Parliamentary briefing: Specialist chemistry and primary science teaching in Wales

The subject knowledge of chemistry and primary science teachers has a positive impact on pupil attainment, yet in Wales there is a shortage of teachers with this knowledge. The Royal Society of Chemistry believes that the Government should take action to address this shortfall in order to give students in Wales a world-class science and chemistry education.

Chemistry benefits the Welsh and UK economies

Chemistry plays an important role in both the Welsh and British economies, and provides large numbers of high skilled, well paid jobs. In Wales the nuclear, petroleum, polymer, chemical and pharmaceutical industries are strategically important to the country, employing over 40,000 people.[1]

In the UK as a whole, the chemical and pharmaceutical sectors alone made up 1.9 per cent of gross value added to the UK economy in 2011 (reaching £27bn). The industrial biotechnology industry is predicted to contribute £4-12bn by 2025. These industries are consistently searching for skilled, qualified employees, but there is a skills gap. Cogent, the Sector Skills Council, has estimated that chemistry-using industries in the UK will need 33,000 apprentices and 37,000 graduates by 2020, yet projected supply is only 21,000 and 18,000 respectively. Employers also report that 21 per cent of employees are not fully proficient at their jobs.

It is therefore crucial the young people in Wales are well equipped to take advantage of opportunities in Wales and across the rest of the UK.

Wales is behind the rest of the UK

According to international rankings, science education in Wales lags behind England, Scotland and Northern Ireland, and has actually worsened since 2009. In the most recent PISA assessment of international education standards, Wales dropped from 22nd in science to joint 36th in the world, and scored only 491 for science, compared to 516 in England, 513 in Scotland and 507 in Northern Ireland. In the previous assessment, Wales scored 496, meaning the quality of science education has decreased by five points.[2]

[1] COGENT factsheet on Wales (2011): http://www.cogent-ssc.com/research/Publications/factsheets/Wales.pdf
[2] PISA results 2012 (OECD, 2013) http://www.oecd.org/pisa/keyfindings/PISA-2012-results-snapshot-Volume-I-ENG.pdf . Specific results for Wales: http://www.oecd.org/unitedkingdom/PISA-2012-results-UK.pdf

Specialist teaching is part of the solution

One of the key problems facing primary science and secondary chemistry teaching in Wales is the shortage of teachers who have a background in these subjects:

- Only 49.8% of secondary-school chemistry teachers have a chemistry degree.[3]
- Only 4.8% of primary school teachers have a science degree.[4]

As a contrast, there is a smaller shortage of chemistry graduates teaching the subject in England, with one third not having a relevant degree. In Northern Ireland and Scotland there is little to no shortage of chemistry graduates teaching secondary level chemistry.

What is a subject specialist?

At secondary level, to be a "chemistry specialist" a teacher should have a) a chemistry degree or related (eg, biochemistry); OR have demonstrated sufficient expertise in the subject through previous industry employment, OR have completed a 24-week Subject Knowledge Enhancement (SKE) course. They should also have Qualified Teacher Status.*

At primary level, to be a "science specialist" a teacher should have a degree in a science subject OR at least one science A Level OR has completed an equivalent level of training. They should also have Qualified Teacher Status.

**Please see p. 4 of this briefing for further information on SKE courses.*

This shortage is extremely concerning for Wales, and could partly explain the country's disappointing science results. Evidence shows that **teachers with specialist subject knowledge can have a positive impact on a child's education.**

For example:

- Subject knowledge of teachers "is a **key determinant of success**, especially in the sciences and mathematics", according to a 2010 Department for Education report
- Teaching is of **better quality** where secondary chemistry and primary science teachers hold qualifications in the subjects they teach, according to the National Audit Office
- The Sutton Trust recently found that the most effective teachers have a deep knowledge of the subjects they teach, and **when teachers' knowledge falls below a certain level it is a significant impediment** to students' learning
- A lack of specialist subject knowledge can result in teachers focusing on presenting unrelated facts, rather than teaching with a wider conceptual framework, according to the Wellcome Trust

[3] General Teaching Council for Wales Annual Statistics Digest (March 2014) http://www.gtcw.org.uk/gtcw/images/stories/downloads/Annual%20Statistics%20Digest/Annual_Stats_14_E.pdf

[4] Written Assembly Questions tabled on 13 August 2014 for answer on 20 August 2014, question tabled by David Rees AM: http://www.assembly.wales/en/bus-home/pages/plenaryitem.aspx?category=written%20question&itemid=2927&assembly=4&c=Written%20Question&startDt=01/08/2014&endDt=01/10/2014&keyword=david%20rees

- Subject specialist knowledge enables teachers to be **more capable of stretching the most able students**, according to research undertaken for the UK Department for Business, Innovation and Skills
- The Royal Society of Chemistry has found that chemistry specialist teachers often have a significant **impact on the decisions of students to study the subject at A-level or university**

> "I have recruited and worked in departments with specialist and non-specialist chemistry teachers. Specialists are able to provide a better quality of education due to their breadth of knowledge. They're much more flexible in the classroom and are often more likely to come up with creative ways to teach the subject beyond the text book. In my school, those taught by a chemistry specialist at GCSE have been much more likely to continue the subject at A-level – I believe this is because the quality of teaching has been better and the teachers are more likely to make the subject exciting."
>
> ***Head of Chemistry at a state secondary school***

Policy makers should avoid the temptation of focusing just on secondary school teaching when seeking to address this issue. Effective science teaching at primary level is extremely important, as children start to develop perceptions about whether science is "for them" towards the end of primary school [5], potentially impacting on their long term attainment and interest in the subject. In addition, as young children's own ideas are often in conflict with scientific ones, if taken into secondary school these ideas can inhibit effective learning.[6]

What are the solutions?

To give students in Wales a world-class science and chemistry education, the Government must ensure that by 2020:

1) **Every post-14 chemistry student should be taught by a chemistry-specialist teacher;**

2) **Every primary school should have access to at science subject leader who is a science specialist**

[5] Wellcome Trust: Primary Science: Is It Missing Out? Recommendations for reviving primary science (2014) http://www.wellcome.ac.uk/About-us/Publications/Reports/Education/WTP057244.htm?utm_source=Adestra&utm_medium=email&utm_content=Is%20Primary%20Science%20Missing%20Out%3F&utm_campaign=Primary%3A%20Advocacy%20 and also see Kings College London: Aspires project report (2013) http://www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf

[6] Wellcome Trust: Perspectives on Education – Primary Science (2008) http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtd042076.pdf

Details on how to achieve the above are as follows:

a) Attracting chemistry graduates

One of the most significant ways to increase supply of chemistry specialist teachers is by offering incentives to chemistry graduates. It is therefore encouraging that the Welsh Government introduced financial incentives in early 2014 to encourage chemistry and physics graduates to enter teaching.[7] It is important that the success and uptake of these incentives is monitored in order to determine whether they are positively impacting on the supply of chemistry teachers.

Recommendation 1: The Welsh Government should continue incentives to encourage more chemistry graduates to enter teaching, and monitor the effectiveness of current schemes

b) Subject Knowledge Enhancement courses

In addition to increasing the supply of chemistry graduates in teaching, the Welsh Government should also encourage Welsh universities to provide Subject Knowledge Enhancement (SKE) courses for those who plan to teach chemistry but do not have a background in the subject. As outlined in our definition of chemistry specialist on p.2 of this briefing, if a teacher has undertaken a 24 week SKE course in chemistry, they count as being a subject specialist.

SKE courses are currently provided by some universities in England, and are designed to enhance the knowledge of a particular subject for aspiring and existing secondary school teachers.

In England, courses can last from 2-36 weeks depending on the needs of the students. They focus on subject knowledge and also how to teach the subject (i.e. subject specific pedagogy). Most of the courses provided are pre-Initial Teacher Training, but some are provided post-Initial Teacher Training.

We would recommend that prospective secondary school teachers without a chemistry degree should take a SKE course which is at least 24 weeks long, as this provides a suitable amount of knowledge to enable a teacher to be a subject-specialist.

SKE courses for existing non-specialist teachers who teach chemistry should also be encouraged. We do recognise the difficulties in finding time for such courses during the school year, but where teachers are being required by schools to teach outside of their specialism, the school should strongly consider offering at least a short SKE.

Recommendation 2: The Welsh Government should encourage Welsh universities to provide Subject Knowledge Enhancement courses for prospective and current non-specialist chemistry teachers

c) Increasing the supply of primary science specialists

Increasing the supply of primary science specialists should be a priority. As highlighted above, we recommend that primary schools, where possible, should have one science subject leader who is a

[7] Welsh Government (2014): http://wales.gov.uk/newsroom/educationandskills/2014/8342453/?lang=en

science specialist. As a “science subject leader” this teacher would not teach all the science lessons in the school outside of their own class, but would instead provide support for their colleagues throughout the school, essentially leading science teaching.

We acknowledge that for small rural primary schools the above may not be possible. For these schools, we would encourage the formation of clusters where one science specialist is shared by a group of small schools. Again, this specialist would not teach all science lessons, but would provide support and advice for teachers across the cluster.

To achieve the above, the Welsh Government should introduce schemes to incentivise those with a science degree or science A Level to enter primary school teaching, such as through bursaries, scholarships and targeted promotional campaigns.

Recommendation 3: The Welsh Government should work with groups, or “clusters” of small rural primary schools to develop a science subject leader sharing scheme

Recommendation 4: The Welsh Government should introduce schemes to incentivise those with a science degree or science A Level to enter primary school teaching

d) The importance of continuing professional development

Primary science and secondary chemistry teachers should be encouraged to undertake ongoing, subject-specific, continuing professional development (CPD). This is crucial for those who do not come from a subject-specific background, but it is also important for specialist teachers so their knowledge is kept up to date.

Evidence shows that CPD has a positive impact on results. For example, in England Ofsted’s 2013 report on science teaching in English schools shows a **connection between schools gaining an outstanding inspection grade and whether teachers had access to science-specific CPD**. In addition, the National Science Learning Centre has argued that it is crucial that teachers of STEM subjects are “expected and encouraged to engage with subject specific professional development throughout their career in order to remain up-to-date and retain enthusiasm and thirst for their subject.”[8]

Given the large numbers of primary science subject leaders without a science degree, CPD is especially important in ensuring these teachers have the support they need to teach and co-ordinate science lessons effectively. A review of Scottish teaching highlighted that weaknesses in the performance of children in primary education can partly arise from low levels of confidence among primary teachers about their own knowledge of some aspects of what they are teaching.[9] In addition, Estyn has argued that it is important that primary schools provide training for teachers with weak science subject knowledge.[10]

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[8] *The future of STEM education: A National Science Learning Centre White Paper* (National Science Learning Centre 2013) https://www.sciencelearningcentres.org.uk/media/filer_public/7f/d3/7fd32ef0-a746-452b-a681-8e5d15f5a1da/the_future_of_stem_education_-web.pdf

[9] *Teaching. Scotland’s Future: Report of the Donaldson Review* (Scottish Government, 2011): http://www.scotland.gov.uk/Resource/Doc/337626/0110852.pdf

[10] Science in Key Stages 2 and 3 (Estyn, 2013): http://www.estyn.gov.uk/english/docViewer/281872.5/science-in-key-stages-2-and-3-june-2013/?navmap=30,163

As an additional benefit, research also suggests that increased CPD could contribute to higher retention rates of teachers[11], meaning that it could play a role in keeping more chemistry specialists and primary science subject leaders in the profession.

It is worth noting that from August 2014 the Scottish General Teaching Council has introduced a requirement for all Scottish teachers to be enrolled in a "Professional Update" programme. This requires every teacher to demonstrate that they are actively participating in CPD. If the programme is a success, particularly for science teachers, its extension should be considered across Wales.

Recommendation 6: Schools and governing bodies should consider the specialist knowledge of their staff, and ensure that sufficient time and funding is allocated for subject-specific Continuing Professional Development (CPD).

Recommendation 7: The Welsh Government should monitor the effect of the "Professional Update" programme in Scotland, particularly on science teaching. If the scheme has a positive impact, it should consider implementing a similar scheme.

About the Royal Society of Chemistry

The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With over 49,000 members and a knowledge business that spans the globe, we are the UK's professional body for chemical scientists; a not-for-profit organisation with 170 years of history and an international vision for the future. We promote, support and celebrate chemistry. We work to shape the future of the chemical sciences – for the benefit of science and humanity.

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[11] *The Impact of Science Learning Centre continuing professional development on teachers' retention and careers* (Sheffield Hallam University, 2013) https://www.sciencelearningcentres.org.uk/media/filer_public/7a/e1/7ae12f3e-030b-4e5f-b27a-41b04cddeb46/shu_retention_full_report.pdf