

Science, Technology, Engineering and Mathematics (STEM)

Guidance for schools and colleges
in Wales



Llywodraeth Cymru
Welsh Government

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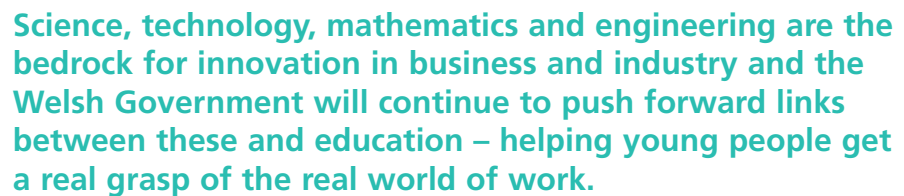
Science, Technology, Engineering and Mathematics (STEM): Guidance for schools and colleges in Wales

Audience	Teachers, headteachers and governing bodies of all maintained schools; colleges and other learning providers that work with 14 to 19-year-olds; local authorities; initial teacher training providers; teacher unions and school representative bodies; ColegauCymru/CollegesWales; church diocesan authorities; national bodies in Wales with an interest in education.
Overview	This document provides guidance on the provision of science, technology, engineering and mathematics (STEM) for 3 to 19-year-olds in Wales. It is, therefore, provided for governing bodies, senior management teams and practitioners in primary, secondary and special schools and colleges with the responsibility for the planning and delivery of aspects of STEM.
Further information	Enquiries about this document should be directed to: Curriculum Support Branch Curriculum Division Department for Education and Skills Welsh Government Cathays Park Cardiff CF10 3NQ e-mail: CSB@wales.gsi.gov.uk
Additional copies	This document can only be accessed from the Welsh Government's website at www.wales.gov.uk/educationandskills
Related documents	<i>Foundation Phase: Framework for Children's Learning for 3 to 7-year-olds in Wales</i> (Welsh Assembly Government, 2008); <i>Science in the National Curriculum for Wales</i> (Welsh Assembly Government, 2008); <i>Mathematics in the National Curriculum for Wales</i> (Welsh Assembly Government, 2008); <i>Design and technology in the National Curriculum for Wales</i> (Welsh Assembly Government, 2008); <i>Skills framework for 3 to 19-year-olds in Wales</i> (Welsh Assembly Government, 2008); <i>Developing higher-order mathematical skills</i> (Welsh Assembly Government, 2010); <i>Developing higher-order scientific enquiry skills</i> (Welsh Assembly Government, 2010); <i>Careers and the world of work: a framework for 11 to 19-year-olds in Wales</i> (Welsh Assembly Government, 2008); <i>Careers and the world of work: Supplementary guidance</i> (Welsh Assembly Government, 2008); <i>Education for sustainable development and global citizenship – A common understanding for schools</i> (Welsh Assembly Government, 2008); <i>Learning Pathways 14–19 Guidance II – National Assembly for Wales Circular No. 17/2006</i> (Welsh Assembly Government, 2006); <i>Science for Wales – A strategic agenda for science and innovation in Wales</i> (Welsh Government, 2012)

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Introduction



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 (March, 2012)

This guidance aims to provide greater clarity for teachers on the vast range of support materials and activities that are available to help promote the provision of science, technology, engineering and mathematics (STEM) for 3 to 19-year-olds in schools and colleges in Wales. It identifies the wide range of opportunities that exist within and beyond the curriculum to fully develop STEM education. It also includes advice on learning and teaching resources, and aims to promote partnerships between practitioners and with stakeholders to encourage development of a planned approach to the provision of STEM education within schools and colleges.

The guidance is, therefore, provided for local authorities, governing bodies, senior management teams, and practitioners/teachers in primary, secondary and special schools as well as colleges with the responsibility for the planning and delivery of STEM and STEM-related education.

What is STEM?

STEM involves the disciplines of science, technology, engineering and mathematics. These disciplines have their routes in a range of subjects that are studied at school and college either individually, or as part of other subjects, including science, applied science, biology, chemistry, physics, mathematics, design and technology, computer science*, control technology, environmental science, health science and engineering. These disciplines are bound by both a body of skills and knowledge that is much sought after in a modern technological world. These include:

- analytical and evaluation skills – researching a topic, making reasoned judgements and drawing evidence-based conclusions
- problem-solving skills – breaking down a complex task to a small number of parts in order to advance a solution, recognising cause and effect relationships, and defending opinions using facts
- mathematical and computer skills – carrying out a range of measurements and calculations in order to model potential solutions to complex problems
- technical skills and know how – troubleshooting the source of a problem, advancing a solution or debugging an operating system
- communication and presentation skills – articulating ideas, presenting arguments and convincing audiences that findings are more than opinions.

These skills involve working both cooperatively within teams, as well as independently, using knowledge from the range of subjects listed above.

***Computer science**

In March 2012, the Computing at School (CAS) Working Group (www.computingatschool.org.uk) produced *Computer Science: A Curriculum for Schools*. In it they state that:

Computer Science is a quintessential STEM discipline, sharing attributes with Engineering, Mathematics, Science, and Technology:

- *It has its own theoretical foundations and mathematical underpinnings, and involves the application of logic and reasoning.*
- *It embraces a scientific approach to measurement and experiment.*

- *It involves the design, construction, and testing of purposeful artefacts.*
- *It requires understanding, appreciation, and application of a wide range of technologies.*

Moreover, Computer Science provides pupils with insights into other STEM disciplines, and with skills and knowledge that can be applied to the solution of problems in those disciplines.

Qualifications in computer science

Computing A level has been offered by a number of awarding organisations for some time. Several awarding organisations are now offering computer science/computing at GCSE level, including WJEC; their specification is available in both English and Welsh for first assessment in summer 2014.

STEM in the school curriculum

STEM draws on the skills and knowledge of many subjects in the school curriculum. The national curriculum Orders and the non-statutory guidance for each subject give details of the required content and skills necessary to develop an understanding of STEM, as well as to promote it. The Orders and guidance are available on the Welsh Government's website at www.wales.gov.uk/educationandskills

Including all learners

The national curriculum contains a section on including all learners which clarifies learner entitlement and schools' responsibilities.

Under the United Nations Convention on the Rights of the Child (UNCRC) and the overarching strategy document *Children and Young People: Rights to Action* (Welsh Assembly Government, 2004), all children and young people must be provided with an education that develops their personality and talents to the full. The Education Act 2002 further strengthens schools' duty to safeguard and promote the welfare of all children and young people.

The equal opportunities legislation, which covers age, disability, gender, race, religion and belief, and sexual orientation, places a further duty on learning providers in Wales towards present and prospective learners to eliminate discrimination and harassment, to promote positive attitudes and equal opportunities, and to encourage participation in all areas of school life.

Learning providers should develop in every learner a sense of personal and cultural identity that is receptive and respectful towards others. They should plan across the curriculum to develop the skills, knowledge, understanding, values and attitudes that will enable learners to participate in our multi-ethnic society in Wales. Learning providers should develop approaches that support the ethnic and cultural identities of all learners and reflect a range of perspectives, to engage learners and prepare them for life as global citizens.

Learning providers must work to reduce environmental and social barriers to inclusion and offer opportunities for all learners to achieve their full potential in preparation for further learning and life. Where appropriate, learning providers will need to plan and work with specialist services to ensure relevant and accessible learning experiences. For learners with disabilities in particular, they should:

- improve access to the curriculum

- make physical improvements to increase participation in education
- provide information in appropriate formats.

Learning providers should seek advice regarding reasonable adjustments, alternative/adapted activities and appropriate equipment and resources which may be used to support the full participation of all learners, including those who use a means of communication other than speech. For learners whose first language is neither English nor Welsh, learning providers should take specific action to help them learn both English and Welsh through the curriculum. They should provide learners with material that is appropriate to their ability, previous education and experience, and which extends their language development. They should also encourage the use of learners' home languages for learning.

Learner entitlement

Learning providers in Wales should ensure that all learners are engaged as full members of their learning communities, accessing the wider curriculum and all activities, and working wherever possible alongside their peers. Learning providers should teach all programmes of study and frameworks in ways appropriate to learners' developing maturities and abilities, and ensure that learners are able to fully use their preferred means of communication to access the curriculum. In order to extend their learning, learners should experience a variety of learning and teaching styles.

To enable all learners to access relevant skills, knowledge and understanding at an appropriate level, learning providers may use content from earlier phases or key stages within the curriculum. They should use material in ways suitable for the learners' age, experience, understanding and prior achievement to engage them in the learning process.

For more able and talented learners working at higher levels, learning providers should provide greater challenge by using material in ways that extend breadth and depth of study and opportunities for independent learning. The level of demand may also be increased through the development and application of thinking, as well as communication, ICT and number skills across the curriculum.

Learning providers should choose material that will:

- provide a meaningful, relevant and motivating curriculum for their learners

- meet the specific needs of their learners and further their all-round development.

Learners of all abilities should have access to appropriate assessment and accreditation.

The Foundation Phase

The *Foundation Phase: Framework for Children's Learning for 3 to 7-year-olds in Wales* (Welsh Assembly Government, 2008) sets out the curriculum and outcomes for 3 to 7-year-olds in Wales. The framework aims to provide a firm foundation in STEM-related subjects.

STEM in Key Stages 2 to 4

For learners aged 7 to 16, the focus of the curriculum continues to be on the needs of the learner. Through an enquiry-based approach, up-to-date skills and knowledge in twenty-first century contexts are progressively developed. The concept of engaging enquiring minds to be able to adapt their knowledge and understanding to new situations or to solve problems creatively, can be effectively developed through all STEM subjects. These subjects should encourage learners to become active participants, rather than passive recipients. If we are to encourage learners to pursue a successful career in STEM, we need to be confident that their founding years in school prepare them well, with good communication and number skills as well as mathematical and scientific literacy skills, if we are to encourage learners into a successful career in STEM.

STEM across the curriculum and why STEM matters

For learners, the key STEM challenge is to understand that, in order to be able to solve real-life problems (analyse, interpret and explain observations), they will need to make sense of each STEM subject independently, as well as understanding the complex web of links that tie them together in powerful ways. Introducing learners to ways of tackling 'big questions' is one way to achieve this and can be done through the school curriculum or through planned enrichment activities, for example:

- Can we safely dispose of nuclear waste in space?
- Why are noses always in between eyes?
- Can human actions cause earthquakes?
- How does your heart keep beating?
- Can trains be fuelled on hydrogen?
- Can a man without legs be the fastest runner in the world?

STEM is not simply a body of knowledge. It is also about developing skills that will help learners be systematic, yet creative in the way they approach problem solving, plan investigative work, evaluate evidence, and work both individually and in teams.

One of the barriers to developing learner confidence in STEM, is the view shared by many learners that STEM subjects are more difficult than other subjects in the curriculum. Teachers in schools and colleges work hard to dispel this myth. Good curriculum choices, support for learners to understand career paths and appropriate early, unbiased career advice, is essential to help learners overcome this negative perception and to understand the nature and excitement of STEM careers. The [Careers in STEM](#) section in this guidance explores possible career paths and gives access to a wide range of case studies.

It is also essential that learners understand how the science, technology and mathematics they study at school, can adequately prepare and equip them to take part in the many rich and varied career pathways in STEM. In this regard, engagement with STEM clubs, STEM Ambassadors and entry to STEM competitions provide good opportunities to help to promote links for schools and learners with practitioners in the STEM industries.

Foundation Phase (3–7)

The four Areas of Learning closely linked to STEM-related subjects are:

- Personal and Social Development, Well-Being and Cultural Diversity
- Mathematical Development
- Knowledge and Understanding of the World
- Creative Development.

Key Stage 2 (7–11)

Science, mathematics, design and technology, information and communication technology (ICT).

Possible links to STEM in the school curriculum

Key Stage 3 (11–14)

Science, mathematics, design and technology, ICT.

- Curriculum Cymreig.
- Careers and the world of work.
- Education for sustainable development and global citizenship.
- Entrepreneurial education.
- Personal and social education (PSE).

Key Stage 4 (14–16)

Core: science subjects and mathematics.

Options: e.g. design and technology/ engineering/computer science/ work-based training.

- Curriculum Cymreig.
- Careers and the world of work.
- Education for sustainable development and global citizenship.
- Entrepreneurial education.

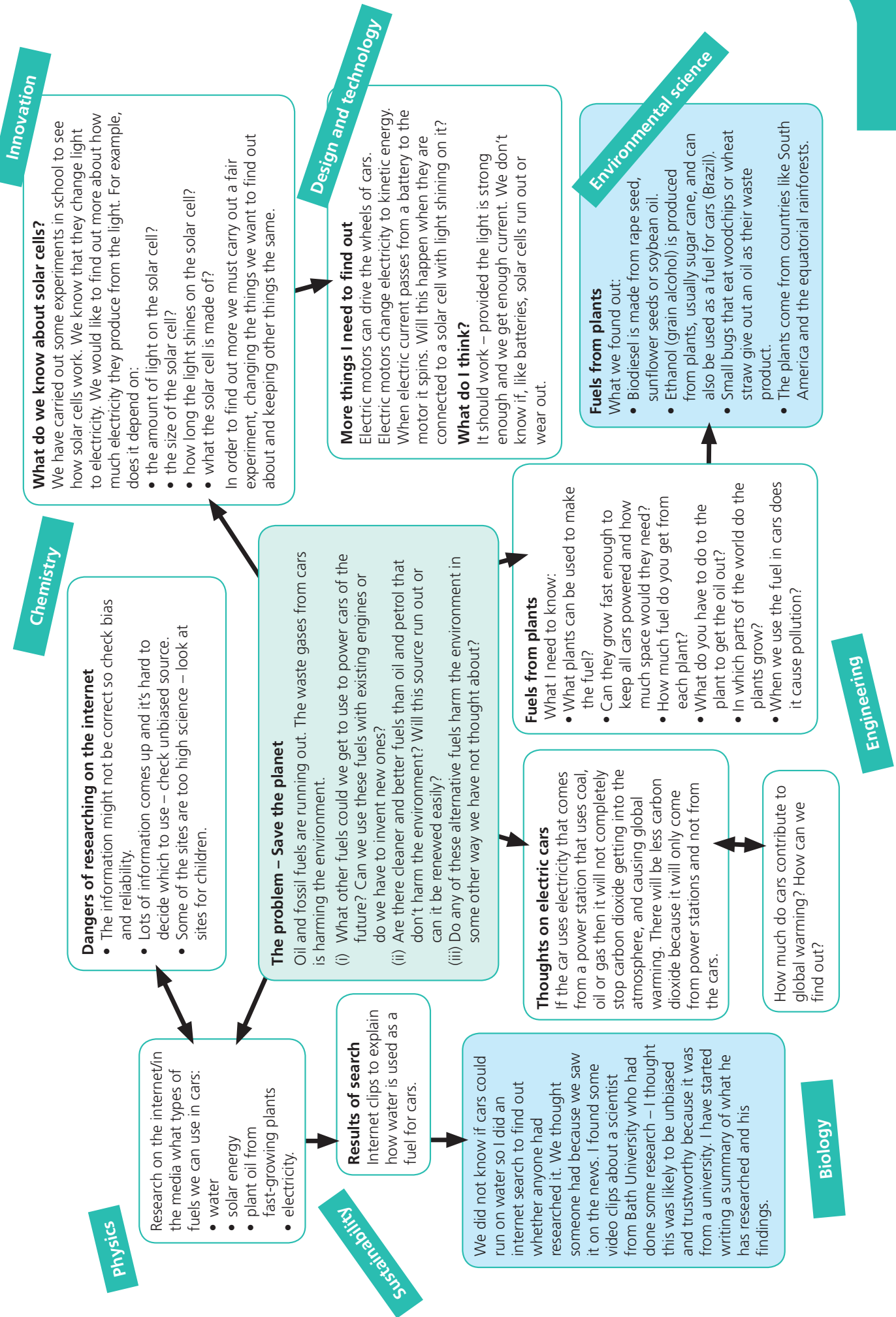
The nature of all STEM subjects means they can be used effectively to demonstrate the skills required in problem solving, and the interdisciplinary nature of its constituent parts. Many schools are developing such approaches even when STEM is taught through traditional subjects like physics, chemistry and mathematics. For example, learners might be encouraged to consider issues such as:

- Were the moon landing photographs fake?
- How effective is solar power likely to be in Wales?
- What fuel would you use in an Olympic flame?
- How can people in a developing country get clean water?
- Would you buy a hybrid car?
- Can cars be run successfully on sunshine or water?
- Can everyone donate blood?
- How do earthquakes happen?
- Are mobile phones a danger to our health?

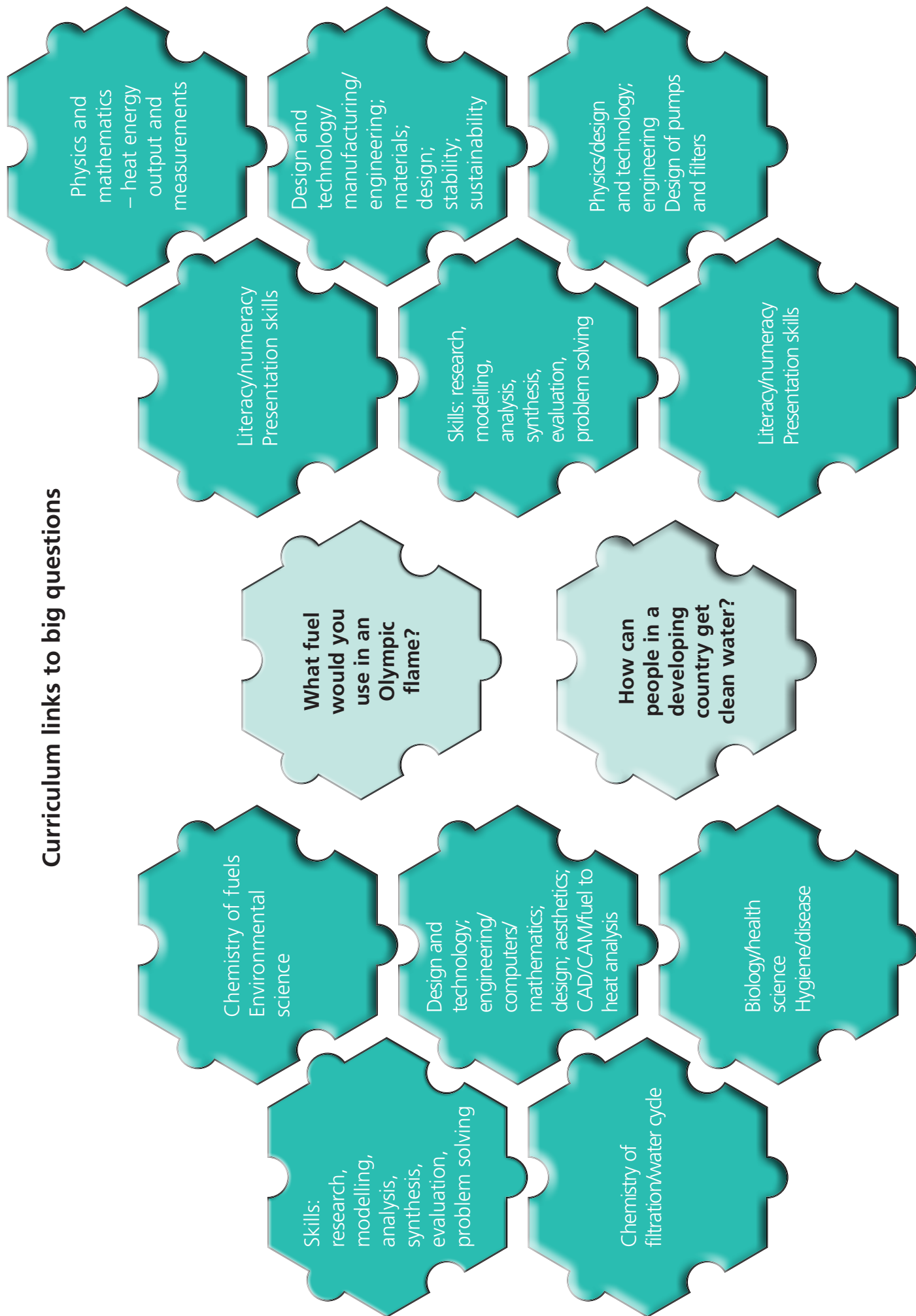
These are just a few of the contexts and big questions which can transform learning and teaching, give purpose to the knowledge and understanding, and help learners to realise the enormous potential in the applications of STEM. Further consideration is given to these on the following pages.

Mind mapping STEM across the curriculum at Key Stage 3/4

Example question: Can cars be run successfully on sunshine or water?



Curriculum links to big questions



STEM in the 14–19 Learning Pathways

14 to 16-year-olds

The Welsh Government's Learning Pathways Strategy allows for a range of curriculum opportunities, not always directly available in schools, but that can be accessed through local network partnerships, e.g. work-based providers, further education institutions and employers working in collaboration with schools to provide tailor-made pathways for learners.

Engineering is the only STEM subject not routinely taught as part of the school curriculum. It is therefore important that engineering is linked to other STEM subjects by teachers and advisers, and that the wider engineering community is able to forge links back into the classroom and to learners. Career paths into engineering are poorly understood by learners. Many believe wrongly that A levels and degrees are the only route to an engineering career. For further guidance on the availability of jobs and apprenticeships, see the Careers Wales website (www.careerswales.com). Careers Wales also have an [apprentice matching service](#).

16 to 19-year-olds

Beyond 16, there is a wealth of opportunities to engage with STEM-related subjects through a wide range of courses leading to a variety of well-established and respected qualifications. There are both traditional routes and vocational routes to meet with individual needs.

- Traditional routes include GCE AS and A levels in the sciences, mathematics and design and technology leading to first degrees in related subjects.
- Vocational pathways, such as BTEC National Qualifications in applied sciences and engineering at Level 3, lead to Higher National (foundation degrees) or first degrees. (More information on 'routes' can be found on [page 16](#); all these qualifications can also lead directly to employment.)

In a well-planned, coherent curriculum where STEM is a priority, schools and colleges can bring attention to some of the key unifying themes that bring together skills and knowledge from a wide range of subjects, and integrate careers advice and links to everyday contexts where possible. Some examples are given on the following pages and are related to the Welsh Government's nine key sectors as outlined on [pages 19/20](#) of this document.

Careers in STEM

The Welsh Government is seeking to ensure that all residential premises and all businesses in Wales will have access to Next Generation Broadband by 2015 – Wales will therefore need a good supply of programmers, ICT engineers and technicians as well as communications engineers and network managers. The Welsh Government is also focusing on nine key sectors which are, or have the potential to be, key to the economy of Wales. The aim is to nurture businesses in these sectors to maximise their prospects for market success. The nine key sectors are:

- Advanced materials and manufacturing
- Construction
- Creative industries
- Energy and environment
- Financial and professional services
- Food and farming
- Information and communication technology (ICT)
- Life sciences
- Tourism.

STEM skills are vital to each of these sectors.

The core messages about employment in a STEM-related industry can be found in the Careers Wales document *Spotlight on STEM* (2011) which seeks to answer many STEM-related questions, and is a useful document for learners, teachers, parents/carers and employers. It is an interactive PDF and highlights the following.

- Why STEM skills are important to Wales.
- Why employers want STEM skills.
- Where can STEM take me?
- If I study STEM subjects will it improve my chances of getting a job?
- What about the future?
- Do I need Welsh language skills?
- Where are the skills gaps and shortages?
- What can I earn with STEM qualifications?

- So what can I earn as a...?
- What's happening in Wales?
- Case studies.
- How do I find out more?

Online resource

A very visual interactive website and online tool, including short film clips/interviews and information about career pathways in STEM, is available at <http://www.futuremorph.org/>

Online [self-assessment CPD modules](#) on giving STEM careers advice and using labour market information (LMI) have been developed by the National STEM Centre, the Centre for Science Education (Sheffield Hallam University), Babcock International Group and others.

Possible routes to a STEM career

There are a wide range of routes available to prepare learners for a career in STEM including courses in school sixth forms, as well as FE and HE colleges and universities. Courses could include GCSE, GCE or vocational qualifications in science leading to HND or foundation degree course and undergraduate courses.

Further information about available courses can be found at

www.thecompleteuniversityguide.co.uk

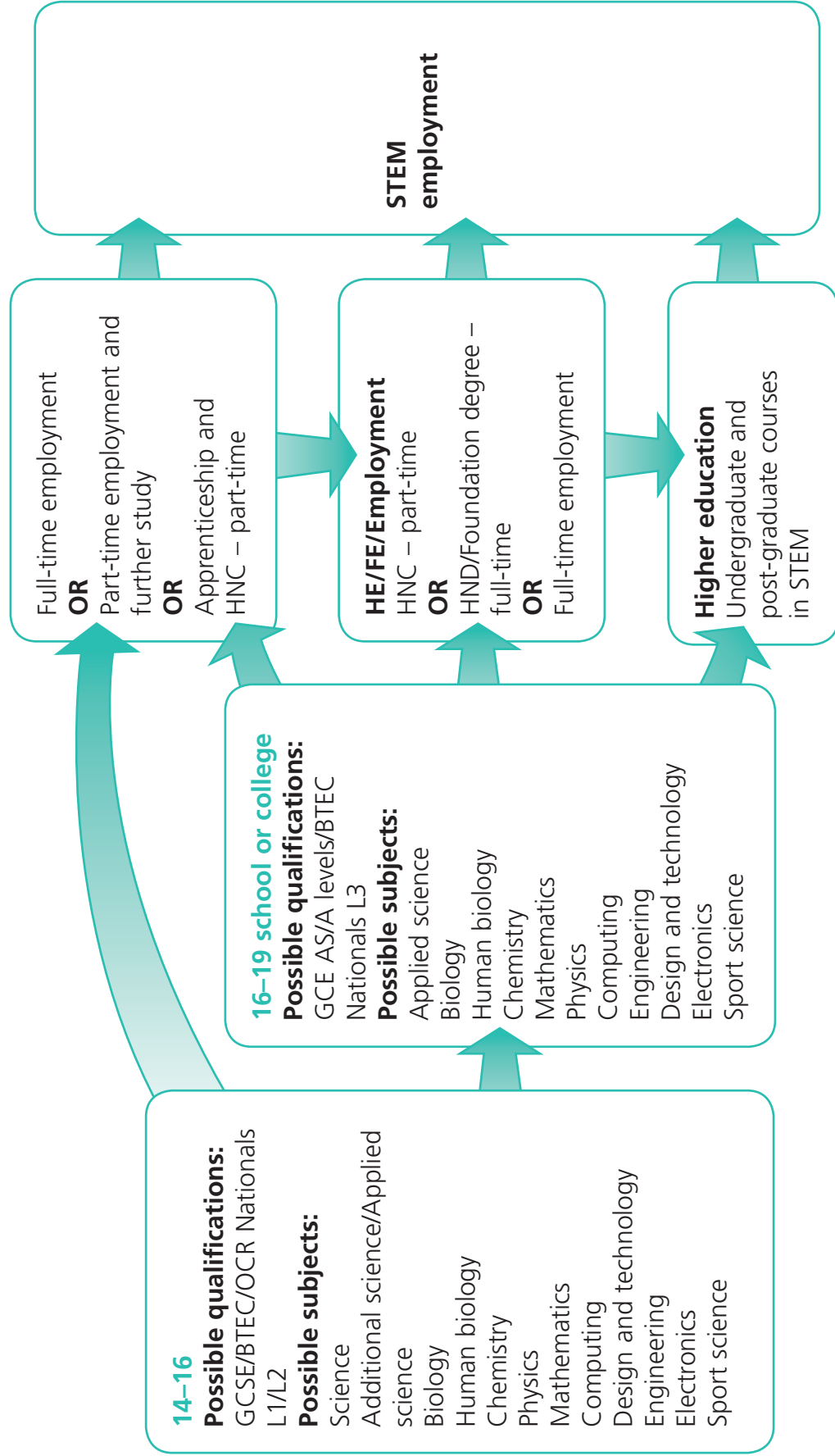
www.ucas.com

www2.careerswales.com/coursesinwales/default.asp?page=LCD_ADVANCED&menuid=2

Employer-based training is also available, e.g. an apprenticeship scheme that also includes further study for an NVQ, HNC and degree qualifications.

The diagram on the following page shows some possible routes to a STEM career.

Possible routes to a STEM career



Tips to introduce STEM as a career to learners

Things to encourage and stimulate learner interest

- Integrate career messages as much as possible into the work that learners are experiencing.
- Develop and run workshops that encourage active participation and small group discussions.
- Build a careers dimension into a topic you are currently working on in curriculum subjects, e.g. renewable energy sources. Look for local employers to support you to produce curriculum materials or get involved in a project.
- Hot seat mentors from a range of STEM employers.
- Engage employers in school-based projects and engagement days, e.g. Business Enterprise, Institute of Physics, Ashfield Music Festival Activity, etc.
- Actively involve mentors from local and national companies to support project work and participation in competitions, e.g. through STEMNET and STEM Ambassadors.
- Encourage regular and purposeful use of links to the Careers Wales website at www.careerswales.com

Things to avoid

- Large-scale lectures that do not engage learners or do not involve them in participatory activities and group discussions.

Employer engagement

Most STEM employers recognise the importance of engaging with schools and colleges. Employers can support teachers and learners in understanding the excitement and potential of STEM in a variety of ways, for example by:

- providing support to schools and colleges
- encouraging employees to become STEM Ambassadors
- supporting STEM activities within schools
- sponsoring STEM clubs
- encouraging employees to become school or college governors.

Employers have indicated that they are more likely to engage with schools and colleges if:

- they fully understand the learner's needs and objectives
- they are involved with learners at an early stage of planning
- they are supported in the delivery by staff at the school or college
- they set up employer consortia to build relationships with other employers and collaboratively are able to consider the most appropriate type and level of employer engagement for specific activities/units within a particular curriculum/qualification
- teaching staff are released to attend professional development teacher training/placements to update their industrial knowledge linked to the line of learning they will be delivering (Careers Wales are very proactive in running teacher awareness days).

Challenges that face employers include:

- the effect of the economic climate has resulted in a reduction of the workforce and the ability to release staff for work-focused education
- health and safety restrictions can sometimes limit the type and nature of work-related opportunities that can be offered to certain age groups
- national company policies or strategies may place restrictions on the company's level of involvement with the education sector.

The case studies on [pages 37–56](#) highlight a range of school/college links with employers.

What is the Welsh Government doing to promote STEM?

Science for Wales – A strategic agenda for science and innovation in Wales (Welsh Government, 2012) sets out the strategic vision for science, engineering and technology, and establishes STEM as a key priority for the future well-being of Wales.

Science touches most things in our lives, and has the capacity – if intelligently and selectively used – to improve our people’s welfare, health, lifestyles and self-regard. Wales can be a small, clever nation, but we must understand that this will only bear fruit if we work very hard, and with focus. No one owes us a living. The timing is urgent – for much of what we call for we need to see significant changes for the better within 3 to 10 years. If we do not seize the great opportunity before us, we will not realise those benefits. If we do take action, we can use a stronger science base to support a better economic future for our people.

Professor John Harries, Chief Scientific Adviser for Wales

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

STEM graduates offer skills and knowledge that are highly valued in the labour market. Chemistry and physics graduates will earn, on average, 30 per cent more over their working lives than graduates in other subjects. The demand for STEM graduates is likely to grow significantly over the next few years. The Department for Business, Enterprise, Technology and Science (BETS) in the Welsh Government is focusing on nine key sectors which are, or have the potential to be, key to the economy of Wales. The aim is to nurture businesses in these sectors to maximise their prospects for market success. The nine key sectors are:

- Advanced materials and manufacturing
- Construction
- Creative industries
- Energy and environment
- Financial and professional services
- Food and farming
- Information and communication technology (ICT)

- Life sciences
- Tourism.

Further information on [support for these sectors](#) is available online.

Innovation, research, the development of cutting-edge technologies, communications, advanced manufacturing and creativity are the drivers of future growth in the Welsh economy, leading to greater wealth and more jobs. STEM therefore has a vital role to play in all our lives in the future. The National Science Academy has a key role in coordinating efforts across Wales in promoting STEM (see [pages 22–24](#)).

Development of best practice report in mathematics at Key Stage 4

The School Standards and Delivery Unit (SSU) within the Welsh Government is currently undertaking a priority review of the teaching and learning of mathematics at Key Stage 4.

The percentage of learners gaining A*–C in mathematics is consistently lower than those gaining the same grades in English/Welsh first language across all four consortia and all 22 authorities in Wales. In 2011, 56.5 per cent gained GCSE grades A*–C in mathematics compared to 62.8 per cent obtaining the same grade in English.

In liaison with Estyn, 11 schools have been selected, based on their performance over the last two years for mathematics in relation to their expected performance when related to the percentage of learners entitled to free school meals.

A report, outlining what works well in these 11 schools and highlighting best practice will be available on the Learning Wales website in the autumn term. There will also be links from the report to film footage of the participant schools. It is expected that consortia and their schools will use the information contained in the report to improve their practice.

Digital classroom teaching

The Welsh Government is encouraging schools to make full use of social network technologies in order to engage learners and improve learning outcomes. We have provided £3 million funding over three years from 2013–14 to support teaching of ICT and computer science in schools including funding to provide technology like raspberry Pi and .net gadgeteer into classrooms. We have also established a new National Digital Learning Council which will include learner voice as well as practitioner representation. In December 2012 we will also be launching a new virtual learning environment (VLE) for Wales (working title Hwb) and iTunes U platform.

What is the National Science Academy and what does it do?

The National Science Academy (NSA) was launched by the Welsh Government in 2010 as a collaborative alliance of organisations¹ with STEM² interests. Its primary role is to help promote, communicate, and better coordinate STEM outreach and engagement across Wales.

The NSA aims to inspire, motivate, and enhance Welsh STEM activity at all levels. By promoting STEM excellence and celebrating STEM successes, it will contribute towards making the people of Wales more engaged with science subjects and motivate everyone to understand them better.

The aim is not an end in itself. STEM skills are widely acknowledged as essential to the development of a prosperous and sustainable knowledge-based economy.

How does it do it?

The NSA consults, coordinates and collaborates to achieve effective impacts with the available resources.

- It **consults** beyond the NSA membership with key organisations able to deliver good-quality STEM enrichment activities to people. They include schools, further education institutions (FEIs) and higher education institutions (HEIs) concerned with STEM subjects, charities, foundations, employers and potential employers of people with STEM skills or qualifications, trusts, sponsors and other funders/supporters able to contribute to NSA goals. It collects and evaluates evidence on STEM activity and outputs.
- It **coordinates** programmes, events, calendars and activities. It celebrates, showcases and broadcasts successes and provides a networking facility, stimulating, and brokering links between and across organisations involved in STEM issues.
- It **collaborates** by sharing and exchanging information, best practice and resources. It looks across Wales – and beyond – and seeks to fill gaps in STEM provision geographically and among disadvantaged groups, in order to achieve optimum added value.

1 Currently this comprises the five STEM hubs: Centre for Alternative Technology, National Botanic Garden of Wales, Techniquet in Cardiff, Techniquet Glyndŵr in Wrexham, and the Wales Institute of Mathematics and Computational Science in Swansea, together with the Higher Education Funding Council for Wales (HEFCW).

2 STEM is taken here to mean science, technology, engineering and mathematics, including other 'softer' disciplines in so far as they apply a scientific approach such as architecture, psychology and medicine.

The NSA's aims are not confined to increasing the number of high-achieving A level students, graduates and post-graduates in STEM subjects. It will also focus on intermediate level skills for the workforce, and on people with interests other than STEM. This latter group may have untapped potential to move into useful STEM careers.

At heart, the NSA aims to help all citizens – whether they study STEM or not – to engage positively with STEM subjects and gain a better appreciation of their relevance to modern life, and the challenges and opportunities for the future.

What are the next steps for the NSA?

Science for Wales – A strategic agenda for science and innovation in Wales sets out clearly the Welsh Government's vision and aims for the NSA.

Over the next year we will:

- *develop our STEM strategy, building on a survey of existing activity, to engage and develop children and young people and increase the proportion of the cohort studying science and pursuing STEM-related careers, including more girls and women*
- *set direction and coordinate outreach STEM activities through the NSA, including the appointment of an NSA STEM Coordinator*
- *improve labour market intelligence to help shape informed career choices for young people, including market needs for STEM skills*
- *examine ways to raise the standard of science and mathematics teaching from primary through to secondary education, including how improved or specialist teaching can be encouraged through recruitment and training (both initial and through continuous professional development) to provide effective learning for all learners, including those who want to study sciences as single A levels.*

Over the next five years we will:

- *continue to target the supply of high-quality graduates including through incentives into priority areas of STEM initial teacher training*
- *continue to be committed to the provision of continuous professional development for all STEM teachers and to working with partners in developing standards*
- *develop and respond to research into progression in science education, including evidence relating to the study of two and three sciences at GCSE*
- *ensure that our curricula for STEM subjects are in the vanguard of modern, challenging curricula for the learners of Wales.*

STEM beyond the classroom

STEM outreach activities to engage young people are widespread and often highly successful across Wales, with many enthusiastic and energetic practitioners, a lot of activities and some splendid 'shop window' meetings and science festivals.

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

At school and college level, STEM is typically treated as a set of separate subjects including science, mathematics, design and technology, computer science and engineering. In the outside world, however, real-life scientific and technological opportunities and challenges simply do not slot neatly into these categories. It is therefore important for learners to understand the need to develop and transfer both skills and knowledge across subject boundaries as well as within them. While all schools and colleges are restricted by timetables and staffing to varying degrees, many grasp opportunities to:

- build a curriculum that draws on the links across all STEM subjects; the 3–14 curriculum in Wales advocates an enquiry-led approach which promotes the idea of investigating 'big questions' and often takes learners across, as well as within, subject boundaries
- draw on [outside organisations for advice and support](#) to engage learners by using 'real-world' cross-curricular STEM contexts and challenges
- work together with scientists, technologists, engineers and mathematicians from the world of work to give learners an exciting yet realistic picture of a future that motivates them to choose these subjects
- highlight the wide range of rewarding careers available to those who choose STEM subjects.

It is therefore important that we think of STEM as going beyond the walls of the classroom, laboratory or workshop. Making links with higher education, industry, commerce and the world of work is not easy, and sustaining them is even harder, but if we are to make young people more aware of the exciting prospects in STEM it is a must. This guidance points to some successful ways of achieving this aim.

Partnership working/collaboration

Much can be achieved if schools and colleges work collaboratively and involve a wide range of partners including employers, HEIs, learned bodies (e.g. Institute of Physics, Royal Society of Chemistry, etc.) and the raft of associations linked with STEM to raise awareness and make progress in attracting more learners into STEM. However it is not just about making links – it's important to consider the quality of the collaboration and the outcomes they produce.

This is essentially a two-way process and HE providers and employers, for example, can benefit from working with schools and colleges and vice versa. While one-off days often add to the enjoyment, interest and participation in STEM, it is important that participation in these events benefits learners, adds another dimension to their learning and that they ultimately gain more skills and knowledge to engage further with STEM.

Examples of partnership working/collaboration are provided within the [Case studies](#) section of this guidance.

Setting up a school STEM club

What does it involve and what are the benefits to learners?

A STEM club is an opportunity to bring the component parts of STEM together in order that learners can see the relevance it has in the modern world. STEM clubs allow learners to explore, investigate and discover STEM subjects in a stimulating learning environment, away from the constraints of the school timetable or a prescribed curriculum. They allow learners and their club leaders to work together and explore many different ideas and activities.

Tips for staff setting up a STEM club

- Ensure you have the time to make the commitment to the club.
- Investigate ways of funding your STEM club. Attract grants, sponsorship but above all accept any help anyone offers.
- Encourage a team of colleagues to get involved – so you can share the knowledge base and some of the development work and presenting from each of the contributing STEM subjects.
- Limit the size of the club. Aim for a small initial attendance and build up gradually; attendance might not be regular, but keep the interest going and members will spread the word by mouth.
- Aim for the club to provide for the whole age and ability range. Encourage and maximise opportunities for older learners to support younger ones. (This will also help with development of their mentoring and leadership skills.)
- Avoid offering just 'science' or 'mathematics' activities – STEM skills go wider than this.
- Integrate activities into a problem-solving approach, e.g. make a model and test it, using science and mathematics to explain how it works.
- Make the activities fun and practical, e.g. you could make a short film about science/engineering inventions.
- Make the activities or theme for the day as varied as you can, e.g. involve a local astronomical society in a 'Starry night' activity with competitions and prizes.

- Sometimes activities start up from competitions, e.g. Faraday Competition, IET (Institution of Engineering and Technology). The activity in this link has a science/technology start and then ends up being filmed.
www.youtube.com/watch?v=2kilKwzRCjY
- Publicise your STEM club activities through school assemblies, on the school website/newspaper and in open evenings.
- Invite and welcome participation from parents/carers.
- Organise trips to events in your locality, e.g. your local science festival (if there isn't one then perhaps you could organise it for a group of schools), as well as some further afield.

Where can I get more ideas, help and support for the club?

Further information can be found at www.stemclubs.net

Toys are full of science and technology. Here are a few ideas to explore and make simple toys that everyone will enjoy.

www.arvindguptatoys.com/toys.html

It is for schools to select resources according to their needs. However, the following websites contain a wealth of good projects/ideas, including podcasts, that you may find helpful for use in your STEM club.

- www.thenakedscientists.com/HTML/content/kitchenscience/
- www.creative-science.org.uk/MAKE.html
- www.britishscienceassociation.org/crest-awards
- www.sciencebuddies.org
- www.mathsisfun.com/puzzles/index.html
- www.nationalstemcentre.org.uk/elibrary/collection/693/stem-fairs
- www.google.com/events/sciencefair/educators.html
- www.curiositymachine.org

STEM clubs in practice

The case study on [pages 54/55](#) of this guidance highlights an example of a successful STEM club, organised by Careers Wales Mid Glamorgan and Powys and Mid Glamorgan Education Business Partnership.

Contact your local Careers Wales office or your Careers Adviser to see what other opportunities Careers Wales can facilitate in your area.

STEMNET and STEM Ambassadors

Who are STEMNET?

STEMNET is a charitable organisation whose vision is to increase young people's choice and chances through science, technology, engineering and mathematics. It creates opportunities and encourages and inspires young people to develop their creativity, problem-solving and employability skills that are so essential for a STEM career. STEMNET has received funding from the Welsh Government through the National Science Academy to extend the STEM Clubs Network to schools in Wales.

STEMNET in Wales

See Science is the STEMNET contract holder and manages the STEM Ambassadors Programme and the Schools STEM Advisory Network in Wales. See Science are based in Cardiff and can be contacted at ambassadors@see-science.co.uk

Further information on STEM Ambassadors in Wales can be found at www.stemnet.org.uk/regions/1527/content/wales-enhancement-and-enrichment-support

What is a STEM Ambassador?

STEM Ambassadors are, usually, local people from STEM backgrounds who seek to share their experiences as well as encourage young people to consider pursuing a career in STEM subjects. They volunteer as a free-of-charge resource to inspire and be role models for young people. The support they offer varies from, for example, contributing to day-to-day lessons to participating in/helping to facilitate extra-curricular activities such as STEM clubs, careers days and visits.

Ambassadors can help you by:

- providing support for STEM clubs
- mentoring groups through projects and competitions
- acting as role models for learners and giving careers talks
- providing technical help and knowledge-based expertise
- taking part in mock job interviews
- helping to set up and organise a science fair or open day
- helping to organise a 'Dragon's Den' challenge to design, build and present an invention.

Tips for working collaboratively with STEM Ambassadors

Meet with your STEM Ambassador **before** the day of the activity to:

- discuss the nature of the collaboration
- agree your respective roles in the project
- discuss the topic/activity
- discuss the age and ability range, as well as what previous knowledge learners are likely to have about the chosen topic
- make clear the facilities available – i.e. including the room/workshop/laboratory, use of technical equipment for presentations
- agree on timings, e.g. in secondary schools this may be limited by the length of a lesson
- agree the format of any presentations to be done by the Ambassador – explain the importance of keeping to time
- stress the importance of involving learners through group work, timed exercises with clear objectives, etc.

Tips for engaging with learners

Ambassadors come with a variety of skills and it is important to ensure good engagement with the learners from the start.

- Children are naturally inquisitive and the majority like to solve puzzles, therefore suggested opening activities could include:
 - the Ambassador asking a question, e.g. ‘What do I do for a living?’ with learners asked to guess the answer by asking questions; the Ambassador will only be allowed to answer ‘yes’ or ‘no’
 - the Ambassador setting learners a simple problem to solve, e.g. ‘You have 10 minutes to remember one thing that happened to you 1,000,000 seconds ago’ with learners asked to calculate 1,000,000 seconds in days and write a sentence or two about an event which happened 11 days before.
- Keep presentations short with good illustrations.

- Have a follow-up session to the activity. Try getting the learners to 'hot seat' the Ambassador allowing sufficient time for learners to think of questions. (A good way to get learners to ask questions after a session is to give them a few minutes and some sticky notes and ask them to think of questions they want to ask first individually, then in pairs, and finally as a group.) They can then present a few of their questions.
- To help evaluate learner engagement, each learner could be asked to say or write one thing they knew about the speaker's topic before the event and one thing they have learnt from the talk which they did not know before.

Want to find an Ambassador?

See Science can help you link schools with an appropriate STEM Ambassador. See Science deals with requests for STEM Ambassadors in the following ways.

- Teachers can request a STEM Ambassador by completing the STEM Ambassador request form from *STEMNetworking* at <http://networking.stemnet.org.uk> or by e-mailing ambassadors@see-science.co.uk with as many relevant details as possible.
- Requests are then compiled and sent out monthly to all STEM Ambassadors by e-mail and in an e-newsletter.
- STEM Ambassadors who are interested and available are invited to respond to See Science at ambassadors@see-science.co.uk or via *STEMNetworking* at <http://networking.stemnet.org.uk>
- See Science then e-mails both the teacher and the STEM Ambassador so that they can contact each other directly to finalise arrangements.

Typical requests for help from schools and organisations include the following examples.

Request 1: Space/Astronomy Day

Ysgol Uwchradd Glan Clwyd, St Asaph

19 October

As part of a three-day (17, 18, 19 Oct) 'Space' activity event, Glan Clwyd Year 8 learners will be taken on a trip to the National Space Centre, participate in space activities at school and make this part of the CREST silver project.

STEM Ambassadors are required to:

- talk to learners about careers/education using the subject area of space and astronomy
- help with final day activity (producing presentations)
- judge presentations.

Request 2: 'That's Chemistry' Day

Ysgol Gyfun Bro Morgannwg, Barry

19 October

Aim: Careers Wales are organising 'That's Chemistry' in conjunction with the Royal Society of Chemistry (RSC). It will offer an insight into the wide range of careers and occupations aligned to the various branches of the science. Learners can experience and learn about diverse ways in which chemistry is used in industry and elsewhere in production processes, analytical techniques, product development, etc. They hope to enlist the support of companies and others who may be able to put up a display stand, give practical demonstrations or presentations showing the varied work that chemists do in the fields of biosciences, environment and energy, food and nutrition, industry and technology.

If you are able to contribute please contact ambassadors@see-science.co.uk

Request 3: Maths Inspiration Show

The Royal Welsh College of Music and Drama, Cardiff

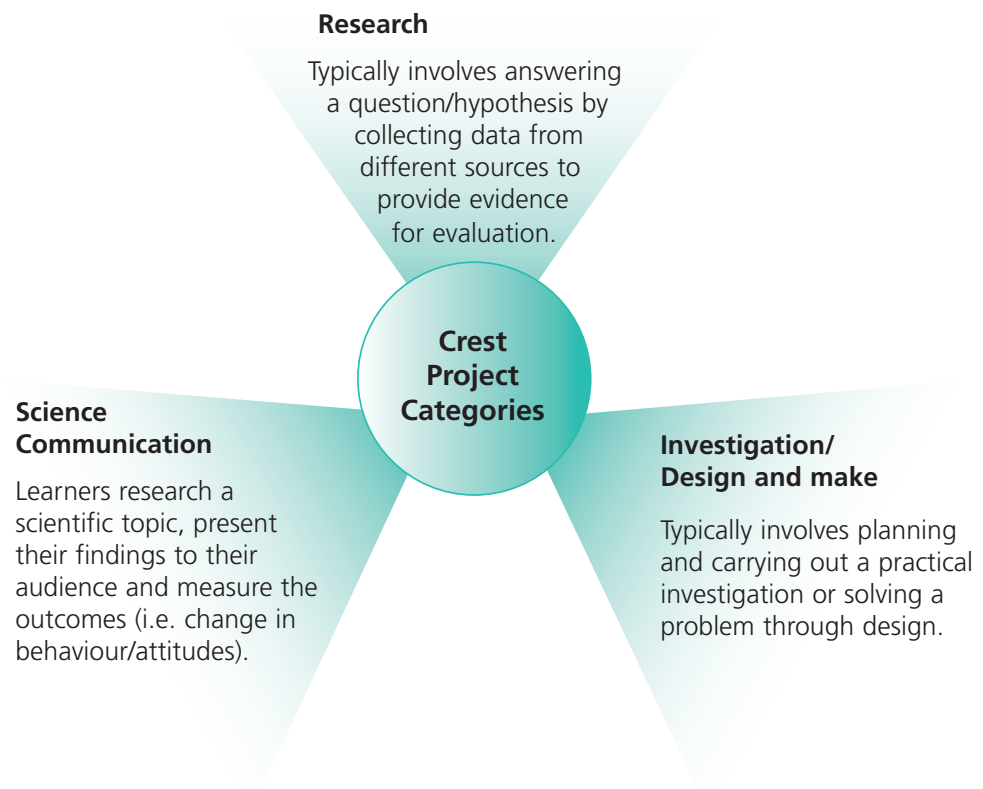
7 December, 9.00a.m.-1.30p.m.

- Rob Eastaway is seeking Ambassadors to assist as welcome hosts with the greeting and registration of schools at this entertaining show. They will be able to enjoy the show themselves following the registration.
- Show content - 'Maths in The Simpsons', 'How Maths Built The Olympic Stadium' and 'The Maths of TV Game shows'.

CREST Awards

The CREST (CREativity in Science and Technology) Award is a well-regarded, high-quality, project-based awards scheme for STEM subjects which links the personal interests of learners to curriculum-based learning. It is organised by the British Science Association (BSA, formerly BA), a charity established under Royal Charter in 1831. It organises major initiatives across the UK, including the annual British Science Festival, and National Science and Engineering Week.

The Welsh Government is encouraging schools to take up the challenges that the CREST Awards present for learners – through seamless schemes provided for 5 to 19-year-olds.



CREST Star Investigators (primary schools)

This scheme is suitable for learners between 5 and 12 years old. The scheme helps learners to solve scientific and technical problems through practical investigation. The activities focus on thinking about, talking about and doing science and design and technology. They are designed to be used either outside classtime (e.g. in a STEM club) or directly in the classroom. All the skills can be matched to the *Skills framework for 7 to 19-year-olds in Wales* (Welsh Assembly Government 2008). Further information can be found at www.britishscienceassociation.org/node/4976

CREST Awards for 11 to 19-year-olds

CREST has proven to be a great success in stimulating interest by providing young people with real hands-on experiences in science and technology while also providing students with a tangible recognition of success.

Lesley Griffiths, AM

These provide opportunities for project work in STEM subjects for all 11 to 19-year-olds in schools and colleges in Wales, i.e. to explore 'real-world projects'. They are available at three levels.

- **Bronze** – targeted at 11 to 14-year-olds and aimed at improving enquiry, problem-solving and communication skills.
- **Silver** – targeted at 14 to 16-year-olds and involve external mentors to work with learners (design and technology projects at qualifications level 1 or 2 is an example of how this might be delivered).
- **Gold** – targeted at 16 to 19-year-olds and delivered, for example, through linked schemes such as Nuffield Bursaries (organised by Techniquest) and the Engineering Education Scheme Wales (organised by EESW at www.stemcymru.org.uk).

The award levels represent a development in learner project skills and activity. There is an opportunity to integrate the project skills into the school curriculum at all key stages, for example:

- linking the projects to the skills framework and the design and technology and/or science curriculum

or

- by organising a day of activities, for example, to celebrate National Engineering Week, to support a STEM club or to encourage participation in linked schemes such as work-related learning (e.g. Nuffield Bursaries, Engineering Education schemes).

Teachers can link to the skills framework to map the progression in learner skills and achievement.

Key steps in the awards include the learner selecting their own project and engaging in activity that will bring it to a conclusion.

The [criteria for the awards](#) are fully explained on the BSA's website.

We need to interest more young people in developing the sorts of skills we need to develop the economy now and in the future and STEM subjects are particularly important in this respect.

Lesley Griffiths, AM

CREST case studies

CREST case studies can be found on the BSA website through the following link.

www.britishscienceassociation.org/crest-awards/case-studies

Local case studies in Wales

Case study 1 – Example of CREST project on YouTube

www.youtube.com/watch?v=dp3rZMPla40&feature=fvst

Case study 2

www.see-science.co.uk/newsletters/newsletter-secondary-november-2011.html

Case study 3

www.see-science.co.uk/newsletters/newsletter-July-2011-secondary.html

Case studies

The case studies in this section highlight a range of school/college links with employers and show how regional support can be effective. These are for illustrative purposes only, and are not exhaustive, as it is clearly for individual teachers and schools to consider available opportunities which will best meet the needs of their learners.

Some local employers have developed a number of successful ways to support schools in their own regions, e.g. G24i has developed an education centre, using their research and development resources to showcase their work. This is an ideal way to stimulate an interest in potential STEM careers.

Case study 1

G24i Cardiff

www.g24i.com

G24 Innovations (G24i) is a company committed to sustainability – both in the products it makes and the way it manufactures those products. Their aim is to become the first manufacturing facility in the world to make renewable products solely through the use of renewable energy.

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They utilise the latest breakthrough in material science and nanotechnology creating a new class of advanced solar cells that are the closest mankind has come to replicating nature's photosynthesis. These can:

- be incorporated into a wide array of energy-saving products
- radically extend the mobility and utility of mobile devices
- generate electricity in remote locations
- mitigate global climate change.

The company is in the process of developing an on-site environmental learning centre (Environmental Futures Centre) to not only showcase G24i's own products but a whole array of renewable energy technologies and approaches to energy sustainability.

Learners from schools and colleges can visit and explore green technology in action, including a display area where solar photovoltaic panels are used both internally and externally to provide power, a wind turbine that provides renewable energy to run the site, electric cars, as well as find out about other sources of green energy in which the company is involved.

Case study 2

Wylfa and Engineering Education Scheme Wales (EESW) support Anglesey's Young Engineers

Wylfa, through its socio-economic policy, has always had a very strong presence in the community on Anglesey that has included work with primary and secondary schools as well as colleges, universities and community groups.

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One of its projects has been to regularly support Engineering Education Scheme Wales (EESW) and its nurturing of young talented engineers. The Head of Maintenance Engineering at Wylfa sees Wylfa's role in the scheme as vital. He said:

If we are to ensure the future prosperity of North Wales and our youngsters, we need to do all that we can to nurture and develop engineering and construction skills locally and through projects like EESW we can do just that. If organisations such as ours are to fulfil future engineering and construction recruitment needs then it's vital we start to do it now.

Engineers at Wylfa will be expanding their work even further, by working with EESW, to take the challenge to all five secondary schools in Anglesey. Their involvement in supporting schools to take part in the EESW Engineering Competition continues. In 2011, Wylfa sponsored each school and provided a link engineer to work closely with each team, as well as hosting an induction day in October 2010 and supporting the finals in Llandudno and Cardiff in April 2011.

Case study 3

Professional development opportunities for teachers at Aberthaw Power Station

npower is committed to taking a long-term approach to attracting young people into STEM careers while at the same time helping them to understand what they can do to save energy and the environment. Further information on the [npower Education Programme](#) and STEM can be found online.

Through a teacher placement scheme they are helping to link industrial STEM with the school curriculum.

Further information about the success of [professional development opportunities for teachers](#) is available through the Careers Wales website.

Professional development opportunities for teachers

Shape the future – STEPS at Work

As part of our STEM engagement in increasing the pool of young people interested in STEM subjects and following a STEM career we support the STEPS at Work initiative and have delivered a number of STEPS at Work teacher placement opportunities at our engineering sites, including our power stations.

STEPS at Work (Science, Technology and Engineering Placements) is a national programme of professional placement opportunities for teachers and careers professionals. It runs as a partnership between The Royal Academy of Engineering and the Institute for Education Business Excellence (IEBE).

The STEPS programme targets teachers of science, technology and engineering subjects as well as those involved in helping to shape young peoples' career plans.

During these placements teachers benefit from:

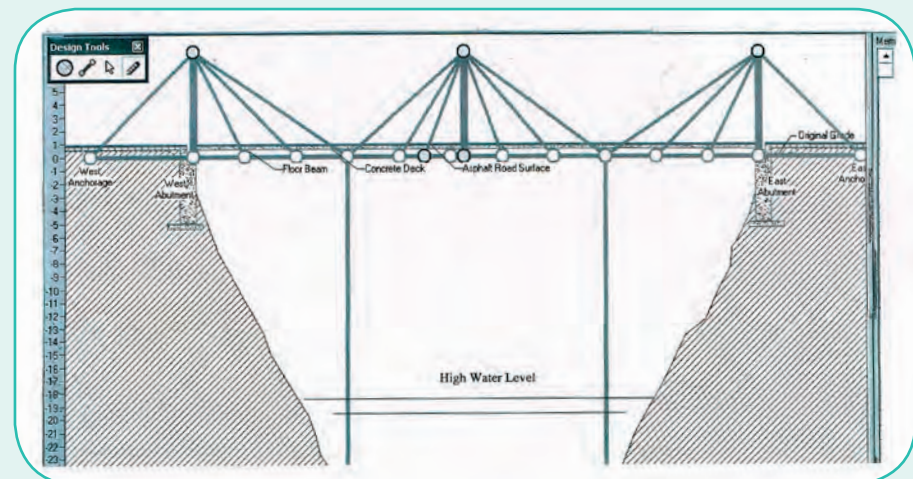
- essential networking
- contacts for speakers and talks
- better understanding of how mathematics and science are used in the workplace and developing stronger links with businesses
- improved information about careers in engineering and engineering routes
- an improved image of engineering
- a real context for science and engineering
- resources and materials for lesson plans.

Case study 4

Mathematics with a STEM flavour

A comprehensive school in south-east Wales linked up with a local civil engineering company, CAPITA SYMONDS, through a Construction Ambassador to make the mathematics curriculum for Year 10 learners come alive and to encourage them to think about a STEM career involving mathematics. Together the school and company worked to develop four key high-quality workshops, for high-achieving Year 10 learners that could be delivered in a day.

- **Drainage workshop** – investigating how storm water off the land can be discharged safely into a river at an acceptable rate preventing flooding of land while not causing further flooding downstream.
- **Structures workshop** – consideration of the design, planning and construction decisions involved in the building of a new local bridge, namely the £2.6m project Pont Calzaghe in Newbridge, South Wales.



- **Geotechnical workshop** – investigating the requirement to level land to build a large housing estate, estimate the number of houses the land could support and the planning requirements of an associated bypass highway to ensure adequate traffic flow.
- **Transportation workshop** – investigating a pedestrian crossing facility in a defence training centre and the design of a visitor centre car park.

Each workshop targeted areas of applying mathematics to help solve a problem which the company had been involved in. The materials developed by the company were innovative and engaging.

The format of the day included:

- meeting at the company premises to set the project in a real context
- a brief discussion on the topic, and familiarity with the associated technical terms used
- a problem-solving exercise – tackling the mathematics issues associated with the STEM project in a real context.

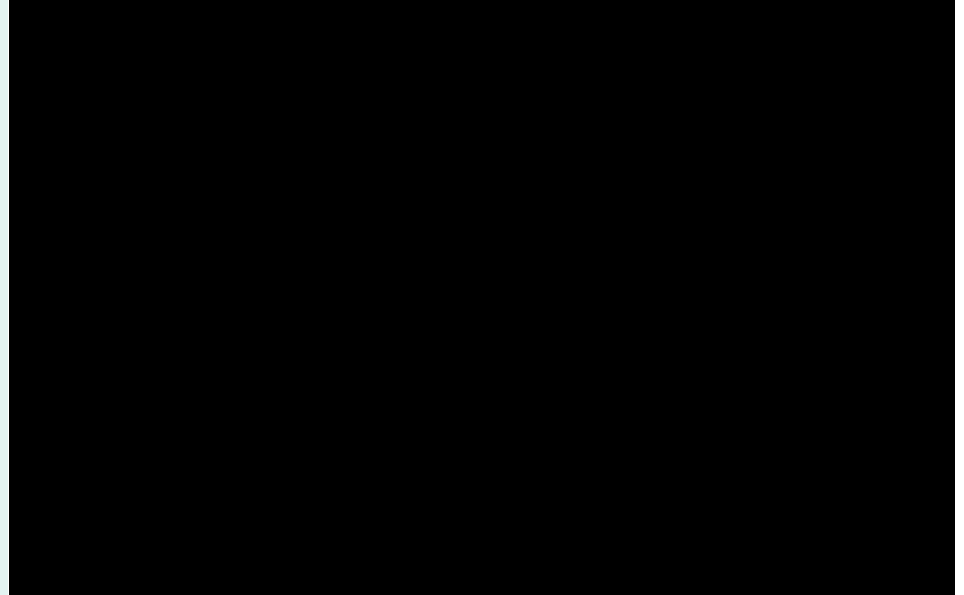
Some comments from the Year 10 participants included the following.

... thinking about drains all day – boring and dull. Turned out to be, more like fascinating and enlightening!

Our mathematical skills and knowledge were certainly extended and put to the test!

We found our trigonometry very helpful when assessing which piece of land would best fit the brief.

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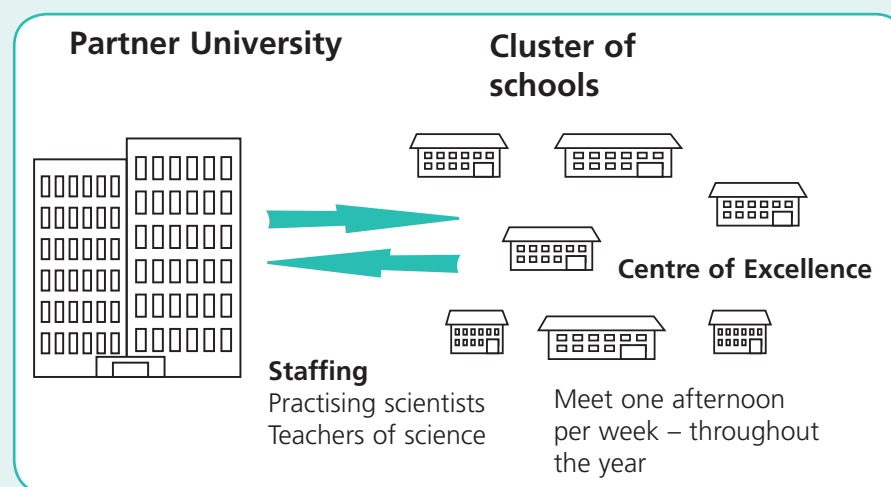
Case study 5

Taking the school STEM curriculum further



This is a successful STEM project aimed at stimulating very able learners by taking them beyond their current GCE A level studies in the sciences.

Monmouth School is the centre of a 'hub' aimed at giving sixth form students from local comprehensive schools in the Monmouth area a chance to engage with advanced skills in the sciences, which gives them a taste for, and equips them with, the skills they will require for HE and research.



The scheme, in its third year (2011), has over 60 students enrolled. They all meet each week to carry out practical investigations and project work that significantly exceed the demands of GCE Advanced Level.

All students undertake three rotations, each of approximately eight weeks covering elements of the main subject areas of biology, chemistry and engineering/physics. There are also visiting presenters. Professor Paul Harper from Cardiff University Mathematics Department teaches some of the elements of operational research and graduate trainees from a local international, defence and communications company, EADS, based in Newport, organise a product design and development session. The final week of each rotation is spent at Cardiff University.

There is also a long-term radio astronomy project where the learners have built, programmed, and operated a radio telescope. It is partially supported by a grant from the Royal Society, a self-governing fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine.

The three university visits enable learners to gain an insight into life at university by providing them with the opportunity to undertake a range of undergraduate-level experiments in world-leading laboratories. The learners work alongside academics from the Schools of Biosciences, Chemistry, Optometry and Vision Sciences, Pharmacy, Medical Sciences, Physics and Engineering. There is a particular emphasis on engaging and enthusing the learners about STEM and its allied careers.

The mix of learners from the independent sector and state sector has been successful in creating a highly competitive and challenging working environment while at the same time allowing learners to collaborate effectively on work programmes.

It has made me more confident in my career choice of medicine.

Learner

It has influenced my choice about university and a future career in the Biosciences.

Learner

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Outreach – Monmouth Science Initiative (MSI) will come to you

MSI staff are willing to travel to schools or to receive both learners and staff at Monmouth School. These sessions can be tailored to the needs of individual schools. All the activities are offered at minimal cost. The Wednesday sessions are free to participants and outreach session charges are simply to contribute to the cost of reagents used.

Each year Monmouth School hosts a science conference that includes presentations by four enthusiastic scientists and a pyrotechnic display by the Chemistry Department.

Further information is available on the MSI website which gives details of activities, comments from learners, the full programme of events and contact details.

www.monmouth-science.co.uk

Case study 6

Solving real STEM problems

Engineering Education Scheme in Wales

The Engineering Education Scheme Wales (EESW) is designed to encourage sixth form students from all parts of Wales to study engineering courses in further or higher education. The scheme operates in all parts of Wales, through local companies setting research and development briefs related to real industrial problems for teams of Year 12 students. The students set about solving these problems, over a period of about six months (October to April), in co-operation with engineers and scientists from the link companies.

Further information on [how to get involved](#) can be found online.

Read about successful projects in [TALENT](#), the newsletter produced by STEM Cymru/EESW.

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Potential outcomes for participants in the EESW scheme

- An enhanced knowledge, understanding and capability in STEM areas.
- The application, development and accreditation of Essential Skills Wales.
- Up to 70 UCAS points available through WJEC Extended Project.

- CREST Award at Gold or Silver level.
- Interview, teamwork and project management experiences.
- Report writing and presentation techniques developed.
- Exposure to a variety of engineering projects.
- An understanding of the multidisciplinary nature of engineering.
- An Award and Presentation Day for winners in July of each year.

Case study 7

Collaborative (Curriculum Cymreig) STEM projects

One effective way to deliver a STEM project to a large audience is for participants to collaborate on the planning and delivery, e.g. one school or organisation taking on board the task of organising the project on behalf of a group of other schools. This way:

- participants' needs are identified and shared by a group of schools
- each school can contribute a different expertise to the project
- large groups of target learners can be reached at the same time
- there is an opportunity for learners to work collaboratively with other local institutions
- the project can be more cost effective by sharing resources.

Two examples of such projects that were funded by the National Science Academy in the autumn of 2010 are Energy Island and Science in Sport.

Project 1 – Energy Island

This involved a school in North Wales, linked with Techniquest Glyndŵr and local energy employers, producing a series of workshops for a number of schools in Anglesey aimed at exploring the issues regarding generating energy for Wales.

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Setting the scene/task – the challenge

After studying the available resources and the previous day's briefing, participants had to decide which sources of energy they were going to develop and where they were going to be located on the identified sites on Anglesey. Their Energy Plan had to meet given targets and have clear reasoning for their choices.

The Energy Plan for Anglesey needed to meet the following targets:

- make Anglesey self-sufficient within the short term (three years)
- double Anglesey's current electricity generation within the medium term (five years)
- see the development of at least three energy sources in the long term (fifteen years) and ensure that Anglesey is a major exporter and supplier of electricity to the UK grid.

The participants were then treated to a number of workshops, each considering aspects of the challenge and involving STEM subjects.

Workshop 1 – Design-based

Consider how future energy plant designs can be made more aesthetically pleasing and blend into the environment.

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Workshop 2 – Science-based

Explore how nuclear power and biomass generate electricity and consider whether Anglesey should invest in generating future electricity from nuclear power stations or renewable energy generators.

Workshop 3 – Mathematics-based

Which household appliances use most energy? Consider the different amounts of electrical energy different appliances consume in homes in Anglesey.

Workshop 4 – Business-based and careers-based

When considering the options for the Energy Island Project, we need to consider the human resource available in the local area. What types of jobs are going to be created? How many? Can the local employment infrastructure (schools, colleges, universities and government agencies) provide the qualifications and training necessary to support these jobs? How will these factors influence the learners' final decision?

Workshop 5 – Is solar power likely to be usable in Wales?

Explore learners' understanding and ideas surrounding solar voltaic panels and make measurements.

Workshop 6 – Investigating wind power: science, design and technology, engineering and mathematics

Do wind turbines work anywhere anytime or just when it's very windy?

What happened next?

Following the workshops, feedback was received from individuals, groups and experts. Opinions were considered and a collective plan with justification was produced for Anglesey.

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Project 2 – Science in Sport

This project was a collaboration between a number of secondary schools in the south-east of Wales and was a two-day event held at Cwmbran Leisure Centre. The focus of the two-day themed workshops was to highlight science, technology, engineering and mathematics (STEM) and its current influence on sport and career opportunities for young people. The project involved two days of interactive workshops for a range of learners between the ages of 11 and 14. Male and female participants were included in approximately equal numbers.

A DVD of the workshops was produced and is available from the school by contacting them via their [online form](#).

There were seven workshops.

Workshop 1 – Introduction: What's science got to do with sport?

This was used successfully to set the scene for the target audience of 11 to 14-year-olds. It identified their interest in science and sport from the outset and posed the ethical questions 'Is using science to enhance the performance of those who participate in competitive sport cheating?', 'Do well-developed countries have an advantage over others who are less scientifically advanced in world competitions like the Olympics?' and 'Can science/engineering make it possible for

disabled people to successfully take part in sporting competitions?'. This introduction posed the questions participants would consider.

Workshop 2 – Enabling the unseen to be seen: data logging

This workshop contributed effectively to demonstrate the link between science and sport. Data loggers were used (learners would have seen these in school laboratories) to measure heart beat, reaction time, etc. A number of investigations directly related to specific sports, including golf and javelin, were used to highlight the context.

Workshop 3 – Drugs in Sport

This workshop was led by local rugby stars from the Newport Dragons. It was very effective in making clear that the use of drugs is highly dangerous and has consequences. The presenters emphasised that it is the responsibility of the player to ensure they are drug free. The workshop looked at the consequences of being caught using illegal drugs and the increasing reliability of drugs testing due to advances in science and technology. The clear message was 'don't use drugs'.

Workshop 4 – Training the mind and working as a team: sports psychology and communication

This was a stimulating workshop that delved into the current mindset behind using psychology. It got its message over by using two sportsmen from boxing and rugby. Learners also learned how effective different means of communication can be in team sports. The video makes the link between science and sport by using the participatory game to work out reaction speed and the influence that encouragement and team support has on performance.

Workshop 5 – Maximising performance in sport: physiology of sport

This emphasised how a knowledge of anatomy and biology in general can help to maximise performance as well as keeping people healthy. Ethical issues were raised and discussed. This workshop also enabled learners to meet students who are studying sport science at UWIC Cardiff. It also gave learners an understanding of how disabled athletes are helped to participate in competitive sports.

Workshop 6 – Off-the-water rowing: perfecting a sport on land

This workshop gave participants the opportunity to experience how modern technology can make training for a sport of any kind possible under controlled conditions. It also demonstrated how technology monitors performance and gives information to the sports person in order to enhance performance.

Workshop 7 – Measurements in sport

It showed how technology can make training very efficient for athletes of all kinds. It also focused on the different kinds of measurements used in sport and how sensors have enabled accurate timings to differentiate between first and second place when that is only a few hundredths of a second.

The workshops also targeted the potential career opportunities in sport science from drugs testing to manufacturing of modern sports equipment.

Case study 8

Discover! Saturday Clubs bring science alive for girls

Year 9 girls from schools across Bridgend have been spending their Saturday mornings learning about everything from cancer cell experiments to manufacturing insulation as part of a bid to encourage more girls to take up science-based careers.

Organised by Careers Wales Mid Glamorgan and Powys and Mid Glamorgan Education Business Partnership, the Discover! Saturday Clubs were attended by 22 girls from schools throughout Bridgend.

Held over a course of five weeks, each Discover! Saturday Club addressed a different aspect of scientific or engineering careers, including a day spent with Cardiff University scientists looking at experiments for cancer diagnosis, a behind-the-scenes tour at major manufacturing employer Rockwool in Bridgend, time in the Planetarium at the University of Glamorgan and a visit to the treatment site at Welsh Water.

Each girl was then presented with a certificate for completing the Saturday Club course. The girls were very positive about the initiative.

This course has made me change my attitude to science and think again about the subjects I choose to study at GCSE.

The Discover! Saturday Club has made me think about all the different career opportunities in science.

All the workshops were practical and hands-on. Local employers have supported the scheme and have been excellent role models for the girls involved.

Dr Vicki Stevenson, Chair of Women into Science Engineering and Construction (WISE) Wales said:

I'm really pleased to see Discover! launch in Mid Glamorgan. It's a really great opportunity for girls to explore technical careers. They also get the chance to meet some fantastic role models.

More information is available through the following links on the Careers Wales website.

www.careerswales.com/employers/server.php?show=nav.5610

www.careerswales.com/prof/server.php?show=nav.7497&outputLang

<http://annualreport.careerswales.com/ebp3.html>

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Links to useful contacts and resources

Many of the contacts and resources contained in this section are English-only but some are available bilingually.



Contact

www.ase.org.uk

See also a free website provided by the ASE
www.schoolscience.org.uk

Who are they?

The Association for Science Education (ASE) is a dynamic community of teachers, technicians, and other professionals supporting science education. The ASE is an independent and open forum for debate and a powerful force to promote excellence in science learning and teaching.

How can they help?

Membership is by annual subscription. It provides members and non-members with:

- up-to-date resources for science teaching
- publications
- local teacher networks across Wales that meet regularly
- organised visits for teachers to industry and science centres
- annual conferences to update teachers and provide inspiring continuing professional development (CPD).



Contact

www.bloodhoundssc.com

Who are they?

The BLOODHOUND SSC (Super Sonic Car) Project is an attempt at the world land speed record. However, it also aims to inspire the next generation of scientists and engineers. BLOODHOUND is unique in the world of advanced engineering in that all the research, design, build and testing of the car will be shared with schools and colleges throughout the UK.

How can they help?

- To join the BLOODHOUND Education Programme, you first need to register your school, college, family or youth organisation. This will then enable you to download ideas to get you started.
- They will send you two free posters and a flyer, and be in touch with you as soon as they can and help you get the best experience out of BLOODHOUND SSC.
- Resources include interactive demonstrations, suggested projects, links to STEM Ambassadors, careers, as well as facts about the car linked to physics, mathematics and engineering.

BLOODHOUND SSC has posted a series of short video clips, including interviews with design engineers at

www.bloodhoundssc.com/education/video_interviews_with_design_team.cfm



Contact

www.britishtscienceassociation.org/crest-awards

Who are they?

CREST (CREativity in Science and Technology) is organised by the British Science Association and is Britain's largest national award scheme for project work in STEM subjects (science, technology, engineering and mathematics). It brings STEM to life by offering young people opportunities to explore real-world projects in an exciting and innovative way.

How can they help?

- The Welsh Government is encouraging participation by subsidising the cost of these awards for learners in schools and colleges in Wales. For more information contact See Science (www.see-science.co.uk).
- CREST Awards schemes are available for 11 to 19-year-olds.
- CREST Star Investigators is available for 5 to 11-year-olds.



Contact

www.careerswales.com

Available bilingually.

Who are they?

Careers Wales provides free, bilingual, impartial careers information, advice and guidance for all ages – linking education and business.

How can they help?

Explanations and guidance including:

- Year 10 and post-16 curriculum options, including local curriculum options
- courses available in Wales
- careers choices and information
- Learning Pathways 14–19
- apprenticeships
- professional development opportunities for teachers



Centre for Alternative Technology
Canolfan y Dechnoleg Amgen

Contact

<http://learning.cat.org.uk/en/resources>

Who are they?

A National Science Academy of Wales Hub. Their aim is to put energy, the environment and sustainability into context which will open doors for STEM learners.

How can they help?

- Day and residential visits with a range of practical and theoretical activities for both teachers and learners, particularly for those who may not respond well to traditional classroom methods.
- It has a wealth of resources to support STEM subjects with a solutions-focused perspective on climate change, global poverty, finite resources and biodiversity loss.
- Energy and sustainability topics are a key feature of all their resources.
- Key Stages 2 and 3 eco-footprint teaching resource – a series of free interactive downloadable cross-curricular resource materials.
www.footprintfutures.org.uk



Contact

www.classroommedics.co.uk

Who are they?

A team of recent graduates or students who are studying for a degree or higher in health, medical, sports or science subjects. They are all CRB-checked, trained in first aid and enrolled as STEM Ambassadors.

How can they help?

Workshops – examples include putting real medical and sports science equipment into the hands of learners so they can experience using the kit seen in hospitals, surgeries and on TV. Some of the most popular activities include:

- using a real needle to take fake blood from Andy the injection arm
- recording an ECG from their heart and calculating the angle of their heart in their chest
- measuring lung function, volume and lung age with a spirometer
- watching videos on different health career paths
- using the Career Finder app on the tablet computers.

COMPUTING AT SCHOOL

EDUCATE · ENGAGE · ENCOURAGE

In collaboration with BCS, The Chartered Institute for IT

Contact

www.computingatschool.org.uk

Who are they?

The Computing at School Working Group (CAS) is a grass-roots organisation that aims to promote the teaching of computing in schools. CAS is a collaborative partner with the BCS (The Chartered Institute for IT) through the BCS Academy of Computing, and has formal support from other industry partners.

How can they help?

Membership is by registration but is free. CAS seeks to work at many levels, including:

- directly supporting ICT and teachers of computing by providing them with teaching material, training, local hubs, newsletters and the opportunity to meet with like-minded colleagues
- acting as a subject association for teachers of computing
- working at an institutional level, e.g. by encouraging the developments of GCSEs in Computing
- advocacy at national policy level, e.g. submitting evidence to the Royal Society study on Computing in School.



Contact

www.darwincentre.com

www.darwincentre.com/schools

Who are they?

The Darwin Centre was established to excite young people about science, particularly at the cutting edge, and provide a vehicle for professional scientists and naturalists to engage with the public. Since moving to Pembrokeshire, a major objective has been to contribute to the educational and ecological programmes in west Wales and Wales as a whole.

How can they help?

The Darwin Centre provides educational programmes for schools that link with the national curriculum in Wales, including:

- roadshows with hands-on science taken into schools
- primary projects on life in rock pools, climate change, marine litter
- investigative science projects leading to CREST Awards
- post-16 lectures.



Contact

www.data.org.uk

Who are they?

The Design and Technology Association aims to inspire, develop and support excellence in design and technology education for all.

How can they help?

The Design and Technology Association provides:

- up-to-date teaching resources (4–19) to support design and technology to prepare learners to participate in tomorrow's rapidly changing technologies, by learning to think creatively
- resources to support curriculum, cross-curricular and STEM projects
- publications
- annual conferences to update teachers and provide inspiring CPD
- advice on health and safety issues.



Contact

www.engineeringuk.com

Who are they?

Engineering UK is an independent, not-for-profit organisation whose purpose is to promote the vital contribution that engineers, engineering and technology make to our society and economy, and inspire people at all levels to pursue careers in engineering and technology.

How can they help?

The Big Bang: UK Young Scientists & Engineers Fair is a free event that is a great opportunity for children to experience science, technology, engineering and mathematics up close in a fresh new way.

www.engineeringuk.com/viewitem.cfm?cit_id=382711

Tomorrow's Engineers provides information and resources about the amazing number of careers available in engineering. It also runs a schools programme to help inspire the next generation of engineers. The programme is made up of a number of initiatives, such as industry visits, workshops, STEM Ambassador partnerships and careers resources.

www.engineeringuk.com/tomorrows_engineers/index.cfm



Contact

Fascinating maths – Professor Chris Budd
<http://people.bath.ac.uk/mascjb>

Who are they?

Chris Budd is Professor of Applied Mathematics at the University of Bath and Professor of Mathematics at the Royal Institution of Great Britain.

How can they help?

The website contains a wealth of resources for workshops, for example:

- Key Stage 3: Mathematics, magic and mystery
- Key Stage 3: How to amaze your friends
- Key Stage 3: Mathematics of castles
- Key Stage 4: How mathematics can help in the fight against crime.



Contact

www.forestry.gov.uk

STEM outdoor education in Wales

www.forestry.gov.uk/forestry/INFD-8KER42
Available bilingually.

Who are they?

Forestry Commission Wales acts as the Welsh Government's Department of Forestry. They are responsible for managing the 38 per cent of Welsh woodlands owned by the Welsh Government. They advise on the development of forestry policy and its implementation. They also encourage sustainable woodland management within the private sector.

How can they help?

This is a helpful bilingual document to get you started, with tips and case studies available in PDF format. *Woodlands for Learning and the Learning Country: Education Strategy for Wales* is available to download at [www.forestry.gov.uk/pdf/woodlandslearning.pdf/\\$FILE/woodlandslearning.pdf](http://www.forestry.gov.uk/pdf/woodlandslearning.pdf/$FILE/woodlandslearning.pdf)

Woodlands provide a stimulating outdoor learning environment. The Woodlands for Learning Team work directly with groups throughout Wales, offering:

- curriculum-linked visits in local woodlands
- training sessions to help teachers, group leaders and others use their local woodlands for learning
- support for the development and delivery of [Forest School](#) and co-ordination of the [Forest Education Initiative \(FEI\)](#) cluster groups across Wales.

Whatever age and ability you work with, from Foundation Phase to 19-year-olds, education officers can help you.



Contact

www.ice.org.uk/Education

ICE in Wales

www.ice.org.uk/nearyou/UK-Regions/Wales

Who are they?

The Institution of Civil Engineers (ICE) is a registered charity that strives to promote and progress civil engineering. They believe that civil engineers are 'at the heart of society, delivering sustainable development through knowledge, skills and professional expertise'.

They are a qualifying body, a centre for the exchange of specialist knowledge, and a provider of resources to encourage innovation and excellence in the profession worldwide.

How can they help?

ICE Wales Cymru supports activities designed to attract young people into the civil engineering profession, including:

- Bridge to Schools – miniature versions of the Second Severn Crossing for younger school children to assemble at school

www.ice.org.uk/nearyou/UK-Regions/Wales/Education/Bridge-to-Schools

- Education Team Challenge – competitions for teams of secondary school learners
www.ice.org.uk/nearyou/UK-Regions/Wales/Education/Education-Team-Challenge

They also provide QUEST sponsorship and scholarships for prospective civil engineers.



Contact

www.theiet.org

Who are they?

Founded 140 years ago, the Institution of Engineering and Technology (IET) is one of the world's leading professional societies for the engineering and technology community.

As part of its charitable remit, the IET encourages the study of engineering and technology and through its many education links aims to enthuse young people about science, technology and engineering.

How can they help?

In the UK, the IET publishes *Flipside*, a teen science, engineering and technology magazine, the only one of its type available for teenagers.

<http://flipside.theiet.org>

The IET Faraday interactive website is an award-winning educational resource, with many inspiring STEM projects such as robotic surgery.

<http://faraday.theiet.org>

IOP Institute of Physics

Contact

www.iop.org/education/index.html

Who are they?

The Institute of Physics (IOP) is a place where any physicist or person interested in physics can go to find something to interest and amaze them, and to form positive connections with others who share their fascination.

How can they help?

The IOP provides:

- up-to-date resources for STEM teaching
- comprehensive publications
- local teacher networks across Wales that meet regularly
- annual conferences, both national and local, to update teachers and provide inspiring CPD.

The website is tailored for both learners and teachers and provides a wealth of tried and tested resources.

For learners:

www.iop.org/tailored/students

For teachers:

www.iop.org/tailored/teachers

Regional networks:

www.iop.org/education/teacher/support/network/wales/index.html



Contact

www.livingandlearningwithwater.com

Who are they?

Living and Learning with Water is a STEM-based utility company located in Wales.

How can they help?

Free resources:

A range of comprehensive resources including investigative work, posters, video clips and worksheets are available to view online or download from Welsh Water's website at www.livingandlearningwithwater.com or can be ordered by telephone on 01443 492720.

A useful summary document can be accessed from [Dŵr Cymru](#).

Education centres:

Welsh Water education centres are located across Wales in four regional centres:

- Alwen in North Wales
- Elan Valley in Mid Wales
- Cilfynydd in South Wales
- Cog Moors near Cardiff.

Find out more about the education centres and how and when you can visit them at

www.livingandlearningwithwater.com/english/education-centres.html



Contact

www.mathscareers.org.uk

Mathematics Careers in Wales

www.mathscareers.org.uk/cymru.cfm

Who are they?

This website provides STEM information and resources linked to mathematics for 11–19 learners and teachers who are working in secondary schools and colleges.

How can they help?

This site gives a great deal more than its name suggests. It makes a real connection with mathematics in STEM. The website:

- has a large number of resources for the 11–19 curriculum
- clearly links topics to mathematics
- provides project work in various categories including ages and topics such as environment, health and society, engineering, etc.
- provides links to STEM Ambassadors to support the work done in schools
- provides links to careers in mathematics and STEM.

Register free for a link to cre8ate maths for further resources at www.cre8atemaths.org.uk



Contact

www.mathsinspiration.com

Who are they?

Maths Inspiration is one of the largest mathematics enrichment programmes for 15 to 17-year-olds in the UK.

How can they help?

It's a chance for Years 11–13 to experience the UK's most inspiring mathematics speakers live, in big venues, presenting mathematics in the context of exciting, real-world situations.

To find a venue near you, see the website events tab or www.mathsinspiration.com/jsp/index.jsp?lnk=200



Contact

www.mei.org.uk/index.php

Who are they?

Mathematics in Education and Industry (MEI) is a membership organisation and a charity that has worked to support mathematics teaching and learning since the 1960s. MEI emphasises understanding and enjoyment of mathematics and also highlights the importance of mathematics in industry and commerce. Any income generated through MEI's work is used to support mathematics education.

How can they help?

- Provide advice and support for teachers of GCSE, AS/A level Mathematics and Further Mathematics.
- Offer local support for teachers through network of MEI branches.
- Offer a range of CPD courses for teachers of all GCSE and A level specifications.
- Pioneer the development of innovative teaching and learning resources.
- Develop extensive online materials to support all major examination syllabuses.
- Responsible for the curriculum of the OCR (MEI) A level specification.
- Provide specialist tuition for learners.
- Work with industry to enhance mathematical skills in the workplace.



Contact

www.gardenofwales.org.uk

Available bilingually.

Who are they?

The National Botanic Garden of Wales opened in May 2000 – the first national botanic garden to be created in the new millennium. They are a charity that receives financial support from the Welsh Government. They are also a National Science Academy of Wales Hub.

How can they help?

The National Botanic Garden of Wales is a great place to learn. They have:

- great indoor and outdoor learning spaces
- more than 45 different curriculum-linked programmes for schools and colleges specialising in plant science, outdoor learning and sustainable technologies
- a friendly team of teachers, course leaders and skilled professionals.

They also run a wide variety of curriculum-linked programmes and courses for schools and colleges as well as a vast range of lifelong-learning opportunities and activities for all ages and abilities.



Contact

www.ncetm.org.uk

Who are they?

The National Centre for Excellence in the Teaching of Mathematics (NCETM) provides and signposts high-quality resources to teachers, mathematics education networks, higher education institutions and CPD providers.

How can they help?

The NCETM encourages schools and colleges to learn from their own best practice through collaboration among staff and by sharing good practice locally, regionally and nationally. They provide:

- online CPD for teachers that is free but requires registration
- mathematics resources for 3 to 19-year-olds.



Contact

www.nationalstemcentre.org.uk

Available bilingually.

Who are they?

The National STEM Centre supports the teaching of STEM subjects through provision of information, resources and guidance for schools and colleges.

How can they help?

- The National STEM Centre houses the UK's largest accessible library of STEM teaching resources, including print, multimedia and practical resources for the 5–19 age group.
- Thousands of resources are also available online through the National STEM Centre's elibrary at www.nationalstemcentre.org.uk/elibrary
- Guidance to support development of a STEM ethos is provided through case studies showcasing practice in a range of schools and colleges, and online STEM planning tools.

NGfL CYMRU GCaD

Contact

www.ngfl-cymru.org.uk

Available bilingually.

Who are they?

The National Grid for Learning Cymru (NGfL Cymru) is managed by the Welsh Joint Education Committee (WJEC) on behalf of the Welsh Government. It consists of high-quality downloadable educational resources that support all key stages of the curriculum, from Early Years to Post-16. Many of the resources are interactive, and all have been produced by practising teachers. It has a specific remit to provide schools and colleges in Wales with easy, free access to high-quality curriculum content in a range of digital formats, to support teaching in the Welsh language and to promote the Welsh dimension in teaching and learning.

How can they help?

NGfL Cymru offers a collection of bilingual resources from 3–19.

Foundation Phase (3–7)

- Creative Development, Knowledge and Understanding of the World, Mathematical Development.
- Cross-curricular themes.

Key Stages 2 and 3 (7–14)

- Design and technology, science, education for sustainable development and global citizenship (ESDGC), mathematics, ICT and themed approaches to delivering STEM across the curriculum.

Key Stage 4 (14–16)

- Science, applied science, design and technology, mathematics, ICT, engineering (vocational).

Post-16 (16–19)

- Biology, physics, chemistry, applied science, design and technology, ICT, engineering.



Contact

<http://nrich.maths.org/stemrich>

For links to specific resources on science, mathematics and health go to <http://maths.org/MathsHealth>

Who are they?

NRICH is a team of qualified teachers who are also practitioners in rich mathematical thinking. This unique blend means that NRICH is ideally placed to offer advice and support to both teachers and learners of mathematics.

They can offer informed guidance and practical advice and help in the implementation of the national curriculum.

How can they help?

NRICH aims to:

- enrich the experience of the mathematics curriculum for all learners
- offer challenging and engaging activities
- develop mathematical thinking and problem-solving skills
- show rich mathematics in meaningful contexts
- work in partnership with teachers, schools and other educational settings.

NRICH provides free, stimulating and relevant resources exploring the links between mathematics and other STEM subjects across all the key stages.

For teachers of mathematics, they:

- offer free enrichment material (Problems, Articles and Games) at all key stages that really can help to inspire and engage learners and embed rich tasks into everyday practice
- help to promote rich thinking in classrooms by offering online and face-to-face support at primary and secondary level
- deliver professional development courses and workshops in rich mathematics
- help teachers to think strategically about 'next steps' and progression in problem solving.



Contact

Main website

www.nuffieldfoundation.org/teachers

11–14 cross-curricular project

www.nuffieldfoundation.org/stem/nuffield-stem-futures

Who are they?

The Nuffield Foundation aims to influence education policy and practice, ensuring all young people develop the skills and understanding required to play an informed role in society. They also support the development and progression of young scientists and social scientists. The current focus is on foundations for learning; secondary education transitions, science and mathematics education, and women's education.

How can they help?

Examples of links include the following.

Primary:

- Primary science and SPACE research reports
- Nuffield design and technology

Secondary:

- Applying mathematical processes
- Free-Standing Mathematics Qualifications (FSMQ) and use of STEM 11–14
- Twenty-first century science
- Salters-Nuffield advanced biology
- Science in society

- Practical physics
- Practical chemistry
- Practical biology
- Applied science
- Teaching about science
- Teaching bioethics

Nuffield design and technology

www.nuffieldfoundation.org/nuffield-design-technology

Nuffield bursaries

www.nuffieldfoundation.org/science-bursaries-schools-and-colleges-0

In Wales – for further information contact Techniquest via their website at www.techniquest.org



Contact

<http://plus.maths.org/content/>

Who are they?

Plus magazine (online) opens a door to the world of mathematics, with all its applications. It provides [articles](#) from the top mathematicians and science writers on topics as diverse as art, medicine, cosmology and sport. *Plus* is part of the [Millennium Mathematics Project](#) at the University of Cambridge.

How can they help?

- Provide interesting enrichment activities and up-to-date information.
- The [latest mathematical news](#) on the site every week.
- Browse the [blog](#) and listen to the [podcasts](#).
- Keep up-to-date by [subscribing](#) to *Plus* (e-mail, RSS, Facebook, iTunes or Twitter).
- Highlight opportunities for careers in mathematics.
- Provide a large number of intriguing puzzles.
- Mathematics book and game reviews.



Contact

www.raeng.org.uk/education

Who are they?

The Royal Academy of Engineering works with partners to ensure that more young people study science, technology, engineering and mathematics (STEM) subjects in schools, further education colleges and universities, where they enrich outcomes by bringing real-world engineering practice into the learner experience. In particular it is encouraging young women and people from a wider range of backgrounds, to work as engineering technicians, graduate engineers and engineering researchers.

How can they help?

The Royal Academy of Engineering's education activities are organised into four strands:

- education schemes for professional development
- 5–19 education
- FE and HE
- education policy.

Contact

www.rsc.org

Who are they?

The Royal Society for Chemistry (RSC) promotes and develops the chemical sciences for the benefit of society.

How can they help?

- Free resources for teachers and learners.
- CPD and conferences for teachers (www.rsc.org/education).
- Learn Chemistry – an innovative new platform with stimulating and interactive resources accessed via a custom-built search engine. Teachers and learners can explore core topics and relate content to real life at www.rsc.org/learn-chemistry

ChemNet provides 16 to 18-year-olds with:

- help with studies
- up-to-date chemistry
- discussion groups
- chemistry beyond school – information on careers in chemistry.
www.rsc.org/chemnet

Contact

www.schoolscience.org.uk

Who are they?

The Association for Science Education brings you a free website to enrich teaching and learning in science.

Schoolscience.co.uk is sponsored by industrial and research partners who provide free online science resources for teachers and learners.

How can they help?

The website is free for all users and aims to provide a comprehensive directory of resources, information and contacts for teachers and learners of science in schools everywhere. It contains free resources for teachers and learners from age 4 to 19.

- The resources are tagged and include biology, chemistry, earth science, engineering, mathematics and physics.
- There are a variety of links to competitions, for example Salters Festival of Chemistry, as well as other useful websites.



Contact

www.sciencemadesimple.co.uk

Who are they?

Based at Cardiff University, Science Made Simple is a leading science communication company that aims to inspire the next generation of scientists and engineers.

How can they help?

Science Made Simple provides a range of shows for primary and secondary schools, including:

- science, engineering and mathematics shows for schools, festivals and special events
- presenter training
- consultancy
- custom-made shows
- science busking for any event
- science busking training for anyone from a learner to an academic
- MadLab electronics workshops for schools, festivals and special events.



Contact

www.societyofbiology.org/education

Who are they?

The future of biology lies with those currently at school, college or university. Therefore ensuring biology education is 'fit for purpose' is a paramount aim of the Society of Biology. They support members working at all levels of education by producing education policy statements, responding to consultations and contributing to curriculum development. Through a partnership with other leading science organisations they aim to increase their influence over the direction of biology education in future years.

How can they help?

The Society of Biology supports teachers working to enthuse the biologists of tomorrow by providing a number of leading resources.

Practical Biology

Biology is a practical science – good-quality biology experiments are the key to enhanced learning.

www.practicalbiology.org

Biological Nomenclature

This unique publication ensures common usage of biological terms and expressions for both biology teachers and awarding organisations.

Becoming a Biologist: degrees and careers in biology

www.societyofbiology.org/education/careers/careersresources



Contact

www.stemcymru.org.uk

Available bilingually.

Who are they?

STEM Cymru are providers of support, STEM challenges and project work for schools and colleges.

How can they help?

Engineering Education Scheme Wales (EESW) – for Year 12 learners.

The F1 Challenge – involves learners of all ages in the secondary schools of Wales.

Headstart Cymru – provides an opportunity for learners in Year 12 to spend three days at university prior to making their UCAS application.

Girls into Engineering – a committed programme of events aimed at encouraging girls to take an interest in STEM subjects so that they consider careers in related areas, particularly engineering; these activities are aimed at 12 to 16-year-old learners.

BLOODHOUND Challenge – involves learners designing, making and racing a model BLOODHOUND car. Teachers will be given training in the use of free software for designing the car. Once the drawings are finished they can be e-mailed to a manufacturing centre where the cars are made.

Year in industry – a leading national provider of UK-based work placements who provide paid, degree-relevant placements for learners in the year out or during their degree course.



Contact

www.stemnet.org.uk/regions/1527

STEMNET Consultancy in Wales: See Science www.see-science.co.uk

Who are they?

STEMNET is an independent charitable UK organisation that aims to inspire young people in STEM. STEMNET manages the School STEM Advisory Network and the STEM Ambassadors Programme. STEMNET has received funding from the Welsh Government through the National Science Academy to extend the STEM Clubs Network to schools in Wales.

How can they help?

STEMNET offers free, impartial and tailored advice to every secondary school in Wales, on opportunities to enrich and enhance the STEM curriculum, including the STEM Ambassadors Programme. More than 1,000 STEM Ambassadors from almost 150 employers in Wales volunteer as inspiring role models for young people. Through its programmes, STEMNET helps schools and employers to develop effective and mutually beneficial links.

TECHNIQUEST

Contact

www.techniquest.org

Who are they?

Techniquest is an interactive science discovery centre based in Cardiff that provides services across the whole of Wales. It is a National Science Academy Regional Hub.

How can they help?

- Techniquest provides exhibits that are learner-centred and ideal for developing investigative work.
- Schools' programme for whole groups in the science theatre, planetarium and laboratory.
- Techniquest can come to you – Techniquest can run programmes at your school from Foundation Phase to Post-16, with pre- and post-visit resource materials for teachers. Further information is available at www.techniquest.org/2012030113/education/education-programmes.html
- Mathcymru – free Wales-wide mathematics activities for schools. Further information is available at www.techniquest.org/mathcymru
- Nuffield Science Bursary Scheme. Further information is available at www.techniquest.org/2012030113/education/education-programmes.html
- Techniquest runs CPD courses in STEM subjects across Wales through funding provided by the National Science Learning Centre. Further information is available at www.techniquest.org/20120315121/education/continuing-professional-development.html



Contact

www.tqg.org.uk

Who are they?

Techniquest Glyndŵr is an interactive science discovery centre based in Wrexham. It is a National Science Academy Hub. Further information on this can be found at www.tqg.org.uk/learning/nsa

How can they help?

- An exhibition floor with hands-on exhibits to challenge and absorb visitors.
- Learning programmes, presentations and workshops for whole groups including science, mathematics and engineering (3–19) – delivered at the centre and through schools outreach.
- Lego Education – an innovation studio that provides exciting, creative and fun educational activities for learners from Foundation Phase to Post-16.
- Competitions, e.g. [Flying High](#) (2011–12) and [Bridging the Gap](#) (2012–13) are engineering design competitions funded by the Royal Academy of Engineering's Ingenious Grant.
- Key Stages 2 and 3 mathematics workshops, e.g. *Backstage Maths*.
- Provide links to STEM Ambassadors in North Wales. www.tqg.org.uk/learning/stem



www.wimcs.ac.uk

Contact

www.wimcs.ac.uk

www.wimcs.ac.uk/schools.html

Available bilingually.

Who are they?

Wales Institute of Mathematical and Computational Sciences (WIMCS) was set up by the Welsh Government through the Higher Education Funding Council for Wales (HEFCW). It aims to enhance the standing of mathematics and computation in Wales; to foster links with industry, commerce and business; to generate substantial research funding; and to provide a forum for education and public awareness of the mathematical sciences. It is a National Science Academy Regional Hub.

It runs masterclasses at Swansea and Swansea Metropolitan Universities, and supports classes at Glamorgan and Bangor Universities. It also promotes, with Science Made Simple, two school roadshows – ‘mathsapps’ that focuses on careers open to those who study mathematics aimed at Years 8 and 9 and ‘I’ve got your number’ for Key Stage 4 learners on the use and abuse of statistics in everyday life.

How can they help?

They provide online access to resources to support further mathematics in schools which are available at www.furthermaths.org.uk

Schools and colleges can submit an online request to register with the Further Mathematics Support Programme. It is free to do so and there are many benefits, e.g. live online CPD for teachers, and lectures and conferences to develop and support mathematics teaching.



WISE

Contact

www.theukrc.org/get-involved/wise

WISE in Wales

www.theukrc.org/get-involved/wise/wise-in-wales

Who are they?

WISE – Women into Science, Engineering and Construction – works with industry and education to inspire girls and attract them into science, technology, engineering and mathematics (STEM) studies and careers.

How can they help?

The WISE Campaign has developed a range of resources to inspire and inform girls and young women, and their teachers, parents/carers and other advisers. They have experience of working with employers to help them set up successful outreach days and work experience packages, specifically targeted at girls and women. They provide a wealth of expertise in communications, engagement and challenging stereotypes, and work with a wide range of organisations and institutions committed to building gender equality in STEM.

Acknowledgements

The Department for Education and Skills (DfES) would like to thank the many teachers, learners, schools and other organisations who have helped in the development of this guidance.

British Science Association – Wales Branch

Careers Wales

G24i, Cardiff

Monmouth School, Monmouthshire

National Science Academy of Wales

See Science, CREST and STEMNET Consultancy, Cardiff

St Alban's RC High School, Torfaen

STEM Cymru/Engineering Education Scheme Wales (EESW), Bridgend

Techniquist Glyndŵr, Wrexham

Ysgol Friars, Gwynedd

Ysgol Gynradd Carwe C.P. School, Camarthenshire

DfES would also like to thank the large number of STEM organisations who have agreed to the use of their logos in the 'Links to useful contacts and resources' section. Those included are only representative of the range of organisations involved in STEM promotion.