

This briefing provides advice for practitioners and can also be used to inform partners, learners and their parents or carers of developments in Curriculum for Excellence (CfE).

# CfE Briefing <sup>15</sup>

## Sciences for all

Scientific and technological discovery are driving progress and positive change across our global society. They are fuelling innovation that is leading to continual transformation in the way most of us lead our lives. This impacts on our economic, social, physical, mental and emotional wellbeing. CfE Briefing 15: *Sciences for all* explores the pivotal role sciences<sup>1</sup> education has in equipping learners with the skills they need to succeed and flourish in this new world of scientific opportunity, and to further enhance Scotland's reputation as a global science leader. Whilst the briefing focuses on the sciences, many of the themes addressed apply equally to technologies, engineering and mathematics. Together, these are known as the STEM subjects.

<sup>1</sup> The term 'sciences' refers to what learners experience at pre-school, primary, special and secondary schools, in all sciences including Skills for Work courses, biology, chemistry, physics, science, human biology, environmental science, biotechnology and managing environmental resources (MER).

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Scientific, technological and mathematical discovery and invention are an integral part of Scotland's identity, culture and heritage.

## 1. Why are the sciences so important in CfE?

*Science is an important part of our heritage and we use its applications every day in our lives at work, at leisure and in the home. Science and the application of science are central to our economic future and to our health and wellbeing as individuals and as a society. Scotland has a long tradition of scientific discovery, of innovation in the application of scientific discovery, and of the application of science in the protection and enhancement of the natural and built environment.*

### CfE sciences: principles and practice

**Do learners and their parents value sciences education and appreciate the contribution it makes to other areas of learning?**

In a modern and ambitious society like ours, **sciences for all** are vital. Learning in and through the sciences creates opportunities for discovery through which people make sense of, and become passionate about, the environment around them. The sciences develop enquiring minds and nurture learners' natural curiosity, imagination and creativity. At the very earliest stages, children show wonder and awe as they find out about the natural world and living things. As they move through the primary stages, the sciences will help answer their countless questions as they encounter new phenomena and experiences relating to, for example, forces, chemical changes or their senses. Through these stages, learners will

develop a desire to explore further and apply their learning in different ways. They will learn to analyse, evaluate and think critically. And as they progress, they will value their learning in the sciences because they can see how it is equipping them with the skills they will need to thrive and succeed in an increasingly globalised and technological society.

All of these learning contexts flow from the **experiences and outcomes** (EOs) of CfE. The **attributes, capabilities** and **skills** developed through the sciences are also important to the future lives, learning and work of our children and young people. For example, **attributes** such as having 'openness to new thinking and ideas', or being able to 'assess risk and take informed decisions' can be nurtured through study of the sciences. Also, our ability to 'evaluate environmental, scientific and technological issues', and to 'use and understand scientific language, concepts and processes' enables us to become **scientifically-literate** as a population. This enriches our wider society as it enables us to engage in dialogue and debate about complex ethical, scientific, technological, political and environmental issues. The trialling of genetically modified crops, the ethics of cloning, or the use of fracking techniques to exploit shale gas reserves, for example, provide topical contexts for developing these attributes in learners.

## 2. Where can learning in the sciences lead?

### Careers and the economy –

Scotland offers many exciting and rewarding careers in the sciences and engineering, as do other countries

around the world. The sciences are vital for key economic sectors in Scotland such as energy, the creative industries (including digital), food and drink and life sciences. For instance, physics-based industries alone contribute an estimated £12.5 billion<sup>2</sup> and 184,000 jobs to the Scottish economy and it is estimated that up to 95,000 further jobs will be created in the Scottish energy sector by 2020. It is often thought that these careers are only available to those who have a university degree in a science or engineering-related subject, but many opportunities also exist for modern apprentices and for technician-level roles too.

The skills gained through the sciences can also open doors to careers in many other sectors. For instance, transferable skills such as the ability to solve problems, make accurate predictions and draw valid conclusions can be applied to many contexts. As a result, sciences skills are much valued, as might be illustrated by data that shows eight out of the highest ten starting salaries go to graduates with science-related degrees<sup>3</sup>, for example. The potential of sciences and STEM careers to support economic regeneration and boost positive destinations for learners is significant. Embedding careers awareness within learning and teaching can help raise aspirations and encourage the pursuit of careers in the sciences.

**Do learners and their parents have a clear understanding of the increasingly wide range of career opportunities available in the sciences?**

2 [http://www.iop.org/publications/iop/2012/page\\_58818.html](http://www.iop.org/publications/iop/2012/page_58818.html)

3 <http://www.independent.co.uk/student/career-planning/getting-job/starting-salaries-what-the-future-holds-814362.html>

Science education provides a wonderful opportunity to learn about Scotland and appreciate the rich legacy and impact that great Scottish scientists, past and present, continue to have on the world.

**Citizen science** – The sciences can also play an important and influential part in the lives of those citizens who don't necessarily pursue science-based employment. Across Scotland, many thousands of amateur weather recorders, bird watchers and astronomers, with a passion and enthusiasm for the sciences, volunteer their time to [collect data](#) that they share with the scientific community. In the age of 'do-it-yourself' bio-labs, crowd-sourced research, mobile phone apps and the Internet, the possibilities for engaging a new generation of citizens with an interest in the sciences are bountiful. The professional science community together with citizen scientists have a role to play in finding solutions to the many challenges that we face, such as developing a [cure for cancer](#) or reducing pollution. Practitioners who are using CfE to instil a passion and enthusiasm for the sciences are nurturing learners with the skills, capabilities and attributes that they will require to transform their local, national and global communities.

*What opportunities exist for learners and parents to contribute to their communities as citizen scientists?*

### 3. So how are we doing?

Scotland enjoys the benefits of a widespread and diverse professional sciences education community that shares a common purpose. This common purpose is converging around the need to ensure that learning and teaching in the sciences is so strong that children and young people will be inspired to pursue science-related careers or develop a life-long engagement with the sciences.

A unique benefit of this widespread professional community is the range of perspectives that it has on existing

practice and on ideas for improvement, based on robust evidence. For example, [Education Scotland's Sciences 3-18 Curriculum Impact Report](#) highlights much strength in sciences provision. It states that, overall, learning and teaching in the sciences is strong, effective and improving, and promotes a positive attitude to the sciences amongst learners. It recognises that secondary school staff have strong subject expertise and are enthusiastic about their subject, and that staff in all sectors are becoming more confident in delivering the CfE EOs using more active learning approaches. [Outdoor learning](#) is also emerging as a strong approach to learning in the sciences and, at the senior phase, the sciences continue to be popular subject choices with most young people achieving well.

The report cites much excellent practice in [early years](#), [primary](#) and [special schools](#) and identifies areas where further work is needed to improve sciences education, not least in building [confidence amongst staff](#). In primary schools, learning in the sciences is often taught through an interdisciplinary approach. Whilst this has many benefits, sometimes it is not planned carefully enough to ensure

proper progression in sciences skills and may leave gaps in knowledge and understanding. The report notes the importance of collaborative professional learning to help build the capacity of teachers. [Education authorities](#) have a key role to play in providing support for this.

Complementary and important perspectives have come from the Scottish Government commissioned [Science and Engineering Education Advisory Group](#) (SEEAG) which outlined a number of recommendations for improving sciences education in its report. These included a call for enhanced links between schools, universities, colleges and industry to ensure sciences education is relevant and [hands-on](#). The importance of high-quality initial teacher education was also emphasised – a view which is echoed in the Teaching Scotland's Future report and by the [Royal Society](#). In addition, the SEEAG report calls for Education Scotland's [STEM Central](#) website to be further developed and, in agreement with reports from [Universities Scotland](#) and the [Targeted Initiative on Science and Mathematics Education](#), calls for more flexible pathways for learners into further and higher education.

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In a society that values its economic, social, physical, mental and emotional wellbeing, **sciences for all** are vital.

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#### 4. What do we need to do now to realise the potential of CfE?

Since the publication of the above reports and recommendations, Education Scotland has been working closely with partners in the science community, such as [STEMEC](#), [SSERC](#), and the Deans of Science and Engineering at Scotland's Universities to take forward the shared aim to improve learning and teaching through CfE. These partnerships have involved activities with children and young people, practitioners, parents, education authorities, and the academic and policy-making communities to determine key priorities. The following reflective questions are intended to highlight the way forward as we continue to embed CfE.

- Working within **school clusters**, how well does collaborative planning ensure continuity and progression in learning across transitions, both from stage to stage and school to school? Does this collaboration ensure [progression in skills, knowledge and understanding](#) to avoid learners experiencing a 'fresh start' when they move to secondary school?
- Are we confident that **higher-order thinking skills** and [practical scientific inquiry and investigation](#) (through observing and exploring, classifying, fair testing and finding an association) are firmly embedded and developed appropriately at every stage?
- To what extent does the [Sciences Principles and Practice \(2009\)](#)

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paper guide learning and teaching for every learner, and how well is the [Sciences: Concept development in the sciences \(2009\)](#) guidance used to bring depth to learning?

- Is [interdisciplinary learning](#) used to develop coherence in learning, to reinforce concepts and skills in different contexts, and to ensure strong progression in learning? Are the sciences delivered predominantly through practical and experiential approaches, and in topical and relevant contexts? Is there a suitable balance of discrete learning and interdisciplinary learning?
- Are the sciences making a full contribution to learners' entitlement to a broad general education? How well does

learning through the broad general education ensure learners have a realistic choice of qualifications at the senior phase, including choice for those who wish to study for two or more science qualifications? Do learners and their parents understand the flexibility they have through the senior phase to do this? Is sufficient specialisation and time provided at fourth level to allow for progression into the senior phase?

- To what extent does **partnership working** with a wide range of science providers, including industry and further and higher education, enhance learning and teaching? Does this involve parents and carers as [key partners in learning](#) and recognise their influence on choices made?
- Are all aspects of sciences education fully engaging, inclusive and meaningful for all learners, including for both genders, for those potentially affected by disadvantage, and for those needing additional support?
- How well do teachers [Assess Progress and Achievement in the Sciences?](#) Are learners being given high-quality feedback to inform their next steps in learning?
- Do staff have access to a wide range of opportunities for professional learning?
- How effectively are learning technologies and GLOW being used to promote learning in the sciences?

