

[National Assembly for Wales](#)

[Enterprise and Business Committee](#)

[Follow-up inquiry into Science, Technology, Engineering and Mathematics \(STEM\)](#)

Evidence from the Welsh Government – STM 16

## **Follow-up Inquiry into Science, Technology, Engineering and Mathematics (STEM) Skills**

### **Welsh Government**

#### *Purpose*

To provide the Enterprise and Business Committee with evidence for its follow-up inquiry into STEM skills, noting progress in areas under its terms of reference.

#### **What impact has the Welsh Government's strategy *Science for Wales* and Delivery Plan had on STEM skills in Wales?**

The *Science for Wales* strategic framework sets out priorities and key commitments to increase the science and engineering talent pool, these are being taken forward in specific policies. Progress in meeting our commitments is reported on internally on a regular basis and we also publish an annual report to update stakeholders on progress, linked to the Programme for Government. The Chief Scientific Adviser reports to Ministers on implementation and advises on any further action needed to meet our goals. We will be monitoring STEM skills within our three theme areas going forward, seeking to identify and address any gaps.

#### **What progress has been made in addressing the adequacy of provision of STEM skills in schools, further education colleges, higher education and work-based learning (including apprenticeships)?**

Early exposure to STEM initiatives positively impacts on primary pupils' dispositions towards STEM subjects and hence science remains important in the primary curriculum. In the Foundation Phase, through the 'Knowledge and Understanding of the World' Area of Learning children are given experiences that increase their curiosity about the world around them and are encouraged to enjoy learning by exploration, enquiry, experimentation, asking questions and trying to find answers.

In 2013 the Welsh Government established a Task and Finish Group to consider computer science and ICT, the group published their report in October 2013. It stressed the need to update the way ICT is taught in schools, making it more relevant to current and future needs. It also called for a Computing curriculum which encourages creativity, allowing thematic working and developing real world problem-solving. Digital literacy is not the end point, learners need to create as well as consume.

The current science curriculum at KS2 and 3 emphasises the development of skills and enquiry led science. In addition to the application of the non-statutory Skills Framework for 3 to 19 year olds, learners are taught to apply their scientific skills, knowledge and understanding to design strategies, solve problems and offer explanations. Estyn, however, has highlighted concerns over the planning of progression in scientific knowledge and understanding (June 2013), and how these key stages are preparing learners for GCSE study. Their report also highlighted that, in the majority of lessons observed, standards in science were good or better.

The Welsh Government recognises STEM skills as critically important, and notes year on year improvements since 2007/08 in the percentage of pupils aged 15 at KS4 achieving A\* to C grades in science. In 2012/13 this was 74.8% - up from 70.6% in 2011/12. However, PISA 2012 showed Wales' performance in science fell below the OECD average, including a 50% fall since 2006 in those attaining the highest levels. Consequently, the Welsh Government is keen to understand better the issues around PISA, how we can further support science teachers, and how we can help change the perception of the sciences and technology as a career or course of study of choice. We are particularly looking to support schools further during Key Stage 4 and tackle gender differentials.

The Minister for Education and Skills recently commissioned Professor Graham Donaldson to undertake an independent review of the National Curriculum and assessment arrangements. The review includes wide ranging stakeholder engagement and considers the needs of business and the economy, including the critical role of STEM skills, as well as issues highlighted by Estyn regarding delivery of science at Key Stages 2 and 3 in schools. Professor Donaldson's report and recommendations will be submitted around the turn of this year.

In taking forward the Review of Qualifications recommendations DfES officials are preparing for a new suite of GCSEs for first teaching from September 2016. It is likely that GCSEs will in future be the only science qualifications that will count towards key school performance measures (a letter set out this intention last year). Planned work includes formal engagement of stakeholders, including awarding organisations, practitioners and Estyn, to ensure our qualifications remain alive to wider developments and that learners access qualifications that are fit for the future.

The numbers undertaking apprenticeships in the main STEM related sectors were:

|                  | <b>2011/12</b> | <b>2012/13</b> |
|------------------|----------------|----------------|
| Engineering*     | 2,319          | 2,021          |
| Electrotechnical | 981            | 1,031          |
| IT User/s        | 842            | 1,222          |
| <b>Total</b>     | <b>4,142</b>   | <b>4,274</b>   |

\*Data for Engineering includes all sector descriptions prefixed by the word Engineering.

One of most popular sectors was IT User/s which shows an increase of 45% from 2011/12 to 2012/13. This is due to the nature of the framework and its relevance to sector employers. The 13% reduction in Apprenticeship learners in Engineering is

possibly due to the number of learners progressing from a Foundation Apprenticeship onto an Apprenticeship, and the recruitment cycles of employers in this sector.

Our additional investment in Apprenticeships has allowed us to fund Semta, the relevant Sector Skills Council to increase the number of STEM Apprenticeships through the 'I am an Engineer' project, in conjunction with the Engineering Education Scheme Wales (EESW) and the National Science Academy (NSA).

We are supporting intensive training for 16-24 year old learners to become Apprentices in STEM, the area which now achieves the strongest progression to Apprenticeships.

The Welsh Government places great emphasis on the continued development of STEM skills in higher education. Through the Higher Education Funding Council for Wales (HEFCW) we continue to support STEM provision in HE in support of the ambitious *Science for Wales* agenda building on HEFCW's successful initiatives of recent years.

We are pleased to note that enrolments in STEM subject courses in HE continue to increase suggesting that interventions we are making throughout the curriculum are having a positive impact on individuals' choices in higher education and that provision in Wales is proving attractive to potential students. In addition, our 2012 HE reforms have put the HE sector in a much stronger position to invest in STEM provision. Latest forecasts suggest that the new funding regime will contribute an additional £200m in income to the sector during the lifetime of this Government, when compared to the previous funding formula.

**What progress has been made in addressing value for money from the additional funding to support and promote STEM skills, and whether the supply of STEM skills is meeting the needs of the Welsh labour market?**

Over 2013-15 the National Science Academy (NSA) grant scheme has funded 29 projects, worth approximately £1,650,000 and estimated as reaching out to 62,000 pupils through a wide variety of STEM engagement and enrichment activities. Participants range from those in Key Stage 1 through GCSE to A-level and other post-16 students. Funding from the Department for Education and Skills (DfES) for Techniquest (TQ) and Techniquest Glyndwr (TQG) is a further £1.755 million. The NSA is complementary to Careers Wales, which provides client-focused information and advice on careers.

The NSA Scheme has operated two competitive grant rounds and currently facilitates a longer term portfolio of projects up to March 2015. The NSA has also awarded grant funding to the EESW to stimulate interest and promote careers in the engineering sector, and to the British Science Association (BSA) towards delivery of the CREST Awards. It is keen to fund projects which attract or target under-represented groups, such as the Institute of Physics 'Lab in a Lorry' (attracting over 1,500 female students), the Swansea University-led 'S4 Summer School' (targeting Communities First Wards and female participants), and 'Girls into Engineering' (under the EESW). Work has been informed by a survey of STEM activity in Wales and relevant indicators are reported in line with the *Science for Wales* Delivery Plan.

A report by the Science Advisory Council for Wales proposed further development of the NSA, including a more formal strategy, set of indicators and project evaluation, and stronger co-ordination with STEMNET. The Chief Scientific Adviser is meeting with partners to discuss this further. During the next year projects will be evaluated and recommendations considered in implementing the next grant round. We are also developing stronger connections with UK science charities and centres and participating in a new STEM forum.

Where relevant, the NSA also co-operates with sector teams. The Advanced Materials and Manufacturing Sector team, for example, supports a pilot programme of Saturday Clubs with the Ford Motor Company to encourage young people into engineering careers through practical work with vehicle electronics and engines (and targeted on girls' engagement, with 29% female participation). Sector work is also supporting Airbus to run an all girls cohort of the Industrial Cadets programme.

Across the UK the STEMNET organisation promotes STEM Ambassadors and science clubs in schools and raises awareness of funding opportunities. 96% of Welsh secondary schools now hold at least one STEM Ambassador event per year, with 65% of schools holding three or more events and a Welsh winner of the latest *Most Dedicated STEM Ambassador Award*. Half of secondary schools run science clubs, with a third of those receiving grant funding in some form.

An evaluation has found that Welsh Government support performs an important function in the Techniquest and Techniquest Glyndŵr programme that teaches STEM skills in schools through on-site and outreach activity. This support is regarded as essential to maintaining current services and enhancing the offer and difficult to replicate from other sources. The vast majority of schools found the most recent service to be fun and exciting for pupils, contributing to tangible learning outcomes and rated as very good or excellent. The most commonly cited pupil impacts were increases in motivation and enthusiasm, subject interest, understanding of the concepts covered, and in overall understanding of STEM subjects.

A detailed external evaluation of the Further Maths Support Programme (FMSP) Wales, providing tuition and aiming to increase uptake of the subject, is being undertaken by Miller Research. The pilot has received over £581,000 Welsh Government funding between 2010-11 and 2013-14. An interim evaluation report (2013) judged that it has been well managed and that the majority of desired outcomes have been achieved. In the pilot areas over the last three years there has been a clear, year-on-year increase in students taking A level Further Mathematics; a four-fold increase between 2010 and 2012 in A level Further Mathematics entries; an overall increase in students studying A level Mathematics; and an increase in the number of applicants to HE mathematics courses.

**What progress has been made in addressing the supply of education professionals able to teach STEM subjects and the impact of Initial Teacher Training Grants and the Graduate Teacher Programme on recruiting STEM teachers and education professionals?**

The overall teacher vacancy rate across Wales remains low, at 0.3%. The latest (2012) Pupil Level Annual School Census found that the average ratio of applications to advertised vacancies for English medium teaching vacancy in chemistry was 13; in

physics 6 and in mathematics 10. The ratio was significantly less (4) for Welsh medium teaching posts. The equivalent ratio number of applications received across all secondary English medium posts is 13 - see:

<https://statswales.wales.gov.uk/Catalogue/Education-and-Skills/Schools-and-Teachers/Schools-Census/Pupil-Level-Annual-School-Census/Staff-and-Governors>

We recognise the importance of an adequate supply of well qualified science and mathematics teachers which meets the demands of maintained schools in Wales. Training incentives are now £20,000 for those with the highest degree classifications undertaking postgraduate initial teacher training courses in physics, chemistry and mathematics and up to £15,000 for teaching computer science. The programme is designed to encourage those with the highest level of subject knowledge to consider teaching in Wales as a career.

We also support these priority recruitment subjects under employment-based routes into teaching including the Graduate Teacher Programme, and from 2013/14 through Teach First Cymru, which emphasises recruitment of trainee science teachers with excellent subject knowledge.

The employment of teachers in schools is a matter for local authorities, head teachers and governing bodies. Governing bodies will take into account the skills, subject knowledge and qualifications of applicants alongside the needs of the school and the balance of expertise within their teaching workforce.

### **What progress has been made in addressing the effectiveness of education and business links between education institutions and STEM employers?**

A previous section highlighted enhanced education business links supported by the NSA and sector work. Under STEMNET in Wales there are now 1,400 STEM Ambassadors, about 70% from private sector employers, covering 870 employers including 120 SMEs. Public sector partners include Public Health Wales and the NHS more widely.

A 2013 review by ICF GHK Consulting Ltd of the Techniquest (TQ) and Techniquest Glyndŵr (TQG) core education services for schools found that the organisations have built strong networks of partnerships with other STEM support providers and universities, and been successful in attracting additional funding from a wide range of sources. Their role in sub-contracting primary outreach hubs has also highlighted how bringing together different organisations, including non-STEM specialists, can enhance the STEM offer to schools. TQG's close links with Glyndŵr University and local industry employers (such as the Toyota UK Engine Plant) are highlighted as being mutually beneficial, enhancing the offer to secondary schools while also providing access to potential new students or recruits for partners.

Building on plans set out in the National Numeracy Programme (2012), the Welsh Government awarded 2 year contracts from April 2013 to TQ, TQG and Steam Powered Stories to provide Numeracy Employer Engagement activity across all 4 consortia regions in Wales. The programme is brokering links between employers and schools to help support teachers and learners with the development of numeracy skills and their application in the world of work. Activity is focused specifically on raising the confidence and capability of numeracy for KS3 and KS4 pupils.

In addition, schools have access to employer led initiatives, such as the Schools Connect programme. This GE Healthcare initiative brings A-level students in Biology, Chemistry, Physics and Mathematics to The Maynard Centre to show what a career in science and technology would look like, focusing on the site work in cell technology and product lifecycle development.

The Lego Education Innovation Studio aims to make STEM subjects fun and exciting, and ensure businesses in the North Wales area have people with the necessary skills and motivation available to move into employment. It is supported by G2G Communities with funding from the European Regional Development Fund.

**Progress made on addressing negative perceptions and gender stereotypes of STEM and promoting good practice to encourage women to acquire STEM skills and to follow STEM related careers.**

The Girls in Science (GOWS) pilot project, funded by the Welsh Government, was led by CaST Cymru and Chwrae Teg from 2012 to 2014 to encourage the wider engagement of girls in STEM education and hence increase the numbers pursuing STEM careers. The project addressed negative perceptions, often developed early in life, that girls are ill suited to STEM subjects. The work aimed to improve the way science is delivered during the KS2-KS3 transition phase in primary and secondary schools to better reflect the needs of girls.

'Science Champions' helped break down the gender barriers in schools. The project also promoted improvements in industry's policies and working practices in engaging with a female workforce. 170 teachers, 1,580 learners and 170 parents were involved, with an estimated further 31,000 learners indirectly benefitting from the project's outcomes. The project led to resulted in the production of guidance on gender lensing, educational resources, good practice materials and case studies. These are being shared with teachers across Wales through Hwb, following a series of dissemination conferences. We are encouraging STEM partners to embrace the gender concept developed through the project, for example, in subsequent changes to DfES grant support for Techniquest and Techniquest Glyndŵr.

In 2013 DfES officials reviewed girls' take up and progression in science, particularly to A level physics. Engaging with the Institute of Physics (IoP) the review highlighted the need to support the skills and knowledge of practitioners and tackle the perception of physics as a subject of choice for girls. It found that more can be done to record and highlight evidence of gender differentials to schools, and giving impetus to introduce remedial measures.

As noted above the NSA has supported several STEM enrichment projects which recognise and address gender disparity.

The issue of gender differentials and progression in STEM related subjects remains a priority area for the Welsh Government in taking forward grant funding, curriculum development and wider work in STEM. Professor Julie Williams, as CSAW, is establishing a 'Women in Science in Wales' group bringing together influential female scientists who will develop and coordinate actions to address this issue. A conference is arranged for September to encourage young women to consider roles in STEM and

as decision makers in public service. We support strongly the Athena Swan awards scheme that promotes best practice in Universities in promoting female research careers. Spearhead Science Wales is planned to include steps to make it easier for researchers to move back into research after a career break, such as for childcare. The Chief Scientific Adviser is working with the Daphne Jackson Trust, who have a success rate of over 90% in helping scientists continue careers following a career break.

### **What progress has been made on learning STEM skills through Welsh medium education and training?**

Under the Welsh in Education Strategic Plans and Assessing Demand for Welsh Medium Education (Wales) Regulations 2013 Local Authorities are required to indicate their strategy for increasing the percentage of pupils aged 15 and over studying for qualifications through the medium of Welsh.

The average number of applications received for Welsh-medium teaching posts across all subjects is typically lower than for English-medium posts. As noted earlier, the same is true for STEM subjects, with in 2012 an average of 4 applications per secondary post for Welsh-medium teaching , compared with 12 for English-medium. The Welsh-medium Incentive Scheme provides practical and financial support, to help increase the number of newly qualified secondary teachers able to teach confidently and competently through the medium of Welsh. There are more than 90 in the scheme this year, including 34 specialising in STEM subjects, of which more than two thirds have already shown an improvement in their linguistic skills by at least one grade.