Primary science teaching in Scotland: the importance of subject knowledge

Summary

Science education is crucial to the long term success of the Scottish economy, yet science education outcomes are behind international competitors. The Scottish Government must focus on improving primary science, because this forms the foundation of a child's long term interest in and enjoyment of the subject. It particularly needs to ensure every primary school has access to a science subject "leader" with a science background, who leads science teaching across the school.

Science benefits the Scottish economy

Science makes an important contribution to the Scottish economy, creating opportunities across the country. Over 200 chemical sciences companies are based in Scotland, directly employing 14,000 people. These companies successfully deliver an annual turnover of over £9 billion and export around £3.7 billion worth of goods to the rest of the world every year, making the chemical sciences Scotland's second top exporter.[1]

It is important that young people in Scotland are well equipped to take advantage of the opportunities science offers to sustain economic growth. As argued by the Commission for Developing Scotland's Young Workforce, "a focus on science… should sit at the heart of developing Scotland's workforce." [2]

We're lagging behind our competitors

Scotland's overall rating for science education in the most recent OECD Programme for International Student Assessment (PISA) lags far behind those of many international competitors including Singapore, Germany, Poland, Vietnam and the Chinese regions of Shanghai and Hong Kong. It also lags slightly behind England.[3]

In addition, the 2008 Trends in International Maths and Science Study (TIMMS) found that Scotland was behind the global average for science at P5 (9-10 year olds) and S2 (13-14 years old) levels. It is, however, difficult to determine whether things have improved or worsened since 2008 as Scotland has now pulled out of the TIMMS study. **We would urge the Government to re-enter the TIMMS study in order to gain a useful benchmark for Scotland's primary science education.**

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[1] Enterprising Scotland: http://www.enterprisingscotland.com/helping-grow-scotlands-chemical-sciences-sector/
[2] Education Working For All! Commission for Developing Scotland's Young Workforce Final Report, Tuesday, June 3, 2014 http://www.scotland.gov.uk/Publications/2014/06/4089
[3] PISA results 2012 (OECD, 2013) http://www.oecd.org/pisa/keyfindings/PISA-2012-results-snapshot-Volume-I-ENG.pdf
Specific results for Scotland: http://www.oecd.org/unitedkingdom/PISA-2012-results-UK.pdf

Good teacher subject knowledge is part of the solution

One way to address these issues is to provide inspiring science teaching from an early age. Evidence shows that children develop perceptions about whether science is 'for them' towards the end of primary school [4], potentially impacting on their long term attainment and interest in the subject, and progression to employment in the chemical sciences. Good science education at primary is also important because young children's own ideas are often in conflict with scientific ones, and if taken into secondary school unchallenged these ideas can inhibit long term effective learning.[5]

What do we mean by "a teacher with a science background"?

We mean a teacher who either has a degree in a science subject OR someone who, by the end of their probationary year, either has at least one Higher in a science subject OR has completed an equivalent level of training.

Teacher subject knowledge plays an important role in excellent primary teaching. The Sutton Trust recently found that the most effective teachers have "deep knowledge" of the subjects they teach, and when teachers' knowledge falls below a certain level it is a significant impediment to students' learning.[6] In addition, the National Audit Office has argued that teaching is of better quality where primary science teachers hold qualifications in the subjects they teach.[7]

Having a background in science increases a teacher's confidence in teaching the subject. However, Education Scotland has found that many primary school teachers across the country report low confidence in teaching science[8], whilst the Scottish Learned Societies Group recently reported low confidence levels in the teaching of practical work (detailed later in this paper). The Royal Society of Chemistry is concerned that these low confidence levels are due to shortages in primary school teachers who have a science background.

There is likely to be a shortage of teachers with a science background

It is difficult to determine how many primary school teachers have a science background, as the data is not available. However, through ongoing work with our educational networks, we strongly suspect that there are shortages. The Royal Society also believes this, arguing that there is an indication that "only a tiny fraction of the primary teaching workforce in Scotland may be represented by teachers holding degrees in science and mathematics."[9]

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[4] 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

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

[6] Sutton Trust: What makes great teaching? Review of the underpinning research (2014) http://www.suttontrust.com/researcharchive/great-teaching/

[7] The Case for Change (DfE, 2010) https://www.education.gov.uk/publications/standard/publicationDetail/Page1/DFE-00564-2010 and Educating the next generation of scientists (National Audit Office, November 2010) https://www.nao.org.uk/report/edu

[8] Education Scotland: Sciences 3-18 curriculum impact report update (2013) http://www.educationscotland.gov.uk/resources/0to9/genericresource_tcm4817001.asp

[9] Royal Society: Vision Report (2014) https://royalsociety.org/~/media/education/policy/vision/reports/vision-full-report-20140625.pdf

It is important to confirm the exact number of primary teachers in Scotland who have a science background, and to determine how big the suspected shortage is. Others have also highlighted the importance of this, with the Science and Engineering Advisory Group recommending in 2012 that the Scottish Government collect data on the qualifications of the STEM teacher workforce, particularly at primary.

Practical science

A shortage of teachers with a science background is likely to have a big impact on the confidence levels and science teaching ability across the teaching workforce, particularly in relation to practical work.

Recent research from the Scottish Learned Societies Group on practical work found that almost half of primary schools surveyed felt they had insufficient access to training on the use of science equipment and consumables. 85% had to access external help to deliver science demonstrations, while just under two thirds of schools reported that support was provided between only one and three times a year.[10]

It is positive that schools are proactively seeking outside help, but to provide a good level of science education, teachers need to be trained to teach science and practical work effectively themselves.[11]

The most effective solution is to increase the supply of primary teachers who have a science background as they would be more likely to be confident teaching practical work and would also be able to support other teachers within their school.

Helping primary teachers teach science

a) Increasing supply

Increasing the supply of teachers with a science background should be a priority. **We recommend that primary schools, where possible, should have access to a science subject leader who has a science background**. 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 primary schools the above may not be possible. For these schools, we would encourage the formation of clusters where one science subject leader is shared by a group of small schools. Again, the science leader would not teach all science lessons, but would provide support and advice for teachers across the cluster.

To achieve the above, the Scottish Government should introduce schemes to incentivise those with a science degree or science Higher to enter primary school teaching. Potential incentives could be financial, such as bursaries and scholarships for teacher training. A targeted communications

[10] Scottish Learned Societies Group and Pye Tait: Resourcing School Science in Scotland: An Indicative Study of Primary and Secondary Schools (2014)

[11] Pye Tait recommend that that the learned societies’ group consider developing a case for more high quality training and CPD for science teachers to improve knowledge and expertise in relation to the effective use of practical equipment

campaign promoting the profession to science undergraduates and graduates could also be useful, particularly in universities and careers fairs.

b) The importance of continuing professional development

Continuing professional development (CPD) is crucial for new and existing teachers. Given the likely small number of primary teachers with a science background, it is important that existing teachers have adequate support.

Repeated reports have highlighted the essential role that CPD plays in maintaining and developing high standards in science teaching in primary schools.[12,13] Recently, Education Scotland highlighted that all staff should be provided with appropriate science-specific professional learning from Initial Teacher Education (ITE)and then throughout their teaching careers.[14]

Scotland's Professional Update programme provides an excellent opportunity to improve CPD for primary school teachers. There is not currently an emphasis on science subject specific CPD and this should be included for primary teachers.

Mentoring programmes could also be effective as a short term measure. In a recent pilot programme undertaken by the Scottish Schools Education Research Centre (SSERC), nominated teachers were provided with science specific CPD, which then allowed them to act as a mentor for colleagues in other schools within a local area cluster. An independent review of this programme concluded that there was consensus across mentors, senior management and other teachers in participating schools that the programme had a positive impact.[15]

c) Effective training of prospective teachers

It is also important to ensure that current Initial Teacher Education (ITE) courses provide sufficient exposure for science, both for those with and without a science background. While firm data on this is not available, there have been some concerns expressed about this through our networks. We would recommend that this issue is looked into in further detail.

Secondary school teaching

Secondary school chemistry teaching in Scotland, unlike England and Wales, is unlikely to have large shortages of subject specialists. Prospective teachers are required to complete a degree which contains at least two graduating courses in the subject they propose to teach. In Scotland, the school census maintains accurate records of the subject specialisations of the secondary teaching workforce but in recent years unfortunately it has stopped collecting data on the current number of teacher vacancies by subject within Scottish schools. It is important that the Scottish Government publishes this data to help identify if any shortages are emerging and whether there could be any long term problems in teacher supply.

[12] Why Science Education Matters. Scottish Science Advisory Committee. 2003.
[13] Supporting Scotland's STEM Education and Culture; Science and Engineering Education Advisory Group (SEEAG) Second Report: January 2012 http://www.scotland.gov.uk/Resource/0038/00388616.pdf
[14] See previous link
[15] Evaluation of the SSERC Primary Cluster Programme in Science and Technology, Glasgow University 2013 http://www.sserc.org.uk/images/Publications/SSERC%20Primary%20Interim%20report%20final_191213_plus_Survey.pdf

Recommendations

Recommendation 1: The Scottish Government should collect and publish data on the number of primary teachers who have a) a science degree or b) at least one science Higher or equivalent. Such data should, where possible, be broken down by region. Without such data, it is difficult to make long term supply projections, and it is difficult to develop targeted and strategic initiatives to increase supply[16].

Recommendation 2: The Scottish Government should commit that by 2020 every Scottish primary school should have access to a science subject leader, who supports science teachers across a school and has a science background. In the case of small schools, they should at least have access to a science subject leader via a local cluster, if it is not possible for the leader to be located within the school.

Recommendation 3: The Scottish Government should introduce incentives to increase the numbers of science graduates and those with science Highers entering primary school teaching.

Recommendation 4: The Scottish Government should encourage primary schools to support and provide subject-specific CPD, particularly in relation to practical work.

Recommendation 5: The Scottish Government should ensure the Professional Update includes subject-specific CPD.

Recommendation 6: Initial teacher education institutions should ensure that their primary education courses provide future teachers with sufficient experience of practical science activities.

Recommendation 7: For secondary education, the Scottish Government should restart the data collection process on the number of teacher vacancies in schools on a subject-by-subject basis.

Recommendation 8: The Scottish Government should re-enter the TIMSS assessment in order to provide a useful benchmark of Scotland's primary science education.

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.

[16] If possible, it would also be useful to know the range of science degrees held by primary teachers, and at what level they passed.

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