The ASE Improving Practical Work in Triple Science Learning Skills Network

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ABSTRACT In July 2010, the Association for Science Education won a bid to run a 'Sharing innovation network' for the Triple Science Support Programme, which is delivered by the Learning Skills Network on behalf of the Department for Education. The network involves schools from the London boroughs of Tower Hamlets and Greenwich. In this article, the development and achievements of the programme are described and these local authorities offer an insight into how the teachers are receiving the training materials.

The importance of practical work in school science is often taken for granted, so much so that it is often difficult to ask the question, '*What is the purpose of this practical?*' or, even more heretically, '*What is the purpose of practical work in science lessons in general?*' The UK Government-funded 'Getting Practical – Improving Practical Work in Science' programme (Box 1), which provides free continuing professional development (CPD) throughout England, bravely asks these questions and goes beyond this, proposing a framework with which to answer them.

One of the consequences of a desire by the Government to increase the number of home-grown science graduates (necessary to secure the future of economic prosperity of this country, the argument goes) has been a significant increase in the number of pupils following courses in triple science covering chemistry, physics and biology to GCSE level (ages 14–16). Between 2009 and 2010, entries per subject increased by around 30 000, to between 120 000 and 130 000 depending on the subject.

A potential challenge that schools may face when introducing triple science is developing an effective curriculum model, with sufficient time for practical work and engaging activities as well as covering the required content. Some models put a great deal of pressure on teaching time. Faced with this, teachers look for time-saving short cuts to learning, and time for practical work is put under pressure. If teachers are unclear about what the learning outcomes are for a particular practical activity then they may be tempted not to bother with it and to substitute a theory lesson instead. The Getting Practical programme encourages greater clarity about the learning outcomes associated with practical work and in so doing makes practical activities less of a 'soft target' when it comes to planning learning in restricted time.

BOX 1 Getting Practical – Improving Practical Work in Science programme

www.gettingpractical.org.uk

This programme offers free, local CPD in England for teachers of science at both primary and secondary level to help improve the effectiveness of the practical science that they teach. The programme gives science teachers the opportunity to reflect upon how they currently use practical work in science and, if necessary, make small changes to their practice. To find out more about the programme and where courses are being offered near you, visit the website.

It was with this in mind that a small group of Getting Practical trainers, funded through a Learning Skills Network (LSN; Box 2) grant won by the Association for Science Education (ASE), worked with the Getting Practical core team to develop a version of the programme's CPD package aimed at teachers of triple science GCSEs. The network involves schools from the London boroughs of Tower Hamlets and Greenwich and is called the 'ASE Improving Practical Work in Triple Science LSN'. From the outset, the intention was to retain the key 'hands-on minds-on' message, focusing on the importance of having clear learning outcomes for any practical activity and evaluating the success of the activity against these, as opposed to simply monitoring whether pupils complete the task. To make the CPD distinctive, the examplar practical activities chosen for session 3 of the training were less familiar ones and, where possible, activities relevant only to the additional material that makes up the triple science GCSEs.

In trialling the materials, it became apparent that some schools have learned lessons from having too little curriculum time and are now allocating a more appropriate amount of time for three full options. In these situations, teachers found that they had a different problem to manage: they now had the time to do more of the unfamiliar practical activities but were not always clear about the intended learning outcomes. For those in this fortunate situation, the Getting Practical approach scaffolds their thinking about the intended learning from less familiar activities, helping to secure a place for these in an exciting separate science experience.

BOX 2 The Learning Skills Network (LSN)

LSN employs experts in learning and development to provide consulting, outsourcing, research, technology and training services. It supports local authorities and schools, further education and higher education, public services, work-based learning and international organisations in achieving best practice. LSN operates on a not-for-profit basis with an extensive network of experts across the UK and internationally.

STEM education is a core strength for LSN. They have successfully delivered the Triple Science Support Programme since 2007, seeing a consistent year-on-year rise in the number of pupils taking triple science GCSEs. Since June 2009, LSN have been delivering the Starting Out mentoring scheme for early career maths and science teachers, which is now supporting over 750 teachers across London, the East of England and the West Midlands.

Involvement of the LSN Triple Science Support Programme

The Triple Science Support Programme (TSSP; Box 3) is delivered by LSN on behalf of the Government's Department for Education. The purpose of the programme is to help schools, managers and teachers plan, develop and deliver triple science GCSEs. The programme is now in its fourth year and was introduced to support schools in England in implementing the non-statutory entitlement for all pupils who achieve at least level 6 at the end of key stage 3 (age 14), and who would benefit, to study triple science GCSEs. Since the programme began in 2007 there has been a significant increase in the number of pupils studying triple science (for physics GCSE there were 56 000 entries in 2006 and 120 455 in 2010).

One of the more successful aspects of the TSSP is the 40 networks of schools that the programme supports. From September 2009 to September 2010, there was an increase in the number of pupils studying triple science GCSEs across all network schools of 29%. These comments from network members and leaders demonstrate their satisfaction with the networks:

I've got on really well with the key people [from LSN] *that I work with … they've been extremely supportive.*

I think working in a collaborative way is always beneficial and is lacking in most schools. I feel the time it provided me to think about lessons and research what is going on with triple science was fantastic.

The support has been effective and has been successful in upskilling the teachers and increasing their understanding of how to deliver triple science.

During 2010–11 the TSSP is supporting 50 networks across England. Across the 50 networks there are currently 31 030 pupils studying triple

BOX 3 The Triple Science Support Programme (TSSP)

www.triplescience.org.uk

The Triple Science Support Programme (TSSP) offers training, consultancy, networking opportunities, resources and publications as well as a comprehensive website and an online community. The consultancy available includes events at regional science learning centres, learning visits to schools that are successfully delivering triple science, bespoke in-school training and peer-coaching. There is an external evaluation of the programme each year, which focuses on the key performance indicators agreed between the Department for Education and LSN and provides monthly updates on progress and recommendations for future activities. A steering group meets termly to discuss progress of the programme and provide recommendations for future activities.

The evaluation of the programme includes in-depth interviews with stakeholders to gather their views on its success and their ideas on what actions they feel would be most beneficial in the future. The evaluation also includes a survey of 700 schools each year to see what teachers perceive as the main barriers to offering triple science and how LSN can support them to overcome these barriers. The feedback received through this survey is used to inform the design of the support offered through the programme.

During 2009–10 a total of 2571 teachers from 988 schools received support through the TSSP.

Training and consultancy 2009–10	Number of teachers	Number of schools
Networks	450	216
Events	824	360
Bespoke	909	220
Learning visits	138	94
Coaching	250	98

Feedback from delegates who attended training included:

The consultant went through a lot of resources, gave me a lot of ideas for lessons and how to use resources.

It increased the teaching and learning in my classroom, leading to pupils being more engaged in lessons.

I think the level of delivery is just really high … the teachers engaged and asked for a follow-up session.

science in 291 schools. The aim is to achieve a 15% increase in the number studying triple science in the network schools by September 2011. The two short case studies below, from local authority consultants, illustrate how an LSN network is supporting professional development in science teachers and increasing the uptake of triple science in two London boroughs.

Triple science in Greenwich – a case study

The national rise in numbers of pupils taking triple science at GCSE has been mirrored in Greenwich schools, with a 37% increase in entries (38% provisional national figure for 2009–2010 (Powell and Hutchinson, 2010)). In contrast with the picture two years ago, every secondary school in the borough now offers these courses. In 2010, nationally, 72% of schools offered triple science compared with 32% in 2007.

Triple science, once taught during extra sessions at lunch-time, as after-school sessions and even through intensive sessions during half-term breaks, has now been given an appropriate share of curriculum time in most schools. As key stage 3 (ages 11–14) outcomes have improved, the numbers of pupils now taking triple science at key stage 4 (ages 14–16) in schools that had previously never offered the separate sciences, or that had not been able to fill whole classes, has now increased dramatically.

In circumstances that were not always ideal for delivering a consistently rich experience, some triple science courses had been pared down to a mainly functional existence. Practical work in particular was, in certain cases, limited to those ‘essential’ experiments that were considered to be of some use in preparing for examinations, or were designated as part of a coursework component.

As a result of the available support and a nationwide drive towards the individual disciplines in recent years, science teachers have found themselves with new opportunities and an increase in the amount of time available to deliver a wider range of practical work. It came as a relief, during the first of the three sessions of Getting Practical for triple science, when teachers reported that the issues of curriculum time had been broadly addressed by curriculum managers and that there would now be opportunities to deliver more engaging and exciting courses to greater numbers of pupils in Greenwich.

Adopting the Getting Practical materials through the LSN

As part of a scheduled subject leaders' meeting, the first two sessions of the Getting Practical course that had been adapted for triple science teaching were delivered to an audience of heads of science and other post-holders. One week later the third session was delivered as a twilight session. During the first session the participants were asked, through a number of thought-provoking activities, to appraise the rationale for practical work and to consider how it was being delivered. The participants' use of practical work, and to some extent the nature of practical work, throughout the borough (as post-holders reflected on work in their departments) was considered.

Responses varied in the group. While these middle leaders and post-holders recognised that they were all attempting to deliver high-quality practical work that was open-ended and investigative in its nature, they also agreed that some adaptations could be made across their departments.

Key elements in improvement were:

- a targeted reduction in the number of outcomes, emphasised through individual sessions of practical work, and thus clear learning outcomes related to specific aspects of the practical work;
- the planning of a wide variety of outcomes honed to complement specific episodes of practical work that could be delivered throughout courses and schemes of work, and that would be based on planned progression;
- the need for precise planning so that pupils could be convinced to approach 'efficient' practical sessions with a purposeful 'hands-on minds-on' approach.

Outcomes were explored through use of the audit tool for numerous practical activities, developed by the Centre for Science Education at Sheffield Hallam University, based on the work of Robin Millar (Millar and Abrahams, 2009). Participants concluded that two of the key factors in ensuring successful learning during practical work were (numerically) limited learning outcomes for the practical aspect being addressed and outcomes that were exceptionally clear to pupils. In many cases, it was obvious that the possible outcomes of practical work were too diverse and numerous for secure learning to occur without confusion. Teachers returned to the twilight session having explored this idea further, and concluded that pupils often left practical sessions thinking that the learning taking place was not what the teacher had intended.

During the second part of the initial session participants considered in depth the evidence they had for successful practical work, and the way in which they could therefore set out success criteria during lessons. It was accepted during this session that the 'hands-on minds-on' balance should be pre-planned to broadly define the balance of procedural and conceptual learning that would take place in practical sessions.

A key development of practice in this session was the use of a 'staging or planning tool'. This laminated bookmark acts an aide-memoire for a cycle of rehearsal, performance and post-performance analysis and is used as the basis for increased effectiveness of the practical work being carried out (according to Millar's flowchart) by building a systematic approach and the scope for reflection and adaptation.

Feedback from the first two sessions at the subject leaders' meeting was among the most encouraging that we had received. The participants were exceptionally positive about their experiences and were clear that they wanted to move the practice into classrooms (and that they would certainly return for the final session!).

For the third session we relied on the help of a local school, the Eltham Foundation School, and one of its technicians, Keith Jones. During this laboratory-based session we continued with a theme we had developed in our triple science support programme, whereby the value of 'underused' physics equipment is demonstrated. On this occasion, participants worked with cloud chambers to develop lesson plans for practical sessions that would allow the observation of alpha particle tracks.

A variety of lesson plans and learning episodes were developed, each using the available triple science support materials and staging the practical in a chosen context. The context varied from the Litvinenko controversy to medical and industrial settings. The systematic approach of the 'staging tool' and 'single activity audit' was applied and in each case a different outcome of practical skills, enquiry or scientific knowledge was considered and shared.

Taking the training further

Further positive feedback was followed by action planning for future practical work in triple science lessons. Individuals chose either to consider personally how they would apply and model the approach to disseminate it to colleagues or, alternatively, began to plan together with their trainer sessions of CPD for their entire department. The Getting Practical materials included examples for biology and chemistry in triple science practical settings, while some participants decided to adapt practical protocols currently in use in their own schools to exemplify the rationale and process.

An agreement was made that schools would trial the process and would each showcase one lesson plan during the next subject leaders' meeting in March. Further use of this approach will also be modelled during the local authority's 'physics master classes', which will be run in the spring term by Des Malone, head teacher at the John Roan School, a science and mathematics specialist school. These will hopefully develop the skills of non-specialists so that they are able to deliver highly engaging and effective practical sessions employing underused physics equipment.

Triple science in Tower Hamlets – a case study

Triple science is now offered by all 15 secondary schools in the London Borough of Tower Hamlets. The last two schools took up this course in 2009. There has also been an increase in the number of pupils studying triple science, with some schools offering triple science to two teaching groups per year.

Up to three years ago, triple science was taught in a variety of ways across the borough. The most commonly offered models were after-school lessons and Saturday sessions. In a few cases, the course was only offered within the 20% curriculum time allocated for two sciences. However, through continued discussions with senior school leaders, including strategy managers, this pattern has changed and now 13 out of 14 schools either offer triple science within the 20% science allocation plus one option block or as a three-year programme starting in year 9 (ages 13–14).

Why is there a need for a triple science network?

The first triple science network was set up in 2008–2009 using funding from the LSN. In the first year of the project, the focus was on how to set up a good curriculum pathway and matching the right number of teachers to the course. In the second year of the project, 2009–2010, the focus was on developing the subject knowledge of teachers in physics and chemistry and bridging this to AS level. In the third year, 2010–2011, the focus for triple science sessions is improving practical work using the Government-funded Getting Practical – Improving Practical Work in Science approach adapted for triple science through the ASE LSN network. The first two sessions were delivered to the science leaders in a scheduled science leaders' development meeting. The aim of this training was to increase the use of effective practical science teaching approaches in class in order to improve and develop a pupil's understanding of triple science.

There were mixed responses from this audience. While some of the science leaders recognised that there was room for improvement in the effectiveness of practical science teaching, others thought that the session would be more beneficial to 'early career' teachers.

The feedback from this session indicated that:

- teachers recognised that practical work becomes more effective when teachers plan how to get the science concepts across to the pupils by first auditing the practical work they offer both in their own classes and as a department;
- if you narrow down the learning outcomes for a practical lesson it becomes more effective with a clearer focus;
- there is a need to audit the range of practical activities in the scheme of work at key stage 4 to get a balance between procedural and conceptual demand;
- a wider range of practical activities needs to be planned for science lessons;
- the availability of the appropriate equipment greatly impacts on carrying out effective practical work.

The third session of Getting Practical was delivered in Stepney Green Secondary School for boys, with a focus on physics activities delivered with a physics specialist and an LSN trainer who has been working with the Tower Hamlets triple science network. This audience was a mixture of experienced and newly qualified teachers and included all the science teachers at Stepney Green School. This third session was therefore adapted to include aspects from the first two sessions.

The question was posed to the participants: '*Do practical activities in science lessons enhance pupils' learning?*' The responses suggested that most teachers did not think that practical activities developed pupils' conceptual understanding of science. Practical activities were seen to be of most use for the completion of coursework and development of the more traditional science enquiry skills, such as planning, obtaining evidence and drawing conclusions. Following the use of the 'staging or planning tool', teachers were very reflective and were able to see how, by focusing on improving the clarity of the learning outcomes when doing practical work, they could enhance pupils' learning of science.

The teachers were given the opportunity to use a systematic approach to planning a practical, carrying it out and then linking it to applications in, for example, forensic science and medicinal science. A variety of physics practical activities focused on 'how ions are produced', comparing the sparks produced by the Van de Graaff generator with those from a spark counter, which shows, and can be used to count, the number of alpha particles emitted. The teachers then planned a learning episode. These episodes included plans for what could be covered in class before, during and after the practical work and these were shared within the group. Further practical resources were made available for individual teachers to try out based on DNA extraction and thin-layer chromatography covered in biology and chemistry respectively.

Overall, there was very positive feedback from this session. All the teachers discussed action plans for future work in their triple science lessons. These ranged from planning a series of three lessons based on available support materials in physics, chemistry or biology to making an audit of the types of equipment that needed to be purchased for the science department.

Finally, in the spring triple science meeting, teachers will share their lesson plans and lessons learned from using the support materials.

Final thoughts

This project has only had a relatively short period of time to create an impact. Teachers in both boroughs are taking on board the messages from the Getting Practical programme and are able to apply them specifically to the triple science classes they teach. As the training establishes itself within school departments and becomes embedded in schemes of work, it is hoped that practical work will become a more prominent feature of triple science. This can only boost the engagement of the pupils with a view to increased uptake of science courses post-16 in the future.

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References

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Useful websites

community.triplescience.org.uk
www.stimulatingphysics.org
www.practicalbiology.org
www.practicalchemistry.org
www.practicalphysics.org

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