum*
- *Plan your meals*
- *Buy or borrow some student cookbooks*
- *Batch cook*
- *Be inventive with your leftovers*
- *Make time to cook!*

I look forward (hungrily!) to seeing any results of improved diet.

Yours
Professor Stillingworth-Armitage
Head of Student Welfare

I am very grateful to Mel Wakeman – Senior Lecturer in Applied Physiology and nutrition expert, and to Rumandeep Gill, PR Officer, Marketing & Communications Department, Birmingham City University, for this item – Ed.

More information on this topic can be found on Mel's blog
– http://healthfoodiemel.wordpress.com/2014/08/15/student-guide-to-eating-on-a-budget/