



Llywodraeth Cymru
Welsh Government

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

Science, Technology, Engineering and Mathematics (STEM) in education and training

A delivery plan for Wales

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

Science, Technology, Engineering and Mathematics (STEM) in education and training

A delivery plan for Wales

Audience

The entire teaching workforce and government and national partners, including regional consortia, local authorities, governing bodies, workforce unions and diocesan authorities.

Overview

This publication sets out the Welsh Government's strategic objectives for the provision of science, technology, engineering and mathematics (STEM) for 3 to 19-year-olds in Wales.

Action required

None – for information only.

Further information

Enquiries about this document should be directed to:

Core Subjects Branch

Curriculum Division

Infrastructure, Curriculum, Qualifications and Learner Support Directorate

Welsh Government

Cathays Park

Cardiff

CF10 3NQ

Tel: 029 2082 6275

e-mail: CurriculumCorrespond@wales.gsi.gov.uk

Additional copies

This document can be accessed from the Welsh Government's website at

www.gov.wales/educationandskills

Related docuemnts

Science for Wales – A strategic agenda for science and innovation (Welsh Government, 2012); *A curriculum for Wales – a curriculum for life* (Welsh Government, 2015);

Successful Futures: Independent review of curriculum and assessment arrangements in Wales (Welsh Government, 2015); *The National Science Academy STEM Enrichment Strategic Plan 2015–18* (Welsh Government, 2015);

Science, Technology, Engineering and Mathematics (STEM): Guidance for schools and colleges in Wales (Welsh Government, 2012); *Science in the National Curriculum for Wales* (Welsh Assembly Government, 2008)

Contents

1. Introduction and strategic vision	2
2. Building the evidence base	6
2.1 Collation and reporting of data	7
2.2 Further research and analysis	8
3. Supporting learning and teaching	11
3.1 Developing fit-for-purpose STEM curricula	13
3.2 Enhancing and enriching the STEM curriculum	15
3.3 Introducing fit-for-the future STEM qualifications	17
3.4 Advice, guidance and teacher support	18
3.5 Provision of bilingual resources	22
3.6 Wider ICT support	23
3.7 Developments in higher education	24
4. Changing perceptions	27
4.1 Reinforcing the importance of STEM	27
4.2 Careers advice and guidance	29
4.3 Women in STEM	31
Annex A: References/additional sources	33

1. Introduction and strategic vision

Education changes lives, it provides opportunity, it enables individuals to shape their futures, it builds stronger, more tolerant and cohesive societies, it is the foundation of a strong economy. In short, education matters. Our vision for education is that:

Learners in Wales will enjoy learning and teaching that inspires them to succeed, in an education community that works cooperatively and aspires to be great, where the potential of every child and young person is actively developed.

Qualified for life: an education improvement plan for 3 to 19-year-olds in Wales (Welsh Government, 2014)

In taking forward that vision, the independent review of the curriculum and assessment in Wales in its resulting report, *Successful Futures (2015)*¹, highlighted the need for common purposes that apply to all our children and young people and promote high aspirations and a determination to achieve. The Minister for Education and Skills accepted all 68 recommendations set out in *Successful Futures* on 30 June 2015. This established the four purposes of the curriculum in Wales will be that all children and young people develop as:

- ambitious, capable learners, ready to learn throughout their lives
- enterprising, creative contributors, ready to play a full part in life and work
- ethical, informed citizens of Wales and the world
- healthy, confident individuals, ready to lead fulfilling lives as valued members of society.

These purposes are no more relevant than in the development of Science, Technology, Engineering and Mathematics (STEM) skills and knowledge from the early years through to post-graduate study and importantly beyond into the workplace. STEM skills enhance our young people's ability to access and succeed in rewarding careers at all levels of employment, and provide the level of understanding necessary for all our young people to succeed in an increasingly science and technology driven world.

The importance of our children and young people developing (STEM) skills and knowledge at all levels is widely acknowledged. These skills are essential to the development of a prosperous and sustainable knowledge economy in Wales.

Science, technology, mathematics and engineering are the bedrock for innovation in business and industry and the Welsh Government will continue to push forward links between these and education helping young people get a real grasp of the real world of work.

Carwyn Jones, First Minister

¹ gov.wales/topics/educationandskills/schoolshome/curriculum-for-wales-curriculum-for-life/why-we-are-changing/successful-futures/?lang=en

STEM subjects, along with other quantitative disciplines, are highly valued across a range of occupations, offering students varied and highly rewarding career opportunities. These subjects also support our commitment in the *Policy statement on skills (2014)*² to jobs, growth and developing a highly-skilled workforce for the future. Our ambition, set out in the *Policy Statement on Skills* and in the subsequent *Skills implementation plan – Delivering the policy statement on skills (2014)*³, is to develop a skills system in Wales that supports our future competitiveness, helps us evolve into a highly skilled society as well as tackle poverty, and is sustainable against the backdrop of ever scarcer resources. Our focus is on raising productivity, reducing barriers into work and supporting people into sustainable employment.

In our strategy *Science for Wales – A strategic agenda for science and innovation in Wales (2012)*⁴, we highlight the importance of STEM skills at all levels. The strategy's 'Increasing the Science and Engineering Talent Pool' chapter notes the essential nature of these skills in developing a prosperous and sustainable knowledge economy.

A central ambition of the Welsh Government is to build a stronger economy. A sound and vibrant scientific and technological base has substantial potential to boost the economy, through advanced ideas, skills and developments and an effective translation through innovation to more high quality jobs.

The National Assembly for Wales' Enterprise and Business Committee's (EBC) follow-up inquiry into Science, Technology, Engineering and Mathematics skills (2014)⁵ called for 'a more strategic and joined-up approach to interventions in the different STEM subjects, based on greater understanding and evaluation of their impact'. It recognised the scale of the challenge across education settings and society to bring about the cultural change necessary for positive, gender-neutral perceptions of STEM. The inquiry also noted that:

Wales needs to strive for excellence in STEM right through the pipeline – from the curriculum and qualifications offered in primary and secondary schools, in colleges and universities, through careers advice and work experience, and into meaningful and sustainable employment.

The EBC called for a coherent plan for the promotion, monitoring and evaluation of STEM enrichment activity through the National Science Academy (NSA), and across the Welsh Government. This plan sets out how the EBC's recommendations are being driven forward, while capturing work on the development of STEM skills through curriculum and qualifications change, professional learning for practitioners and support programmes. It remains focused on actions that relate to STEM skills development, while recognising the essential nature of literacy and numeracy as key to successful STEM skills attainment.

² learning.gov.wales/resources/browse-all/policy-statement-on-skills/?lang=en

³ gov.wales/topics/educationandskills/skillsandtraining/policy-statement-on-skills/skills-implementation-plan/?lang=en

⁴ gov.wales/topics/science-and-technology/science/?lang=en

⁵ www.senedd.assembly.wales/mglIssueHistoryHome.aspx?Id=2225

The National Science Academy (NSA) has formulated a *STEM Enrichment Strategic Plan (2015)*⁶, based on a strategic review of its past operations. This was published in July 2015 in time to inform its latest grant-funding application call.

Access to robust STEM performance data and impact analysis are critical to informing programme development and system monitoring. Such access is even more important at a time of increasing budgetary pressure. Therefore section 2 of this delivery plan sets out upfront how this will be developed and communicated with stakeholders.

Our priority is for the collation, analysis and reporting of progress against key indicators over time. This will provide the information essential for STEM policy and programme development, and system-wide monitoring, including the earlier identification of potential barriers to the flow of STEM skills.

In section 3, we detail actions to deliver increased uptake and development of STEM skills through the evolution of learning and teaching across education and training settings. Major curriculum and qualifications reforms are key elements of this, supported through our revised strategic approach to supporting curriculum enrichment activity. However, the essential underlying support to develop practitioner skills and knowledge through the New Deal for the Education Workforce and access to fit-for-purpose bilingual teaching resources is given equal prominence.

Our priority is to evolve the learning and teaching undertaken in our schools, colleges and universities in a way that supports the development of STEM skills by our young people to meet their needs and employer needs in the twenty-first century.

Our priority is for the long-term, self-sustaining, system-wide development of an education workforce in Wales capable of delivering a new and challenging STEM curriculum.

Our priority is for our STEM-related qualifications in Wales to be of a standard comparable with the rest of the UK and the best in the world.

The impact of putting the building blocks in place to deliver excellence in STEM skills will be restricted unless this is matched by a notable shift in the perception of STEM. Attitudes towards STEM are often based in deep-rooted societal stereotypes, which become a barrier to progression into rewarding careers and further learning. Section 4 recognises the need for sustained effort in this area, and sets out measures targeted at practitioners, learners and their parents/carers.

Our priority is to increase interest and participation in STEM learning, particularly among girls.

⁶ gov.wales/topics/science-and-technology/science/national-science-academy/?lang=en

Our priority is to equip our young people with career management skills and knowledge of the options available to them in the STEM sector, so that they are able to make better informed decisions on their futures.

2. Building the evidence base

This section sets out actions to track, understand and report STEM in education and training, analysis of trends, and impacts of intervention and support programmes.

Our priority is for the collation, analysis and reporting of progress against key indicators over time. This will provide the information essential for STEM policy and programme development, and system-wide monitoring, including the earlier identification of potential barriers to the flow of STEM skills.

Activities set out in the subsequent sections of this plan rely on the results of robust analytical and reporting work. Work in this area informs the delivery of meaningful STEM learning and enrichment opportunities through the more effective allocation of finite resources. It will also ensure that all STEM stakeholders have access to the same information base to inform their planning processes in support of STEM skills.

Work on the systematic collation, analysis and reporting of STEM progress also highlights areas in our intelligence base that may require further investigative work. Plans to plug such potential 'gaps' are also set out in this section, alongside measures to more routinely communicate progress and key issues/findings.

Labour Market Intelligence (LMI) is being increasingly used as part of the evidence base, drawing on a range of analysis including some of the key outputs by the UK Commission for Employment and Skills (UKCES). This includes the Employer Skills Survey and the Working Futures series of employment projections. This information is being better communicated to learners through Careers Wales online, as set out in section 4.2 of this plan.

The EBC's report highlights high levels of STEM education and training activity, but notes that progress in STEM skills attainment has remained too slow. Analysis of Wales' STEM-related performance in the international 3-yearly PISA comparisons, for example, shows that challenges remain for the development of the mathematical and scientific literacy abilities of our 15-year-olds. As set out in this plan, these indicators have been analysed in depth, with the results used to inform curriculum and qualifications reform (plus support and teacher development programmes), to ensure the flow of STEM skills improves.

The committee's report also references the change in focus necessary to ensure that the STEM needs of our young people are met through curriculum and qualifications reform, as opposed to what might be seen as the short-term interests of schools. We need to ensure that an appropriate balance is maintained in the nature of qualifications offered to our young people, and that no artificial barriers are introduced which hinder their progression in STEM subjects. As set out in this plan, measures to track and report information on school level Key Stage 4 local curriculum offers, linked to the new science suite of qualifications in particular, are being introduced. Our local authorities and regional consortia will, consequently, be better placed to work with schools to ensure learners have access to what they need to progress in STEM subjects.

2.1 Collation and reporting of data

There is strong evidence of growing demand from employers for STEM graduates and skills. Data published by the CBI suggests that 72 per cent of all UK businesses rely on people with STEM skills and that 53 per cent of employers expect problems recruiting STEM technicians and graduates in the next three years (CBI, 2014)⁷. It is estimated that by 2022, one in five new jobs in the UK will be STEM jobs (*Working Futures 2012–22*)⁸.

From 2015, demand for STEM-related skills in Wales is being assessed through regional skills partnership regional employment and skills plans. These plans will be updated on an annual basis.

At present, school-related high-level indicators are routinely published, including teacher assessment data at the end of key stages and qualifications attainment data. In analysing performance, our emphasis will be on ensuring that artificial barriers do not hinder learner progression in STEM subjects/areas. This will ensure that our education system better meets the demand for STEM skills as summarised above. This requires a more detailed analysis of performance according to STEM-related qualification type (and any potential gender-related imbalances) to ensure any 'over-application' of qualifications that do not facilitate progression is avoided. To reinforce our emphasis in this area, communication will take place direct with key stakeholders, data will be published and annual Ministerial statements on progress will be issued.

In summary – our actions

We have:

- published annually key science and mathematics data, covering, for example, teacher assessment of learner progress at the end of the Foundation Phase, Key Stages 2 and 3, and attainment at Key Stage 4 and AS/A levels
- ensured that attainment and progression data at key stages is available on the basis of gender and eligibility for free school meals (eFSM)
- initiated work on accessing and collating relevant labour market intelligence (LMI) and employer skills needs to inform policy, alongside key educational attainment data
- worked with UKCES to disseminate the employment projections included in the Working Futures series of reports, and commissioned a summary report for Wales from *Working Futures 2012–22*
- implemented a range of skills performance measures which provide the basis for delivering our ambition for skills in Wales and the changes needed in response to the *Policy statement on skills*. Specifically, the measure on equality and equity will be used to monitor equality of opportunity for individuals in accessing post-19 employment and skills support

⁷ www.cbi.org.uk/media-centre/press-releases/2014/03/cbi-demands-action-on-growing-skills-vacuum/

⁸ www.gov.uk/government/publications/working-futures-2012-to-2022

- improved the availability and use of all LMI in Wales, including intelligence for STEM-related careers, on Careerswales.com. This ensures that clients of all ages, including all young people, have access to appropriately presented information on career and employment opportunities
- made available information on wider employment trends and needs for key decision makers on the Learning and Skills Observatory web site, with the intention to continue to develop STEM LMI into the future.

We will:

- work with stakeholders to develop the details of an annual data report for first publication in 2016, so that all stakeholders have access to a single reference source for STEM in education progress in Wales. This can then be used to inform planning and monitoring arrangements
- starting in 2016 publish an annual Ministerial statement, alongside the data report, on developments in STEM education and training in Wales. This will highlight the sustained emphasis on STEM skills development, areas of progress, and key issues for stakeholders as the focus of future work
- monitor trends and projections on future employment levels in STEM occupations and skills needs through Working Futures and the Employer Skills Survey, so that the data can be used to inform both STEM education and training provision, and robust careers information to learners system-wide.

2.2 Further research and analysis

In addition to the development and production of national STEM skills data, research or other analytical work will need to be undertaken to better understand specific issues regarding the learning and teaching of STEM skills. Such analysis will directly inform future support, guidance, and delivery programmes.

In many respects, specific actions in this area will flow from changes in STEM performance over time. Whether data is showing progress (or the lack thereof) the information below sets the framework through which additional analysis work will be reviewed and managed. It also includes specific actions we have already identified to help decision-makers and wider stakeholders better understand issues behind performance. In addition to specific commissioning, work will continue to take place through engagement with key STEM stakeholder organisations operating in Wales, and the capturing of their views on performance issues.

To oversee the day-to-day work in this area, and the plan as a whole, we have established an internal Welsh Government cross-Departmental STEM in Education and Training Group. The group which is chaired by the Chief Scientific Adviser for Wales will report progress to Ministers.

In summary – our actions

We have:

- undertaken an evaluation of the Numeracy Employer Engagement Programme, to capture lessons learned on the management of school-employer links and inform the development of the Enhanced Employer Engagement project
- ensured that Wales' PISA mathematics and scientific literacy results have been analysed to capture trends in areas of content, context or assessment approaches that Welsh 15-year-olds do well in, or have shown difficulty in accessing correctly. This is already informing the content of classroom resources in support of the new GCSE qualifications, and advisory support being delivered by regional consortia for these new qualifications
- analysed science Key Stage 4 qualification take-up on the basis of qualification type, including the impact of BTEC science in recent years, against other science qualification options. This has allowed informed decisions to be made on revisions to Key Stage 4 performance measures and negative impact on progression in science to be better tracked
- in 2014, undertaken a survey of science practitioners on curriculum, assessment and teacher support issues to inform the development of further support
- established a termly networking group between Welsh Government officials and the three science learned societies and Association of Science Education, to formalise dialogue on school science curriculum and qualifications development
- undertaken and distributed to schools via regional consortia, a detailed analysis of the 2015 OECD Scientific Literacy framework against the current suite of Key Stage 4 science qualifications. Schools need to better understand the differences between current science learning and the PISA assessment so that they can minimise exposing learners to uncovered assessment content
- announced a network of three regional skills partnerships, tasked with analysing its local economic challenges and identifying what skills are needed within the local workforce. This demand-led approach will support the effective prioritisation of funding whilst bringing maximum benefits to the workforce
- undertaken a summary of planned delivery for 2016/17 by further education institutions (FEIs) by sector subject area. In addition, we collated programme delivery data from April 2015 final delivery plans to show current and planned learner numbers on full-time vocational programmes.

We will:

- engage and consult with Welsh-medium stakeholder organisations on the progress of this plan, so their views can better inform support programmes
- introduce consistent measures for learner outcomes in sixth forms, FEIs and work-based learning providers, including qualification success, Welsh Baccalaureate attainment, destinations, and value added activities
- undertake a follow-up survey with science practitioners, including increased input from Welsh-medium schools, to inform future support programmes following the introduction of the new GCSE science suite in September 2016
- commission a detailed analysis of PISA 2015 attainment in science and mathematics following publication of the headline results in December 2016.

This will identify areas where Welsh learners do not perform and inform curriculum development and application in schools

- by summer 2016, arrange further analysis of the apparent disparity in gender performance in mathematics between GCSE and PISA assessments, as recommended by Estyn. Better understanding of possible gender-based impact from different assessment types will inform future assessment arrangements in Wales
- over the year ahead explore whether future skills projections can be meaningfully matched against existing post-16 learning provision, to ensure that we have people in the right place to meet future demand
- task the three regional skills partnerships to publish annual regional employment and skill plans which identify economic priorities as well as local demands and opportunities to support major infrastructure projects in their region. The content of the plans will build on priorities identified by the enterprise zones and city regions programmes, where appropriate
- consider options for a review of student numbers by subject and occupational area in the FE sector, so we can better understand the balance of FE provision against national priorities
- undertake a summary of future planned delivery by FEIs for September 2016/17 by sector subject area and share these with the regional learning partnerships so that the balance of FE provision will meet regional priorities.

3. Supporting learning and teaching

We know that the need for STEM skills in Wales, and the exciting career opportunities they unlock for our young people, will remain as our economy continues to grow. We also know how important those skills are in underpinning our future economic growth.

Our priority is to evolve the learning and teaching undertaken in our schools, colleges and universities in a way that supports the development of STEM skills by our young people to meet their needs and employer needs in the twenty-first century.

In 2015 we saw the publication of key documents setting out radical new proposals for changes to our education system in Wales. Professor Graham Donaldson's report, *Successful Futures*, presents a vision for the future of education in our schools. It is telling that it sets the development of STEM skills from age 3 to 16 front and centre, recognising their importance in an increasingly science and technology driven world. With the agreed four purposes of the curriculum at its core, *A curriculum for Wales – a curriculum for life* (Welsh Government, 2015)⁹ sets out the steps that we will take to achieve *Successful Futures*. The new curriculum, for all year groups, could be available to schools as early as September 2018.

Successful Futures reinforces the importance of the teaching of STEM skills, setting out Areas of Learning and Experience (AoLEs) for Science and technology, and for Mathematics and numeracy. These aim to support teachers through focus on key strands such as capitalising on learners' curiosity in generating and testing ideas and gathering evidence. The science and technology AoLE embraces physics, chemistry, biology, engineering, design technology as well as craft, design and graphics. It also incorporates computer science, focusing on developing the types of thinking skills used in computation. In this area, the recommendations in *The ICT Steering Group's report to the Welsh Government* (2013)¹⁰ point clearly to the conclusion that digital competence is increasingly fundamental to learning and life, and we have, therefore, accepted that digital competence should be a cross-curriculum responsibility for all teachers.

Through the Pioneer Schools Network, Digital Pioneers are focusing on the design and development of the Digital Competence Framework. This aspect has been 'fast tracked' so as to be available from September 2016. The framework will identify the core digital skills that all learners need to have and provide a clear structure for learning and progression.

Successful Futures also highlights the essential nature of pedagogical development and that Wales' education practitioners need the skills and knowledge necessary to be able to deliver a new curriculum. This is no more important than in the STEM field, where we know from global research that the subject knowledge of teachers (in areas such as mathematics and science) is a direct factor in learner attainment. Professor John Furlong's report, *Teaching tomorrow's teachers – Options for the*

⁹ gov.wales/topics/educationandskills/schoolshome/curriculum-for-wales-curriculum-for-life/?lang=en
¹⁰ learning.gov.wales/resources/browse-all/ict-steering-groups-report/?lang=en

*future of initial teacher education in Wales (2015)*¹¹, presents us with a series of options to better prepare our new teachers for a twenty-first century curriculum through changes to initial teacher education and training. When read alongside the Minister for Education and Skills' statement on the *New deal for the education workforce (2015)*¹², a coherent approach emerges.

Our priority is for the long-term, self-sustaining, system-wide development of an education workforce in Wales capable of delivering a new and challenging STEM curriculum.

A new approach to curriculum, assessment, professional learning and initial teacher education and training will take time to consider and implement. We need to get it right, while continuing to drive improvements through existing curriculum arrangements (such as the 2015 revision of the mathematics programme of study). Rapid progress in introducing a new STEM-related curriculum, not supported by the essential teacher development to ensure their readiness to deliver, would be counter-productive.

Practitioners and key stakeholders are being engaged to develop thinking on the way forward. Their sustained engagement and support is critical to the process of reform. It is they who will develop the STEM skills we need for the future.

The Pioneer Schools Network will be at the forefront of designing the new curriculum and assessment arrangements providing expert advice and support. The all-Wales partnership will include curriculum and assessment experts, and other key stakeholders, including Estyn. Pioneer Schools will work with their wider school clusters and networks and beyond, including pupil referral units (PRUs), non-maintained settings and FEIs to ensure that as many learning providers as possible are part of the design and development process. They will share thinking, test ideas and keep up-to-date with the latest developments as the curriculum and assessment framework develops. Robust quality assurance processes are being put in place to ensure we fulfil our ambition to develop a world-leading curriculum.

STEM qualifications gained in Wales also need to reflect our approach to the learning and teaching of STEM, while remaining portable for the learner. Through STEM qualifications gained in Wales, our young people should be able to study and work wherever is best for them.

Our priority is for our STEM-related qualifications in Wales to be of a standard comparable with the rest of the UK and the best in the world.

In taking this priority forward, we have retained and are in the process of strengthening our STEM-related GCSEs and A levels in Wales, in addition to a more rigorous Welsh Baccalaureate. The introduction of two new mathematics GCSEs for first teaching from September 2015, for example, has clearly signalled the emphasis we place on fit for purpose STEM-related qualifications.

¹¹ gov.wales/topics/educationandskills/publications/wagreviews/teaching-tomorrows-teachers/?lang=en

¹² gov.wales/about/cabinet/cabinetstatements/2015/newdealeducation/?lang=en

For vocational qualifications, we are ensuring the relevance, value and rigour of qualifications in receipt of public funding. The *Review of Qualifications for 14 to 19-year-olds in Wales – Final report and recommendations (2012)*¹³ highlighted that assessment must be robust, valid, appropriate and proportionate, with the value and currency of qualifications being largely dependent on the extent to which they are recognised and understood. We are now engaged in a programme of UK-wide communication to explain and raise the profile of qualifications in Wales, particularly with higher education institutions (HEIs).

The actions to support the learning and teaching of STEM skills set out in this section are the core focus of this plan. They are wide-ranging, covering issues such as curriculum design, qualifications development, STEM enrichment, and support to enhance the skills and knowledge of practitioners.

Linked with *Teaching Tomorrow's Teachers – Options for the future of initial teacher education in Wales* and the New Deal for the Education Workforce, a range of actions are being progressed, as outlined in this section of the plan, to enhance STEM practitioners' skills and knowledge. As a key part of this process, we have increased the science element of the grant support to the regional consortia for 2015–16 to facilitate improved science support for teachers.

3.1 Developing fit-for-purpose STEM curricula

An engaging and inspirational curriculum in STEM subjects is the essential core to STEM skills and knowledge development in schools.

Our priority for the evolution of twenty-first century STEM learning and teaching is embedded in our emphasis on ensuring we have the right STEM curricula in Wales. It is the curriculum followed by schools and colleges that provides our young people with the subject knowledge they need to attain STEM qualifications for their progression into further learning and the world of work. It is also the curriculum, delivered through great teaching, which provides the space and guidance necessary for the development of the enquiry, reasoning and practical skills essential to STEM. In instances where a young person does not intend to go on to further STEM-related learning or work, the skills they develop through a well-taught STEM curriculum are still widely recognised as applicable in preparing them for employment opportunities and the life ahead.

Our work prioritising numerical skills in Wales is, encouragingly, resulting in a growing sense of value around mathematics, and improved attainment in the subject. We established a Mathematics Task and Finish Group in early 2015 to review what more could be done to improve the learning and teaching of mathematics. The group reported its findings to the Minister for Education and Skills in the autumn, and he accepted the resulting recommendations on 16 December 2015. It is also essential that all our young people leave school with stronger **scientific literacy**¹⁴ if they are to succeed in their lives.

¹³ gov.wales/topics/educationandskills/qualificationsinwales/revofqualen/?lang=en

¹⁴ [OECD PISA Scientific Literacy Framework, 2015](#)

In summary – our actions

We have:

- from September 2015 introduced on a statutory basis a revised Area of Learning and Programme of Study for mathematics, so that our expectations for literacy and numeracy, as expressed through the National Literacy and Numeracy Framework (LNF), better align to our mathematics curriculum
- undertaken an independent review of the curriculum and assessment arrangements for Wales – which takes STEM skills development into account
- engaged all stakeholders in the Great Debate on Welsh education to enable STEM practitioners and stakeholders to respond to the curriculum and assessment review's report, *Successful Futures*
- accepted all of the 68 recommendations in *Successful Futures* and published an implementation plan *A curriculum for Wales – a curriculum for life*
- identified Digital, Curriculum and New Deal Pioneer Schools which will take forward the work of developing the new curriculum as well as the teaching workforce
- set up a Mathematics Task and Finish Group and accepted all 14 recommendations to improve the learning and teaching of the subject
- maintained ICT as a statutory subject in Welsh schools at Key Stages 2 and 3 and as part of the non-statutory Skills Framework for 3 to 19-year-olds
- introduced learning programmes for 16 to 19-year-olds which provide greater focus on courses that employers and universities value, such as STEM subjects, and which offer industry-relevant curriculum and work experience
- continued grant funding to the successful Further Mathematics Support Programme Wales, to better support the flow of higher-order mathematics skills with increasing emphasis on girls' progression and teacher professional learning support.

We will:

- work closely with STEM practitioners and key organisations, such as the learned societies and Association for Science Education, in developing a fit for the twenty-first century STEM-related curriculum across primary and secondary settings in Wales
- work with the Pioneer Schools leading on digital competence, as well as with other experts and stakeholders, on the development of the digital competence framework which will be available to settings and schools by September 2016
- work with the Pioneer Schools leading on the design and development of both the Science and technology and the Mathematics and numeracy AoLEs, as well as with other experts and stakeholders, to develop a new curriculum by September 2018
- work with Pioneer Schools and other mathematics stakeholders to further develop the support arrangements for improving the learning and teaching of mathematics, taking forward the Task and Finish Group's recommendations
- refresh our national literacy and numeracy programmes in early 2016 in order to recognise the importance of literacy and numeracy as key cross-curriculum responsibilities

- facilitate the work of the Pioneer Schools as they develop and support the most effective pedagogy to deliver the new curriculum
- by July 2016 review the Further Mathematics Support Programme Wales, including how this programme can be rolled out Wales-wide ensuring more learners are supported to develop their higher-order mathematics skills.

3.2 Enhancing and enriching the STEM curriculum

Global research suggests that the STEM skills and knowledge developed through formal education is enhanced through the provision of STEM enrichment activities for young people. It is difficult to completely understand all the interrelated factors contributing to the indirect or the direct impact of a particular intervention on knowledge attainment or attitudinal change (leading to STEM career choices). However, as a consequence of wider understanding and our priority on the learning and teaching of STEM skills, high-quality and relevant STEM enrichment opportunities remain an important component of a rounded education system. And in a time of challenging budgetary pressures (as referenced in section 2) provision must be targeted in a more strategic way, in line with identified priorities.

Successful Futures emphasises the importance of rich experiences being integral to the curriculum and to deep learning. Our plan *A curriculum for Wales – a curriculum for life* acknowledges this and includes a national expectation that all our schools, building on the experiences already available in and through their school, design and deliver their own Pupil Offer to enrich the curriculum and raise the aspirations of their learners.

Our emphasis on girls in STEM is explored in more detail in section 4, and our key educational priority to narrow the gap in educational attainment based on socio-economic status clearly feeds through in our support for STEM enrichment. For example, we know that young people from disadvantaged communities are less likely to engage in extra-curricula activities, or participate in experiences likely to inspire them into further STEM-related study or work.

In the 2012 and 2013 autumn grant rounds NSA funded programmes allowed for the delivery of over 1,000 STEM enrichment activities, attracting in excess of 132,000 participants. NSA funding also supported professional development events for over 1,300 teachers and 57 researchers.

In 2014 the Chief Scientific Adviser for Wales commissioned a strategic review of the NSA and STEM enrichment and inspirational learning. The review aimed to build on our strengths with the intention of examining long-term stable support for programmes. The resulting plan for 2015–18 was published in July 2015. It sets out the NSA's intention to fund 'what works': to provide longer-term funding for programmes; to focus on children aged 7 to 14 (those years when they are making their subject choices); and to target work on addressing the gender-related issues in the take-up of some STEM subjects and STEM careers. Commendable, high-performance NSA projects which reapplied have been awarded further longer-term funding. For example, NSA funding for such projects has resulted in a higher percentage of schools being awarded a CREST Award, compared to the rest of the UK.

In summary – our actions

We have:

- grant funded Techniquest and Techniquest Glyndŵr to provide science and mathematics enrichment for primary and secondary learners and charged the organisations with priorities to enhance girls' progression in physics and mathematics, and target provision at disadvantaged communities
- agreed with the European Commission that the new ESF programme in West Wales and the Valleys has a specific objective for the development of STEM skills among 11 to 19-year-olds, to reflect the need for greater funding for activities in these areas
- provided NSA grant funding to support a number of universities in Wales to enhance STEM provision in schools, e.g. GCSE science revision courses; support for Year 10 and Year 12 students in bioscience, computing, geography, mathematics and physics; and enhancing the provision of computer science teaching for 3 to 19-year-olds
- through the NSA, grant funded the three science societies to provide a range of projects focused both on primary and secondary schools
- provided NSA grant funding for a range of projects with wider STEM organisations, including work with young people at risk of becoming NEET; theatre performances to children and parents/carers; and STEM workshops and teacher professional development
- funded, through the NSA, the British Science Association's well-regarded CREST Awards, allowing the delivery and awarding of over 4,500 awards to Welsh learners, the highest take-up rate in the UK
- funded regional approaches to STEM enrichment activity through the Schools Challenge Cymru Pupil Offer, including:
 - *Mission Discovery* – 200 learners in South Wales spent a week with astronaut Steve Swanson, and had the opportunity to have their ideas for an experiment carried out on the International Space Station
 - *Supersonic Cymru* – 200 Welsh students were given first hand experience of super computing technology as part of the Bloodhound 1,000 mph land speed record challenge
- grant-funded the Innovation Awards scheme for students studying WJEC design and technology at GCSE, AS and A level to promote a culture of innovation linked to STEM skills development. Over 2,500 teachers and learners attend the events.

We will:

- over the next three years, continue grant funding through the NSA, ensuring activities are targeted on the priorities agreed through the NSA review, including support for children aged 7 to 14 and activity to promote the take-up of STEM subjects by girls, and that a longer-term view is taken on funding strategically aligned project activity
- grant fund Techniquest and Techniquest Glyndŵr, with specific strategic objectives to enhance girls' progression and target disadvantaged communities in 2016–17

- consider and share practice from the development and delivery of the Pupil Offer in Schools Challenge Cymru, using emerging evidence to inform thinking around a national Pupil Offer expectation. Our Pioneer Schools Network will also use emerging evidence to inform thinking about the ‘experiences’ during the design and development phase of each AoLE.

3.3 Introducing fit-for-the-future STEM qualifications

The *Review of Qualifications for 14 to 19-year-olds in Wales* ensured that we have qualifications that are understood, valued and meet the needs of our young people and the Welsh economy. Following wide consultation, the recommendations accepted in January 2013 inform the development of STEM-related qualifications, such as revised mathematics GCSEs.

The two new GCSEs in mathematics-numeracy and mathematics have been introduced for first teaching from September 2015, at the same time as the revised mathematics Areas of Learning and programmes of study become statutory. This links with our work in aligning the revised curriculum and qualifications with the National Literacy and Numeracy Framework (LNF). It also reflects our commitment to equip learners with the skills they need to function effectively in everyday life and employment – skills that will meet the needs of our young people and the economy.

In summary – our actions

We have:

- introduced, for first teaching from September 2015, two new mathematics GCSEs, one covering numeracy and the other covering aspects of mathematics techniques, in line with the Review of Qualifications recommendations
- introduced a comprehensive and unprecedented national programme of support to schools for the new GCSEs in mathematics and science, including bilingual teaching resources, sample assessment materials, and subject specific advice delivered via regional consortia
- reformed the Welsh Baccalaureate for first teaching from September 2015, which gives the opportunity to develop skills through challenges and an individual project. We have also overseen publication of related specifications, teacher assisting materials and learner assessment materials, and guidance for practitioners; which highlight how STEM can be pivotal to the challenges and the individual project
- consulted closely with stakeholders on the composition and content for changes to the science GCSEs suite, and issued guidance to WJEC for the development of this suite of qualifications. Approval of these new GCSEs has now been given by Qualifications Wales, the new independent regulator
- accredited revised GCE AS and A level science qualifications for Wales, as well as revised GCE AS and A level qualifications in Computer Science, to maintain qualifications comparability and portability, while responding to the needs of higher education
- categorised all vocational qualifications as IVET (Initial Vocational Education and Training) or CVET (Continuing Vocational Education and Training) to determine their appropriateness for teaching pre-16

- invested in higher apprenticeships to support frameworks associated with STEM subjects
- agreed to fund certain prescribed higher education qualifications when undertaken as part of a published Higher Apprenticeship Framework. This will provide an additional stimulus to the employer market to kick start delivery in STEM-related higher apprenticeships.

We will:

- continue to grow apprenticeships in priority sectors and stretch them to meet emerging skill shortages in technical and highly-skilled occupations, such as engineering and IT, which will drive productivity
- ensure Qualifications Wales prioritises the introduction of the revised GCSE science suite of qualifications for first teaching from September 2016, to take into account scientific literacy principles and better facilitate progression to the revised A level science suite
- continue to support schools' introduction of the new science GCSEs through the development of additional bilingual teaching materials and regional consortia delivered advice and guidance
- ask Qualifications Wales to reform GCE AS and A levels in mathematics and further mathematics in Wales for first teaching from 2017, to facilitate progression from the new mathematics GCSEs and retain the portability of our A levels.

3.4 Advice, guidance and teacher support

Practitioners across all educational settings value fit-for-purpose advice, guidance and professional learning support which positively impacts on their learning and teaching in the classroom. Effective teachers ensure good learning outcomes for their learners.

As noted at the start of this section, our priority to support our education workforce in their professional development is linked to the capacity of delivering the new and challenging STEM curriculum and qualifications arrangements set out in sections 3.1 and 3.3.

Global studies¹⁵ into what makes great teaching highlight six components which have a demonstrable benefit on learner outcomes. Within these, the content knowledge of teachers is clearly highlighted as a strong factor. We are, therefore, emphasising measures to address the STEM subject specific knowledge of our practitioners, particularly in areas such as physics, ICT/computing and mathematics. Alongside this, the quality of instruction provided has been highlighted as the other strong factor which impacts on learner outcomes. Effective questioning skills and techniques are a key element; and are an issue which has featured in the support now available in Wales, for example on the development of numerical reasoning skills in primary and secondary settings. Other areas of great teaching identified include classroom management and teacher behavioural approaches, all of which are captured in the focus on pedagogy in wider professional learning development.

¹⁵ *What makes great teaching?*, Sutton Trust, 2014

In taking forward our priority to support STEM practitioners' skills and knowledge, the New Deal for the Education Workforce is critical. Through career-long reflection and development of practice, STEM teachers will have a structured entitlement to high-quality programmes and development opportunities. A number of STEM stakeholder organisations in Wales already provide a high level of professional learning support, and we will work with them to enhance emphasis on access and availability, linked to agreed standards.

We have also provided a range of guidance to schools in STEM-related areas, including on forward changes to Key Stage 4 performance measures. Linked to our priority to increase the flow of STEM skills, from 2017 performance measures will place greater emphasis on a revised capped points score, including an increased requirement for mathematics and science study. These changes will reduce the focus on the grades of the C/D borderline and create greater incentive for schools to stretch all learners to achieve their full potential, including the more able and talented.

In Wales the term 'more able and talented' (MAT) is used to describe learners who display abilities in one or more areas beyond normal expectations, and require enriched and extended opportunities across the curriculum in order to fully develop and build on these abilities. As part of our priority to increase the flow of STEM skills in Wales, it is essential that we nurture and inform our MAT learners.

Our guidance *Meeting the Challenge – Quality Standards in Education for More Able and Talented Pupils* (2008)¹⁶ encourages schools to develop a whole-school approach to supporting more able and talented learners. The need to stretch, enthuse and respond to the learning needs of our MAT learners is directly relevant to STEM skills acquisition.

One of the outcomes of the *Final Report of the Oxbridge Ambassador for Wales* (2014)¹⁷ into under-representation of Welsh students in leading universities has been the establishment of the Seren Network¹⁸. The Seren Network supports high achieving students in reaching their academic potential and progressing to the most competitive universities in the UK. Each partnership hub will introduce a programme of super-curricular academic support, designed to stretch and challenge high-achieving students with increased emphasis on higher-order STEM skills.

The Minister for Education and Skills also commissioned an independent Mathematics Task and Finish Group to consider future support for the learning and teaching of mathematics in primary and secondary settings. Their report¹⁹ along with our positive response was published on 16 December 2015.

¹⁶ learning.gov.wales/resources/browse-all/quality-standards-in-education-for-more-able-and-talented-pupils/?lang=en

¹⁷ gov.wales/topics/educationandskills/learningproviders/seren/oxbridge-project/oxbridge-final-report/?lang=en

¹⁸ gov.wales/topics/educationandskills/learningproviders/seren/?lang=en

¹⁹ gov.wales/topics/educationandskills/publications/wagreviews/maths-task-and-finish-group-report/?lang=en

In summary – our actions

We have:

- published a *guide on the OECD 2015 scientific literacy framework (2015)*²⁰, and an online bilingual INSET module including filmed classroom content. This helps teachers to better understand scientific literacy and its relevance to all learners
- introduced in 2014 a specific regional consortia-based advisory function for schools in science and mathematics to support GCSE qualifications reform and understanding of the learning and teaching of PISA skills, and further expanded the support on science from September 2015
- published for primary and secondary schools, science infographics and termly curriculum planners and a *Spotlight on STEM* guide²¹ for careers. This gives teachers and learners better access to up-to-date facts about STEM career opportunities and support programmes
- funded a pilot of the Institute of Physics (IoP) Stimulating Physics Network (SPN) in Wales, providing mentoring support for non-specialist teachers of physics. The aim is to improve their skills and knowledge, and girls' progression to A level study
- charged Techniquest and Techniquest Glyndŵr to enhance their teacher professional learning offer in science and mathematics through the agreement of a specific objective for their Welsh Government grant funding. This allows practitioners to access more relevant, professional learning locally
- facilitated fully-funded professional learning for Welsh physics teachers at CERN in Switzerland. This allows teachers to experience cutting-edge global research, and learn how to use that in their science teaching
- enhanced the delivery of ICT and computer coding in schools through funding workshops for learners and teachers in every secondary school in Wales
- expanded from September 2015 the IoP's SPN programme in Wales so that more non-specialist physics teachers have access to mentoring support, and more girls take up A level physics study
- delivered a national conference for secondary Heads of Mathematics to share good practice and effective approaches for mathematics pedagogy
- charged the Mathematics Task and Finish Group to consider how the quality and quantity of mathematics teachers can be enhanced
- introduced regulations to ensure the professional development needs of the school workforce form part of the school's strategic development plan
- continued to offer teacher training incentives for STEM graduates and career changers with a background in industry undertaking post-graduate initial teacher education and training courses leading to Qualified Teacher Status (QTS), including support for graduates able to teach STEM subjects through the medium of Welsh
- placed more emphasis on the capped points score for monitoring Key Stage 4 performance (requiring two mathematics and two science qualifications from 2017), impacting on work to develop MAT learners

²⁰ learning.gov.wales/resources/browse-all/pisa-scientific-literacy-a-short-guide-for-key-stage-4-teachers/?lang=en

²¹ learning.gov.wales/resources/browse-all/focus-on-science/?lang=en

- determined that only science GCSEs will be included as part of the prescribed five qualifications within the new capped points score from 2018
- introduced standards and guidance to support schools to further develop provision for MAT learners, as part of a whole-school improvement agenda
- undertaken a review of provision for MAT learners aged 3–19 (including for STEM subjects) to understand how they are identified, supported and challenged to inform future guidance and support arrangements
- introduced three regional partnership hubs in the pilot phase of the Seren Network, to better support learner progression to top universities.

We will:

- update our current STEM guidance document²² for teachers, in 2017, in the light of *Successful Futures*. This will include content on unconscious gender bias in STEM, building on findings of global research and work in Wales on ‘gender lensing’
- publish termly easy-access infographics on STEM for teachers, and expand the range of content on support available in primary and secondary settings. This will mean teachers are better able to access available programmes
- continue to promote the use of STEM Ambassadors in primary and secondary settings to the benefit of both teachers and learners
- review and update guidance on delivery of *Careers and the world of work: a framework for 11 to 19-year-olds in Wales*²³ (2008), as part of enhancing school-employer links
- through grant funding, require Techniquest and Techniquest Glyndŵr to provide professional learning support to primary and secondary science and mathematics teachers so that teachers in Wales have access to professional learning opportunities locally
- through the ongoing funding of computing workshops for learners and teachers, ensure that every secondary school has at least one teacher with direct experience of coding by 31 March 2016
- continue to actively promote physics teacher professional development through fully funding opportunities at CERN, Switzerland. This gives more teachers access to cutting edge research, and the impact on their teaching of science
- in conjunction with regional consortia, organise events in 2016 for primary mathematics teachers to share good practice and effective approaches for mathematics
- develop a range of provision that will underpin the New Deal for the Education Workforce (including a new Masters programme). This will provide practitioners with access to the highest quality STEM professional learning opportunities
- collate and make readily available to teachers in spring 2016 information on professional development opportunities in the fields of science, mathematics, ICT and computing linked to the New Deal for the Education Workforce.
- in line with recommendations contained in *Teaching Tomorrow’s Teachers: Options for the future of initial teacher education in Wales*, evaluate the effectiveness of training incentives to support STEM teacher recruitment, and

²² gov.wales/topics/educationandskills/publications/guidance/stemguidance/?lang=en

²³ learning.gov.wales/resources/browse-all/careers-world-of-work/?lang=en

consider ways to strengthen STEM Initial Teacher Education Training as part of wider reforms

- publish the findings of the review to identify *Provision of More Able and Talented Learners in Wales* in 2015, and revise current guidance and develop resources to support provision by practitioners and schools
- create further Seren Network hubs by 2016 to ensure support is available to all students in Wales, facilitating the flow of Welsh learners into the UK's best universities. Furthermore, through building links with partner STEM organisations (such as the Further Maths Support Programme Wales and the Engineering Education Scheme Wales) ensure that all students involved in Seren are aware of opportunities for higher STEM skills development at A level and beyond.

3.5 Provision of bilingual resources

Practitioners in all education settings need good quality teaching resources that they can access easily and have confidence in. It is essential, therefore, that in taking forward our priority to support STEM teachers, that our Welsh-medium and bilingual schools are also well equipped to deliver STEM skills through the medium of Welsh, and that such resources are readily and easily available. This point was clearly noted by the EBC in its 2014 report. It is also important that the supply of Welsh-medium STEM-related teaching resources is maintained in line with practitioner demand. We will, therefore, regularly test with practitioners the availability of resources and their evolving needs going forward.

In summary – our actions

We have:

- published bilingual sample PISA scientific literacy and mathematics questions in .pdf format and as an interactive online resource for schools and colleges
- through the WJEC, published additional bilingual specimen assessment materials (SAMs) for the new mathematics GCSEs
- produced new bilingual teaching resources (teaching assessment materials – TAMs) in support of the new mathematics GCSEs, together with an audit of existing resources relevant to the new qualifications. This gives teachers access to new materials in advance of teaching the new GCSE mathematics suite
- commissioned Techniquet and Techniquet Glyndŵr to produce Key Stage 4 science modules for outreach delivery targeted at the key areas (such as forces and motion, and cells) identified through the analysis of existing Key Stage 4 qualifications and the OECD Scientific Literacy framework
- uploaded OPAL Project surveys on Hwb to enable the downloading of bilingual resources
- published *Tiwtor mathemateg*, a free Welsh-medium app to support learners with mathematics
- held Welsh-medium needs identification panels for science and engineering. The needs identified have been issued to tender and projects will be awarded in January 2016
- grant-funded, through the NSA, a number of projects which include the development of bilingual STEM enrichment resource materials

- facilitated the establishment of Hwb networks between regional consortia to better capture, quality assure, and subsequently publish bilingually online (through Hwb) science and mathematics Key Stage 3 and Key Stage 4 resources developed through local school-to-school working.

We will:

- in January 2016 commission further Welsh-medium resources for Key Stages 3 and 4, for publication on Hwb, which will be appropriate for use in class or in the home learning environment
- produce, via the WJEC, bilingual SAMs in support of the new science GCSE suite, in advance of first teaching from September 2016
- publish bilingual TAMs in advance of the new science GCSE suite being introduced for first teaching in September 2016
- continue to commission relevant Welsh-medium print and digital resources to support STEM subjects, and to consult with teachers and other practitioners to identify the resources required
- where appropriate, as an ongoing condition of grant, require future NSA grant recipients involved in the development of online materials/resources to also make those available through Hwb.

3.6 Wider ICT support

In addition to the specific actions highlighted above, we have brought forward wider measures which support the delivery of STEM in education, particularly around the use and application of digital technology. This work has built on the findings of the Independent Review of Digital Classroom Teaching Task and Finish Group²⁴. For example, the all-Wales learning platform Hwb+ was launched in 2012, and has now been rolled out to all schools in Wales. Hwb+ has been further complemented by an extensive suite of digital content resources and a wide range of e-Safety support materials and tools which have been made available through Hwb, the National Digital Content Repository.

One of the major benefits of the Hwb+ platform is the integration of online tools; most notably Microsoft Office 365. Providing online tools via the national Hwb+ platform allows for a consistent approach across all schools and ensures that there is not a proliferation of different systems and protocols in place. Microsoft Office 365 provides a suite of free web applications, including Microsoft Word, Excel, PowerPoint and OneNote. While a large number of schools all over the world are already using Microsoft Office 365, we understand that Wales' approach provides the first instance of an all-country tenancy. This approach facilitates national collaboration in a way that has previously not been feasible.

Our centrally-funded initiatives provide a wide range of financial and pedagogical benefits consistently across all schools in Wales. Importantly in a STEM context, through access and use of such tools, teachers will develop new approaches to STEM learning and teaching as their own understanding and application of digital technology grows. In support of this, we have already provided hands-on Hwb+

²⁴ gov.wales/topics/educationandskills/publications/wagreviews/digital/?lang=en

training to over 3,000 teachers through the extensive Hwb Digital Leader training programme.

In summary – our actions

We have:

- invested around £37 million to improve Wales' digital infrastructure through the Learning in Digital Wales grant programme, providing improved broadband services for schools in Wales. This gives all primary, special and secondary schools improved in-school and internet connectivity
- developed the Hwb+ platform as a single resource, providing access to high-quality digital resources for schools (including some very high-quality STEM material), and a single point of entry to a range of centrally-licensed tools. These tools provide schools with access to some of the latest in-classroom digital aides to support learning and teaching
- developed additional functionality for inclusion on Hwb, in conjunction with feedback from stakeholders. This includes:
 - Hwb networks: the facility to create online professional learning communities which exploit the collaboration technology built into Hwb
 - Hwb community: an area on Hwb where practitioners can upload and share their digital resources with the wider Hwb community
 - an e-Safety zone hosted on Hwb which promotes safe and responsible use of all digital technology across Wales
 - playlists: tools to sequence digital learning materials to support classroom activities in an engaging and interactive way.

We will:

- from 2015 as part of an all-Wales implementation, use technology to link educators digitally in a way that has not previously been possible through areas such as Hwb networks
- ensure computing remains a focus for STEM activities by the Higher Education Funding Council for Wales (HEFCW) and universities in Wales, including work on employer accreditation
- continue to develop the range of digital content and tools to further support stakeholders' use of digital technology to support the transformation of classroom practices
- continue to support the adoption of the digital tools and resources provided through the Learning in Digital Wales programme, building on the Ministerial commitment to the Hwb+ project until August 2018 and aligning their use to developing the Digital Competence Framework.

3.7 Developments in higher education

The *Policy statement on Higher Education* (2013) and annual HEFCW remit letters make it clear that the science research agenda remains a high priority for us. HEFCW has a key role in building core research capacity and research excellence through its quality research programme funding, and works with HE institutions in Wales to increase competitively won research and its exploitation. The 2015–16

remit letter requires the Funding Council to build upon its own research and that of others to address the shortfall in research scientists in Wales, especially in the areas of clinical medicine, engineering and other STEM subjects.

Building on the excellent outcomes of the 2014 Research Excellence Framework (REF) assessment, HEFCW has been charged with promoting continued improvement in research performance through the development of stronger research environments, greater critical mass, and research excellence. Funding may also support the greater involvement of women in science and support for enhanced cooperation between HEIs and schools to facilitate teacher and learner understanding of STEM. STEM engagement will be coordinated with the activities of the NSA to achieve complementarity mix. In the 2015–16 academic year HEFCW allocated funding of more than £71m in support of quality research and around £5.2m in support of postgraduate research training.

The REF results confirm that there are very significant research strengths in Wales, but they also provide further evidence that Welsh universities suffer from a shortfall of researchers, particularly in the STEM disciplines. HEFCW will continue to support initiatives to increase Wales' research capacity in key areas of science, most critically the next phase of the Welsh Government's *Sêr Cymru* programme. In the 2015–16 academic year HEFCW allocated more than £3.2m in support of the current *Sêr Cymru* programme.

In addition to evidence of higher demand from employers for STEM-related skills, there is also evidence of growing demand for STEM subjects from undergraduate applicants. UCAS figures show that the number of Welsh undergraduates accepted onto STEM-related courses has grown steadily from just under 7,000 students in 2007 to over 8,700 students in 2014.

Implementing our contribution to the call in *Science for Wales – A strategic agenda for science and innovation in Wales* to boost Wales' research capacity and capture more competitively-awarded research funding, the *Sêr Cymru* programme has put in place four 'star' research chairs with their academic teams and also established three National Research Networks (NRNs) in Wales' research universities. More recently, the complementary *Sêr Cymru II* programmes have been developed with the same aim of boosting capacity.

Through the EU Marie Skłodowska Curie programme, there are fellowships for high-performing candidates (typically three to five years after their PhD) from outside the UK, and equivalent schemes for UK-based fellowship candidates. Prestigious and highly competitive 'Rising Star' fellowships will aim to attract the very best of academic research talent. Welsh Research Fellowships again target stellar candidates who are three to five years beyond their PhD from anywhere in the world including the UK, encouraging them to come to work in Wales. There is also a strand which sets out to recapture research talent, by providing support for researchers returning to work following a career break.

While these high-flying researchers will be exemplars in their own right for young people looking to study science and engineering, we have sought to give them a formal role in the important role of inspiring our young people with the excitement, interest and rewards that a career, based on the study of STEM subjects to a high

level, can hold. The NRNs have performance indicators requiring them to put in place a marketing and communications strategy, to raise the profile of their NRN, as well as a strategy to encourage and attract more under-represented groups (e.g. women) to their field and to foster equality and diversity.

In summary – our actions

We have:

- through the 2014–15 remit letter to the HEFCW, required it to take a whole-sector view of Welsh universities' financial position, as well as each individual university
- asked HEFCW to review the funding support for subjects within universities, and the effect of the new tuition fee and student support arrangements introduced in 2012 on HEIs' approaches to resource allocation
- for 2015–16, required HEFCW to review its current funding formula. In doing so, the Funding Council has been asked to recognise the importance of part-time HE, supporting quality research (QR), and the funding of subjects that are expensive to operate (for example, medicine and dentistry)
- seen HEFCW award, for the 2015–16 academic year, more than £79m to HEIs in Wales in support of research activities including QR, postgraduate research, support for the Sêr Cymru programme and other research initiatives
- made it a requirement that the three national research networks, established under our Sêr Cymru Scheme primarily to enhance research capacity, should also have performance indicators requiring them to have a marketing and communications strategy to raise the profile of their NRN as well as a strategy to encourage and attract more under-represented groups, such as women and girls, to their field and to foster equality and diversity
- required all fellows funded under the Sêr Cymru II programme to, as a rule, become 'STEM Ambassadors' under the STEMNET-led programme or any equivalent
- set up an independent review of HE funding and student finance chaired by Professor Sir Ian Diamond, Vice-Chancellor of Aberdeen University while support for STEM subjects is one of the issues that has been considered by the review, which will report in 2016.

We will:

- during 2015–16, consider the views of HEFCW on what encouragement it should provide to the HE sector to ensure STEM provision in Wales is able to keep up with demand. This in the light of the growing demand for highly-skilled graduates, and the potential returns for individuals in terms of future career prospects and earnings, is fuelling a growth in demand for STEM provision
- consider the final recommendations of the *Review of Higher Education and Student Finance Arrangements in Wales (2015)*²⁵, and respond accordingly in 2016.

²⁵ gov.wales/topics/educationandskills/highereducation/review-of-he-funding-and-student-finance-arrangements/?lang=en

4. Changing perceptions

Changing a person's perception of STEM as an appropriate route for study, or field in which a career can be sought, is widely recognised as challenging. Perceptions often involve outdated understanding of what study and work in STEM-related employment might involve. This is influenced by a view of engineering, for example, based on out-dated heavy industry. Changing perceptions to recognise the reality of contemporary STEM often, therefore, involves attitudinal change from deeply embedded societal stereotypes.

This is most certainly the case regarding the relevance of STEM to girls. Despite some progress in gender-equity in some areas of STEM, emphasis needs to remain particularly in areas such as physics, technology/computing and engineering.

Our priority is to increase interest and participation in STEM learning, particularly among girls.

As highlighted by the EBC through its STEM inquiry, this will require a sustained effort over time; plus the support and contribution of a wide range of STEM practitioners, stakeholders and civic society. Those working in Wales' education and training system have a key role to play in contributing to attitudinal change. If we are to meet future demands for the STEM skills we know Wales needs for sustained economic growth, we need to increase the supply of STEM skills through greater numbers of young people pursuing STEM as an option. To achieve that, we simply cannot ignore half the population.

The provision of professional, impartial careers information, advice and guidance (CIAG) is a key element in the development of young people's education and future career choices over their lifetime.

Our priority is to equip our young people with career management skills and knowledge of the options available to them in the STEM sector, so that they are able to make better informed decisions on their futures.

The need also exists to disseminate and raise awareness of the wide range of career opportunities in different sectors, such as STEM, among parents/carers and teachers, as key individuals who influence and guide young people on their journey into adulthood.

This section, therefore, is concerned with changing perceptions and attitudes about STEM skills, careers and further learning with education leaders, teachers, children, young people and their parents/carers.

4.1 Reinforcing the importance of STEM

There is evidence to suggest that some STEM subjects have received less priority in curriculum planning in some maintained schools in recent years. The rapid increase in the application of certain vocational science qualifications, at the expense of more traditional GCSEs, has arguably been a factor in Wales' declining performance in

PISA scientific literacy. This also impacts on how prepared our young people are for life in an increasingly science and technology driven world, and their ability to access the exciting and rewarding career opportunities afforded through further STEM study.

The essential emphasis on literacy, numeracy and narrowing the gap between attainment and socio-economic status, as key priorities for schools, has to be maintained. Emphasis on and development in these three areas are key to unlocking greater progression and take-up in STEM. However, as reflected on in *Successful Futures*, the increasing importance of STEM skills and knowledge as a means of accessing rewarding careers needs to be more widely recognised across the education landscape.

The ongoing 'Education begins at home'²⁶ campaign highlights a number of areas including, literacy, numeracy and science. In relation to numeracy '*What you say counts*' is one of our key means of reducing people's negative attitude towards mathematics. All too often, people are heard saying 'I can't do maths', to the extent that it is often socially acceptable. Although people in Wales recognise they use mathematics on a daily basis, many express negative views about mathematics in front of their children. Having a negative attitude towards number can readily transfer to children, resulting in poor numerical skills development. The messages within 'Education begins at home' focus on the need for all adults to be more confident when dealing with and talking about mathematics.

Launched by the Minister for Education and Skills in October 2014, our ongoing Focus on science campaign is targeted at practitioners, learners and their parents/carers. It was developed in response to calls for greater emphasis on science in schools. The campaign is now building momentum and a growing body of resources, information, case studies and role models, with the key themes that: science is valued, science is fun, and science is just as important for girls.

In summary – our actions

We have:

- linked the Focus on science²⁷ campaign to the parent-focused 'Education begins at home' campaign promoting key messages about the importance of science and mathematics to learners, teachers and parents/carers, via television, radio, and social media, and roadshows in Communities First areas
- ensured that Focus on science materials have been 'gender lensed', with an emphasis on girls in STEM, and worked closely with EESW in relation to promoting girls' study of science (including case studies with Sony)
- produced a range of narrative and video-based Focus on science case studies, including with role models who have careers in science ('science takes you places') linked to key STEM enrichment activities and the campaign themes
- promoted to all Welsh secondary schools, via various media, the CERN three-week summer school for physics teachers, and produced a video case study on the Welsh teacher group course at CERN in February 2015. As a result we had

²⁶ gov.wales/topics/educationandskills/schoolshome/parents/education-begins-at-home/?lang=en

²⁷ learning.gov.wales/news/sitenews/qualified-for-life-focus-on-science/?lang=en

the first ever Welsh Physics teacher attend the three-week summer school at CERN in July 2015

- developed (and funded), in conjunction with Pearson, a new category of ‘Science Teacher of the Year’ for the UK national teacher awards, and sponsored the ‘best application of science’ award at the 2015 Big Bang events organised by EESW
- increased the number of visitors to the Focus on science stand at Skills Cymru 2015 in north and south Wales by 29 per cent compared to 2014
- developed a dedicated area on the Learning Wales website for all science resources to support teachers
- provided weekly articles in Dysg under the sub-heading ‘Qualified for life – Focus on science’ and subscribed all school Heads of Science in Wales to receive Dysg direct
- produced a series of termly resources specifically for science teachers.

We will:

- drive forward Focus on science and ‘Education begins at home’ actively promoting their key themes over the year ahead in support of attitudinal change towards STEM
- publish further resources for parents/carers, linked to the ‘Education begins at home’ campaign, so they better understand the importance of STEM learning for their children
- support science activity at local science festivals, Skills Cymru events, and Big Bang events in Wales, over the year ahead so that key campaign messages can be communicated and learners can better access STEM-careers information
- as part of Focus on science activity in 2016, promote existing case studies with a focus on role models and career options, targeting enhancement of girls’ engagement with STEM subjects, and disseminate widely
- over the next two years, work with the UK-wide Your Life²⁸ Key Stage 4 mathematics and science campaign to ensure synergies between the campaigns are maximised, and that young people in Wales (and notably girls) have access to Your Life opportunities
- deliver family learning events to engage Key Stage 2 learners to promote the importance of science in Community First areas across Wales
- promote to all Welsh secondary schools the bespoke teacher training course at CERN in February 2016, as well as the three week summer school at CERN in July 2016.

4.2 Careers advice and guidance

As noted in section 2, the advice and guidance provided through the Careers Wales website and other channels, including face-to-face where appropriate, is informed by professional bodies including Sector Skills Councils, employers, labour market intelligence data, and research. As a result of these links, Careers Wales has developed a series of features for its website, one of which, Spotlight on STEM highlights the opportunities and careers in this area. Such year-round guidance is

²⁸ yourlife.org.uk/tough-choices-the-real-reasons-a-level-students-are-steering-clear-of-science-and-maths/

enhanced at key points – for example, young people receiving their GCSE and A level results each summer.

Building on its role as the all-Wales, all-age, impartial and bilingual Careers Information and Guidance (CIAG) service, Careers Wales has a strategic function facilitating the development of closer links between schools, colleges and employers. The annual remit letter from Welsh Ministers to Careers Wales sets out how, in the coming year, Careers Wales will support the implementation of a new model for school-employer links, facilitated by the Enhanced Employer Engagement project. This project was launched in October 2015 by the Deputy Minister for Skills and Technology. Following a competitive tender, Business in the Community (BITC) was awarded the contract and is working in partnership with Careers Wales. The approach will build on BITC's Business Class programme which is a tried and tested model.

The Wales Strategic Forum for Career Development brings together representative organisations and expertise from public, private and third sector organisations, including education and employer representatives. In 2015, it considered the different issues affecting individuals' choices of STEM careers, including recognising the challenges females can encounter in pursuing STEM career pathways and entering such occupations. Good careers advice can help an individual overcome barriers, and help tackle gender stereotypes.

In summary – our actions

We have:

- targeted careers advice and guidance support through Careers Wales to ensure accurate and impartial information is available to young people before they make crucial subject choices
- prioritised improvements in the universal offer through Careers Wales online to provide updated career tools and job information, and its continued hosting of the portals for Apprenticeship Matching Service and Jobs Growth Wales opportunities
- improved accessibility to LMI through Careers Wales online, particularly for younger users, through a more visual snapshot of key information on potential careers, including those in STEM
- ensured that information on STEM average wages, hours, types of work, levels of qualifications needed, and level of demand in Wales is presented online for young people in a more simplified 'icon-based' format
- through the Careers Wales website, established the Skills Gateway service to provide a way for adults to get the support they require in order to improve their skills and move into sustainable employment
- charged Careers Wales to support the development of stronger and more sustainable partnerships between schools, colleges and employers to better facilitate school-employer engagement through a brokerage function, and support such as guidance for schools.

We will:

- inform the development of the CareersWales.com website with user feedback and consultation with clients and stakeholders, including examining the use of new technologies, for example social media
- ensure the Enhanced Employer Engagement project establishes 60 Business Class Cymru partnerships, with the aim of every secondary school having the opportunity to participate by 2018
- require Careers Wales, through the annual remit, to deliver a comprehensive impartial universal service offer to all clients, with prioritisation on certain client groups, providing as appropriate, an impartial one-to-one careers guidance interview, group session interactions, and accessible online information
- continue to support careers events, such as Skills Cymru, ensuring relevant information on STEM careers is available to young people
- ensure that Careers Wales addresses the needs of young people with particular challenges, for example, additional learning needs, in line with the annual remit letter and relevant Welsh Government guidance, through identification of client need and prioritisation
- continue work with Careers Wales on the development of the Common Area Prospectus (CAP) and its phased roll-out into schools.

4.3 Women in STEM

Girls' take-up of mathematics, ICT/computing, engineering and physics as they progress through their education and into the world of work remains behind that for boys. Girls are, therefore, not fully benefitting from the opportunities that the STEM sector can offer.

Equally, there are issues with the women lost to science careers later in life. The Minister for Economy, Science and Transport established a Woman in Science Task and Finish Group with a broad remit to investigate what barriers may exist to women studying STEM subjects in Wales. It is due to report in early 2016. This section highlights additional work being undertaken to promote and increase female participation in STEM.

In summary – our actions

We have:

- prioritised girls' progression in physics and mathematics as key strands of our marketing and communications work
- highlighted a gender balance in education progression as a key objective through our grant funding to STEM stakeholders – for example, in NSA funding to Engineering Education Scheme Wales Ltd (EESW) for *Girls into Engineering*, which encourages girls to consider engineering pathways that are accessible, interesting and relevant
- agreed with the European Commission that girls' progression should feature as a priority within the STEM specific objective of the new ESF programme in West Wales and the Valleys for interventions for 11 to 19-year-olds

- funded increased focus, through our Further Maths Support Programme, on the importance of equality of opportunity for girls to take further mathematics.

We will:

- continue to prioritise girls' progression in physics and mathematics as key strands of our marketing and communications work
- continue to highlight a gender balance in education progression as a key objective, through our grant funding to STEM stakeholders
- through the NSA strategy, focus on actively encouraging more girls to take up and study STEM subjects and go on to pursue careers in science and technology
- consider the recommendations of the Women in Science Task and Finish Group after it reports in early 2016, with particular emphasis on possible impacts for policy and programme development underpinning STEM skills
- continue our funding for the Further Maths Support Programme maintaining focus on the importance of equality of opportunity for girls to take further mathematics.

Annex A: References/additional sources

Science for Wales – A strategic agenda for science and innovation (Welsh Government, 2012)

gov.wales/topics/science-and-technology/science/?lang=en

A curriculum for Wales – a curriculum for life (Welsh Government, 2015)

gov.wales/topics/educationandskills/schoolshome/curriculum-for-wales-curriculum-for-life/?lang=en

STEM Enrichment Strategic Plan 2015 (Welsh Government, 2015)

gov.wales/topics/science-and-technology/science/national-science-academy/?lang=en

The ICT Steering Group's Report to the Welsh Government 2013

learning.gov.wales/resources/browse-all/ict-steering-groups-report/?lang=en

The Review of Qualifications for 14 to 19 year-olds in Wales – Final report and recommendations (Welsh Government, 2012)

gov.wales/topics/educationandskills/qualificationsinwales/revofqualen/?lang=en

OECD PISA Scientific Literacy Framework, 2015

<http://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Science%20Framework%20.pdf>

Successful Futures: Independent review of curriculum and assessment arrangements in Wales (Professor Graham Donaldson CB, 2015)

gov.wales/topics/educationandskills/schoolshome/curriculum-for-wales-curriculum-for-life/why-we-are-changing/successful-futures/?lang=en

Teaching Tomorrow's Teachers: Options for the future of initial teacher education in Wales (John Furlong, University of Oxford, 2015)

gov.wales/topics/educationandskills/publications/wagreviews/teaching-tomorrows-teachers/?lang=en

New Deal for the Education Workforce: Written Statement (Welsh Government, 2015)

gov.wales/about/cabinet/cabinetstatements/2015/newdealeducation/?lang=en

Policy statement on skills: Written Statement (Welsh Government, 2014)

gov.wales/about/cabinet/cabinetstatements/2014/8417459/?lang=en

CBI demands action on growing skills vacuum

www.cbi.org.uk/media-centre/press-releases/2014/03/cbi-demands-action-on-growing-skills-vacuum

UK labour market projections: 2012 to 2022

www.gov.uk/government/publications/working-futures-2012-to-2022

Enterprise and Learning Committee Report: The STEM agenda (National Assembly for Wales, 2011)

www.assembly.wales/en/bus-home/bus-third-assembly/3-committees/3-scrutiny-inquiries/Pages/research-completed_inquiries.aspx#enterpriseandlearningcompleted

Enterprise and Business Committee Report: STEM Skills (National Assembly for Wales, 2014)

senedd.assembly.wales/mgIssueHistoryHome.aspx?IId=2225

Foundation Phase Framework (Revised 2015) (Welsh Government, 2015)

gov.wales/topics/educationandskills/earlyyearshome/foundation-phase/?lang=en

Final Report of Oxbridge Ambassador for Wales (2014)

gov.wales/topics/educationandskills/learningproviders/seren/oxbridge-project/oxbridge-final-report/?lang=en

SEREN Network

gov.wales/topics/educationandskills/learningproviders/seren/?lang=en

Mathematics Task and Finish Group Report (Welsh Government, 2015)

gov.wales/topics/educationandskills/publications/wagreviews/maths-task-and-finish-group-report/?lang=en

Science in the National Curriculum for Wales (Welsh Assembly Government, 2008)

learning.wales.gov.uk/resources/browse-all/science-in-the-national-curriculum/?lang=en

STEM Guidance for schools and colleges in Wales (Welsh Government, 2012)

gov.wales/topics/educationandskills/publications/guidance/stemguidance/?lang=en

Design and technology in the National Curriculum for Wales (Welsh Assembly Government, 2008)

learning.wales.gov.uk/resources/browse-all/design-and-technology-in-the-national-curriculum-for-wales/?lang=en

Skills framework for 3 to 19-year-olds in Wales (Welsh Assembly Government, 2008)

learning.gov.wales/resources/browse-all/skills-development/?lang=en

Careers and the world of work: a framework for 11 to 19-year-olds in Wales (Welsh Assembly Government, 2008)

learning.wales.gov.uk/resources/browse-all/careers-world-of-work/?lang=en

More able and talented – Standards and guidance

learning.wales.gov.uk/resources/improvementareas/inclusion/more-able-and-talented/?lang=en

What makes great teaching? (Sutton Trust, 2014)

www.suttontrust.com/researcharchive/great-teaching