Developing a Scottish STEM Evidence Base: Final Report for Skills Development Scotland

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Report completed/submitted by:	Richard Weaver, Jeremy Hanks, Susan Staiano
Proof check completed by:	Rachel Gibbs
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Report reviewed by:	Kirsten Hedland, Susan Staiano
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1 Introduction

1.1 This report presents a key part of the evidence base which underpins the Scottish STEM Strategy for Education and Training. The evidence base sets out the demand for and supply of STEM skills in Scotland, covering the scale and nature of the STEM workforce across occupations and industries in Scotland and the education and skills pipeline across all types of provision (schools, college, university, and work and community based learning). The report also considered the drivers of change and challenges for STEM and issues arising in the STEM skills pipeline. This informed an initial assessment of key priorities for the emerging STEM Strategy, additional research required in future, and potential KPIs to measure progress on STEM skills.

Study approach

1.2 The study ran from May 2017 to early August 2017 and included extensive desk based research, analysis and consultation with stakeholders. The approach involved the following four strands of activity:

- **Literature Review:** The study began with an extensive review of the existing literature on current and future forecasts for STEM supply and demand, and challenges faced in the STEM labour market and pipeline.
- **Scoping Calls:** Scoping calls were held with partners to discuss and agree a definition of STEM, particularly in relation to the employment industries, occupations, educational subjects and qualifications that should be included. From this scoping exercise a definition paper was produced to outline the agreed definitions.
- **Baseline Report:** Data gathered from public sources and through data requests was used to produce a baseline report which set out the scale and nature of the STEM workforce and education and skills pipeline in Scotland. Data requests were sent to Office for National Statistics (ONS) for industry and occupation data, Scottish Government for schools and universities data, Scottish Funding Council for college data, and Skills Development Scotland for apprenticeship data.
- **Consultations and Focus Groups:** Following the baseline report consultations and focus groups were held with key stakeholders, employers and Industry Leadership Groups. The consultations and focus groups focused on key drivers of change and challenges for STEM; the current and future STEM landscape in terms of supply and demand; routes into STEM; and the gender balance in STEM education and employment.

1.3 The findings from each of the strands above have been combined to produce the evidence base which presents both quantitative data on the current and future STEM labour market and educational supply and a qualitative overview of drivers for change and potential challenges for STEM in Scotland. It is an important piece of work that provides a rigorous evidence base on the current and future landscape for STEM in Scotland, which will be used to inform the Scottish STEM Strategy for Education and Training.

Structure of the report

1.4 The report is structured as follows:

- **Chapter 2** sets out the agreed STEM definition informing this work;

- **Chapter 3** provides an analysis of the STEM workforce by industry in Scotland, giving consideration to geographical patterns of employment, and also by gender and mode of employment (full/part time);
- **Chapter 4** provides a similar analysis of the STEM workforce by occupation in Scotland, considering geography, gender and mode of employment;
- **Chapter 5** gives a review of the key drivers of change and challenges surrounding the demand of STEM skills;
- **Chapter 6** details the skills pipeline for STEM across all levels of education and training, from schools through to HEI provision;
- **Chapter 7** explores some of the wider issues around the STEM skills, education and training supply pipeline; and
- **Chapter 8** provides a summary of the key findings, before highlighting the key priorities that need to be tackled by the emerging STEM Strategy and work aligned to it. It also identifies further research and analysis required to address evidence gaps identified through the production of the report, and presents some initial thoughts on appropriate high level key performance indicators which can be used to track the performance and impact of the Government's STEM strategy for education and training.

2 Establishing a STEM definition

Introduction

2.1 It is widely acknowledged that STEM can be hard to define and this has resulted in different definitions across datasets and research studies. The difficulties reflect the fact that STEM can be conceived as a set of inter-related disciplines and required skills rather than a sector per se. They also reflect the need for multiple definitions for use with different datasets to set out what constitutes STEM from an employment, occupational and skills supply perspective. Therefore, agreeing a definition of STEM education, training, sectors and occupations, requires careful consideration, and a clear rationale.

2.2 This chapter sets out the definitions that have been agreed with the Project's Short Life Working Group and adopted for this study. It also provides an overview of the approach taken to arrive at the definition and the key considerations which have informed its final coverage.

2.3 In scoping out STEM in support of the draft Scottish STEM Education and Training Strategy[1], it establishes the key elements for consideration in arriving at a data definition for STEM. It builds on work that has been undertaken by SDS and relevant partners[2] to begin to develop meaningful definitions of what constitutes STEM from an employment, occupational and skills supply perspective, for data analysis.

Study approach to defining STEM

2.4 The draft STEM Education and Training Strategy provides the following conceptual definition of STEM. It sets out the key features of Science, Technology, Engineering and Mathematics education and training, and the increasing importance of digital skills within STEM disciplines (Figure 2.1). This provides a useful starting point for defining STEM. The next step is to consider STEM in terms of data.

[1] Scottish Government (2017) Science, Technology, Engineering & Mathematics: Consultations on a Strategy for Education and Training

[2] This is set out in the ITQ for this commission: SDS (2017) *ITQ P17-005: Developing a Scottish STEM Evidence Base FINAL*

Figure 2.1: Definition of STEM used in the draft Scottish STEM Strategy

What is STEM?

Science, Technology, Engineering and Mathematics education and training seeks not only to develop expertise and capability in each individual field, but also to develop the ability to work across disciplines and generate new knowledge, ideas and products through inter-disciplinary learning.

- Science enables us to develop our interest in, and understanding of, the living, material and physical world and develop the skills of collaboration, research, critical enquiry and experimentation.
- Technologies cover a range of fields which involve the application of knowledge and skills to extend human capabilities and to help satisfy human needs and wants, operating at the interface of science and society. This covers business, computing science, chemicals, food, textiles, craft, design, engineering, graphics and applied technologies.
- Engineering, a specific branch of the technologies, draws on scientific methods and knowledge to address and solve real-world problems.
- All of STEM is underpinned by Mathematics, which includes numeracy, and equips us with the skills we need to interpret and analyse information, simplify and solve problems, assess risk and make informed decisions.
- Similarly, digital skills play a huge and growing role in society and the economy and enable the other STEM disciplines. Digital skills embrace a spectrum of skills in the use and creation of digital material, from basic digital literacy, through problem solving and computational thinking to the application of more specialist computing science knowledge and skills that are needed in data science, cyber security and coding.

2.5 As noted above, there are different options for defining STEM, dependent on the aspect under consideration, i.e. education, industry, or occupation. In order to address this, we require multiple definitions to use with different datasets. The ITQ provides an initial definition, which is set out in Appendix 2. In order to develop this definition, we reviewed existing research and approaches to defining STEM, giving consideration to how different data can be used, and the associated limitations. This enabled us to add to and refine the components of the initial definition. To test these, we conducted a series of data scoping consultations with key stakeholder organisations (detailed in Appendix 1) to establish the extent of the STEM definition in terms of subjects, industrial sectors, and occupations.

2.6 Taking all of this into account, we arrived at a composite definition based on education subjects at a range of levels, industrial sectors, and occupations, which was agreed with the project's Short Life Working Group. This approach and its outcomes is explored in the following sections.

STEM in existing research

2.7 There is broadly consistent understanding of what STEM industries and skills are. However, the approaches to defining STEM across occupations, industries, and education and training differ. The main issue is that STEM is not a sector in itself; it comprises some sectors that are very clearly STEM-based e.g. Engineering, and some sectors that are not STEM-based but include STEM-related occupations in the workforce, e.g. an accountant working in Financial and Business Services, or a Clinician working in Human Health and Social Work. Further, the degree to which STEM occupations themselves require STEM skills, or STEM qualifications, will necessarily vary. Their inclusion or exclusion in any definition will require a degree of judgement. Consequently, the starting point for defining STEM is typically skills, and education, rather than industry or occupation. This results in a degree of variation in definitions for STEM presented in the wider body of literature.

2.8 For example, a European Commission definition considers that STEM skills are defined as those skills *"expected to be held by people with a tertiary-education level degree in the subjects of science, technology, engineering and maths"* (STEM). These skills include *"numeracy and the ability to generate, understand and analyse empirical data including critical analysis; an understanding of scientific and mathematical principles; the ability to apply a systematic and critical assessment of complex problems with an emphasis on solving them and applying the theoretical knowledge of the subject to practical problems; the ability to communicate scientific issues to stakeholders and others; ingenuity, logical reasoning and practical intelligence"*.[3]

2.9 It is important to note that a number of existing definitions imply that STEM skills only exist at tertiary level. However, the focus of the STEM Strategy for Education and Training is clear in the need to develop STEM skills in primary and secondary school learners from age 3-18, as well as in tertiary education. The ambition is to develop STEM skills in all learners, and for those who want to enter STEM sectors without necessarily going down the university route, or for whom a vocational education route is more suitable.

2.10 An alternative (and narrower) definition, provided by the Centre for Economic Performance at LSE, defines STEM as simply degrees or graduates in Physical science, Mathematical and Computer science and Engineering.[4] A similar qualification-based definition has been used in recent discussion of STEM skills in Australia.[5]

2.11 An initial definition in occupation terms is provided by UKCES, which considers STEM disciplines to incorporate those skills which support scientific enquiry and research, and the growth of these disciplines. They include: data analysis and interpretation; research and experimental design; testing hypotheses; analysis and problem-solving; and technical skills.[6] STEM is subsequently defined according to a series of Standard Occupational Classification (SOC) codes determined by the proportion of graduates, proportion of STEM degree holders, and proportion of STEM degree-holding entrants to STEM-related sectors that work in these occupations (e.g. *Information Technology and Telecommunications Professionals*).

2.12 This is elaborated upon in a 2013 evidence report. The research and analysis undertaken by UKCES[7] for this initially defines STEM (divided across med-STEM and Core STEM) in terms of the following degrees: Medicine and dentistry; Medical related subjects; Biological sciences; Agricultural sciences; Physical / environmental sciences; Mathematical sciences and computing; Engineering and Technology; and Architecture.[8] The definition then draws on 4-digit Standard Industrial Classification (SIC) codes and 3- & 4-digit SOC codes based on densities and proportions of STEM degree holders within a sector or occupation. This approach provides an additional strand to the initial education definition, and the resultant SOC definition is similar to, but narrower than, the initial working definition for occupations (see Appendix 2 for both) – for example, some occupations are not included in the definition, e.g. Transport Drivers and Operatives (821). It also draws on SOC data for 2011 – so therefore uses SOC2010 codes rather than SOC2000, though the latter are drawn upon for comparison.

2.13 This is used to arrive at a precise analysis of the incidence of STEM occupations at 4- and 5-digital SIC industrial sub-sector level. This extremely forensic analysis of Labour Force Survey raw data is outwith the scope of this commission, but it nevertheless provides a useful, though

[3] EU Skills Panorama (2014) STEM skills Analytical Highlight, prepared by ICF and Cedefop for the European Commission

[4] De Philippis, M. (2016) STEM Graduates and Secondary School Curriculum: Does Early Exposure to Science Matter? CEP Discussion Paper No 1443, August 2016

[5] NCVER (2016) Defining 'STEM' skills: review and synthesis of the literature Support document 1

[6] UKCES (2011) The supply of and demand for high-level STEM skills: briefing paper

[7] UKCES (2013) The Supply of and Demand for High-Level STEM Skills: Evidence Report 77

[8] Joint Academic Coding System principal subject areas

perhaps now dated, insight into the incidence of STEM occupations throughout the UK economy. It is worth noting that any such analysis at a Scotland level would likely not be sufficiently robust, and unreliable due to the survey-based nature of the data and the samples that would be available.

2.14 More recently, an approach by UKCES defines STEM occupations as "*those that require knowledge and skills in science, technology, engineering and mathematics"*. This approach considered the proportion of graduates within a particular 4-digit SOC unit group, combined with analysis of skills use taken from the UK Skills and Employment Survey.[9] Though extremely detailed, such an approach is impractical, and not likely to yield sufficiently robust data for this research, as the next section illustrates.

Data limitations

2.15 There are some limitations with data classification systems that underpin definitions for industry sectors, occupations and skills, such as SIC and SOC codes, which add to the complexity of defining STEM.

2.16 SIC codes, which are used to define industries and sectors, may not accurately capture and reflect the totality of STEM for a number of reasons. SIC data is gathered through a business/organisation self-assessment survey and so there can be a degree of respondent misclassification or misinterpretation. Added to this, SIC codes focus only on principal business activity, rather than on principal inputs or processes involved, or main services provided to customers or clients. Therefore, an industry where only parts of its inputs are STEM-related would not necessarily be captured in a STEM definition - for example, businesses opening in the Administrative and Support Services sector, which may include a significant proportion of hard digital technology services and products, would not be considered or represented. At the same time, an industry where the majority, but not all input is STEM-related, may be included. This can result in STEM sectors being poorly understood.[10]. The limitations with SIC codes also reflect and are compounded by the age of SIC codes (the current SIC codes are from 2007) which do not take account of changes in how industries are organised and operate.

2.17 Occupational data through SOC codes is perhaps more accurate than the industry-based data discussed above. However, it still has its limitations. Like the SIC data, it is age-limited, though perhaps less so as current SOC codes were revised in 2010. Nevertheless, there are now STEM-related roles not necessarily covered by the codes, e.g. within cyber-security. Furthermore, research into Digital Technologies occupations suggests that the current SOC classification system does not adequately capture emerging job roles within Digital Technologies[11], due to the rapidly changing nature of the sector. This may apply to other STEM sectors and roles.

2.18 The key limitation for SIC and SOC data is the robustness of the data involved. Both the Labour Force Survey (LFS) and Annual Population Survey (APS) are based on survey samples, rather than census-level data – The LFS is conducted at a UK level with a sample size of around 40,000, and feeds into the APS, combined with local-level 'boost' surveys, which are also sample-based. As such, availability of any data is dependent on the available sample size for any given cross-tabulation. Our previous experience demonstrates that any

[9] UKES (2015) Reviewing the requirement for high level STEM skills: Evidence Report 94

[10] Growth Intelligence/NIESR (2015) *Measuring the UK's Digital Economy with Big Data*

[11] NESTA/techUK (2015) *Dynamic Mapping of the Information Economy Industries*

analysis will ultimately be limited by sample size at four-digit SIC and SOC code and geographies below the Scotland level. Since this commission is focused on the national and regional (ROA/RSA) level, 3-digit SIC and SOC codes should be sufficiently detailed, yet still yield robust data.

2.19 There are also some issues with SQA data. There have been a number of subject title changes in recent years. As a result, it is possible that there may be inconsistency in time-series data, but we understand that SQA has mapped old subject titles to new titles, so any potential discrepancies should be minimised. In addition, a change in qualifications in 2015 has led to some inconsistency in datasets (Standard Grades were replaced by National 3, 4, and 5 Qualifications). However, these are easily resolved by referring to SCQF levels.

2.20 Overall, it is clear that in contrast to skills definitions developed for specific industries, the starting point for STEM is at education and skills, rather than industrial sector. All current research and definitions in the wider literature draw on a composite definition to define STEM. Any definition should therefore reflect all elements of education, skills and workforce pipeline. Limitations of survey-based data in LFS and APS mean that industry and occupation definitions should remain at 3-digit SIC and SOC code level.

Rationale informing the definition of STEM

2.21 This section sets out our rationale and development of the data definitions used in arriving at a composite definition for STEM.

Shaping the education and skills definition

2.22 The starting point for many definitions of STEM in existing research is the consideration of education and skills, Joint Academic Coding System (JACS) codes for STEM degree courses. While this broadly aligns with the definition proposed by the ITQ in terms of subject areas, it does not take full account of the full STEM education and training pathway, nor does it take cognisance of the variety of entry routes and levels into STEM occupations. Further, it does not (fully) recognise more vocational education and training, and the potential to acquire STEM skills and qualifications through Foundation, Modern and Graduate Level Apprenticeships and other awards such as Skills for Work, National Certificates and Progression Awards.

2.23 Similarly, the initial definition presented in the ITQ focuses on primary, secondary, further, and vocational education, and could be expanded to include higher education (HE) courses, as per definitions in the wider literature. We have therefore included a wider range of FE subject superclasses in our definition, to capture all STEM-related subjects and, importantly, align with the HE-level definition common in other STEM definition research.

2.24 STEM education in Early Learning and Childcare, and Primary school settings is undoubtedly important, and has an impact on how children engage with and perceive STEM-related subjects. However, teaching (and acquisition) of STEM skills at this level is more blended, with a focus on literacy and numeracy; attainment and skills are not assessed through achievement of qualifications. Whilst STEM learning and understanding in Early Learning and Childcare and Primary settings is a critical basis of the journey that may lead into STEM employment, leavers at this stage do not form part of the skills pipeline as workforce entrants, they move into secondary education rather than tertiary education, training or employment. As entry and attainment statistics are readily available for secondary education onwards, we have therefore removed a small number of subjects that are taught at Primary level, such as Literacy and Numeracy, and updated these with the current SQA subject classes.

2.25 We therefore consider that while the definition currently advocated in literature concerning STEM definition and skills is focused on the right skills areas, it is too narrow. Consequently, we consider that any definition of STEM from an education and skills perspective should consider the full education and training spectrum, and include the following:

- The senior phase of secondary education, covering Mathematics, Sciences, and Technologies subjects;
- Skills for Work qualifications;
- FE college superclasses for STEM-related subjects;
- Subject areas for STEM-related HE courses delivered at FE colleges;
- Frameworks for STEM-related Apprenticeships at Foundation, Modern and Graduate levels; and
- JACS subject areas for STEM-related degree courses[12] delivered at HE institutions.

2.26 Whilst we recognise that other qualifications and awards, such as National Awards, National Certificates, National Progression Awards, National Workplace Courses and Professional Development Awards are available in STEM-related subjects, full data is not available for these. Attainment data is only readily available for all subjects combined for a given qualification. Further, entry data is only available for the top subjects (e.g. the 10 subjects with highest number of entries), making time-series analysis difficult. Because of this, these qualifications and awardshave been excluded from the analysis, though we note that this is something that could be considered for future analysis.

2.27 Defining STEM in this way takes the fullest recognition of all STEM education and training. It also reflects the full scope of the emerging STEM Strategy for Scotland.

Shaping the SOC definition

2.28 The SOC definition presented in the ITQ (detailed in Appendix 2) is a useful starting point for articulating STEM in terms of occupations. However, this should draw on the most up-to-date SOC classifications and definitions, and so we have referred to the SOC2010 manual[13] to cross-reference and identify the relevant corresponding codes. Further, we have rationalised the codes initially included; for example, 821 Transport Drivers and Operatives (SOC 2000; 821 Road Transport Drivers/823 Other Drivers and Transport Operatives SOC 2010) includes bus drivers and taxi drivers, and we do not consider this occupational group to require a sufficient degree of STEM skills to be considered as such. We have retained the potential related STEM occupations included in the initial definition in the ITQ.

2.29 We have drawn on a number of the definitions available in the wider literature, and particularly the UKCES definitions for STEM occupations, since these identify the proportion of STEM-qualified workers in these roles. We have used this research to supplement the initial SOC list with additional STEM occupations. Further, any such occupational definition should be cognisant of existing STEM-related SOC definitions prepared for SDS for consistency in approach across skills evidence base research. Therefore we have drawn upon our definition

[12] HESA define these subjects as Science subjects in their statistical outputs and other reports

[13] Office for National Statistics (201) Standard Occupational Classification 2010, Volume 1: Structure and descriptions of unit groups

of Digital Technologies occupations for our analysis of Digital Technologies in Scotland[14], so that there is read-across.

2.30 As noted above, availability of data for some occupations or geographies, even at the Scottish level, may be restricted in using 4-digit SOC codes. As existing definitions show, using 3-digit SOC codes to define STEM occupations is sufficiently detailed to arrive at a robust definition for statistical purposes. We therefore propose that we continue to use 3-digit SOC codes to define STEM occupations, to maintain consistency with the initial definition presented in the ITQ, and common practice in the wider literature.

Shaping the SIC definition

2.31 Similarly, the starting point for a SIC industry definition of STEM presented in the ITQ (Appendix 2) is sound, and captures the main industrial groups. However, in some instances these groups will invariably capture some industrial sectors or subsectors that may not be completely STEM in terms of the full range of their activity. It is therefore important to arrive at a more detailed SIC definition.

2.32 In line with our reasoning for arriving at a SOC definition for STEM, we consider that the most appropriate level would be at the 3-digit SIC level, in order to get sufficiently detailed information about STEM sectors in Scotland at both national and regional levels. Using a 4-digit SIC code definition may result in data being withheld due to issues of robustness, reliability or disclosure. We have principally drawn on the range of analysis undertaken by UKCES in this area to arrive at an industry definition for STEM using 3-digit SIC codes. Again, this has been informed by our previous work on Digital Technologies, as well as other sectoral scoping work undertaking for SDS and other clients.

The STEM definition

2.33 Following the discussion and rationale presented in the preceding sections, a composite definition for STEM has been agreed in conjunction with the project's Short Life Working Group. This includes:

- A revised list of school subjects, due to a focus on secondary school subjects as advised by the Scottish Government and SQA;
- An expanded list of college FE superclasses, to include subjects under *P: Health Care/ Medicine/Health and Safety*, *Q: Environment Protection/Energy/Cleansing/Security*, *S: Agriculture, Horticulture and Animal Care*, *V: Services to Industry*, *W: Manufacturing/Production Work*, and *Y: Oil/Mining/Plastics/Chemicals*, plus the exclusion of *IT: Computer Use*, *Using Software and Operating Systems*, and *Libraries/Librarianship* within *C: Information Technology and Information*, as these were excluded from the previous definition of Digital Technologies for SDS;
- Incorporation of Foundation and Graduate Level Apprenticeships; and
- A wider SIC definition to 3 digits.

2.34 We recognise that there may be some inconsistency across the various components of this definition. As such, there may be a need for ongoing revision and updating of the definition

[14] ekosgen (2017) Scotland's Digital Technologies Sector Analysis: Final Report, for SDS, April 2017

beyond the scope of this work, and for future research informing the ongoing development and implementation of the STEM Strategy for Education and Training.

2.35 The following tables detail the agreed definition across education and skills, industries, and occupations.

Education and skills definition

Secondary level

Secondary school qualifications	
Mathematics	Design and Manufacture
Lifeskills Mathematics (soon to be Applications of Mathematics)	Engineering Science
Mathematics	Design and Technology
Mathematics of Mechanics	Fashion and Textile Technology
National Units in Numeracy	Graphic Communication
Statistics	Health and Food Technology
Statistics Award	Information and Communications Technology
	Music Technology
Sciences[15]	Practical Electronics
Science	Practical Metalworking
Biology/Human Biology	Practical Woodworking
Physics	
Chemistry	***Skills for Work qualifications/awards***
Biotechnology	Automotive skills; Building services engineering; Construction crafts; Creative digital media; Energy; Engineering skills; Food & drink manufacturing industry; Laboratory science; Practical experiences: construction and engineering; Skills for work in the textile industry
Environmental Science	
Science in the Environment	
Geology	
Technologies	
Computing Science	

[15] Geology and Biotechnology included for past comparability, though these courses are no longer being delivered

FE college level: FE and HE subjects

College FE Superclasses	
C: Information Technology and Information	***T: Construction and Property (Built Env't)***
Computer Technology	Built Environment (general)
IT: Computer Science / Programming / Systems	Property: Surveying/Planning/Development
Information Systems / Management	Building Design/Architecture
Text / Graphics / Multimedia Presentation Software	Construction (general)
Software for Specific Applications / Industries	Construction Management
Information Work / Information Use	Building/Construction Operations
	Civil Engineering
N: Catering/Food/Leisure Services/Tourism	Structural Engineering
Food Sciences/Technology	
	V: Services to Industry
P: Health Care/Medicine/Health and Safety	Industrial Design/Research and Development
Health Care Management/Health Studies	Engineering Services
Medical Sciences	
Complementary Medicine	***W: Manufacturing/Production Work***
Paramedical Services/Supplementary Medicine	Testing Measurement and Inspection
Medical Technology/Pharmacology	Chemical Products
Dental Services	Polymer Processing
Ophthalmic Services	
Nursing	***X: Engineering***
Semi-medical/Physical/Psycho/Therapies	Engineering / Technology
Psychology	Metals working / Finishing
	Welding / Joinery
Q: Environment Protection/Energy/Cleansing/ Security	Tools / Machining
Environmental Protection/Conservation	Mechanical Engineering
Energy Economics/Management/Conservation	Electrical Engineering
Pollution/Pollution Control	Power / Energy Engineering
Environmental Health/Safety	Electronic Engineering
	Telecommunications
R: Science and Mathematics	Electrical / Electronic Servicing
Science and Technology (general)	Aerospace / Defence Engineering
Mathematics	Ship/Boat Building/Marine/Offshore Engineering
Physics	Road Vehicle Engineering
Chemistry	Vehicle Maintenance / Repair
Astronomy	Rail Vehicle Engineering
Earth Sciences	
Land and Sea Surveying / Cartography	***Y: Oil/Mining/Plastics/Chemicals***
Life Sciences	Mining/Quarrying/Extraction
	Oil and Gas Operations
S: Agriculture, Horticulture and Animal Care	Chemicals/Materials Engineering
Agricultural Sciences	Metallurgy/Metals Production
Agricultural Engineering/Farm Technology	Polymer Science/Technology
Veterinary Services	

Apprenticeship frameworks

Foundation Apprenticeships

FA Frameworks
Civil Engineering
Creative and Digital Media
Engineering
Hardware and System Support
Scientific Technologies
Social Services and Healthcare
Software Development

Modern Apprenticeships

MA Frameworks	
Agriculture	Heating, Ventilation, Air Conditioning and Refrigeration
Aquaculture	Horticulture
Automotive	Information Security
Bus and Coach Engineering and Maintenance	Industrial Applications
Construction: Building	IT and Telecommunications
Construction: Civil Engineering	Land-based Engineering
Construction: Professional Apprenticeship	Life Sciences and Related Science Industries
Construction: Specialist	Network Construction Operations (Gas)
Construction: Technical	Pharmacy Services
Construction: Technical Apprenticeship	Plumbing
Creative and Digital Media	Power Distribution
Dental Nursing	Process Manufacturing
Electrical Installation	Rail Engineering
Electronic Security Systems	Trees and Timber
Engineering	Upstream Oil and Gas Production
Engineering Construction	Water Industry
Equine	Water Treatment Management
Gas Heating & Energy Efficiency	Wind Turbine Installation and Commissioning
Gas Industry	Wind Turbine Operations and Maintenance

Graduate-level apprenticeships

Graduate Level Apprenticeships
Engineering: Design and Manufacture (SCQF level 10)
IT: Software Development (SCQF level 10)
IT: Management for Business (SCQF level 10)
Civil Engineering (SCQF level 8)

HE degree subjects

JACS subject areas
A – Medicine and Dentistry
B – Subjects Allied to Medicine
C – Biological Sciences
D – Veterinary Sciences, Agriculture and related subjects
F – Physical Sciences
G – Mathematical Sciences
H – Engineering
I – Computer Sciences
J – Technologies
K – Architecture, Building and Planning

SOC definition

Core STEM SOC codes	
112	Production Managers and Directors
113	Functional Managers and Directors
115	Financial Institution Managers and Directors
118	Health and Social Services Managers and Directors
121	Managers and Proprietors in Agriculture Related Services
124	Managers and Proprietors in Health and Care Services
211	Natural and Social Science Professionals
212	Engineering Professionals
213	Information Technology and Telecommunications Professionals
214	Conservation and Environment Professionals
215	Research and Development Managers
221	Health Professionals
222	Therapy Professionals
223	Nursing and Midwifery Professionals
231	Teaching and Educational Professionals
242	Business, Research and Administrative Professionals
243	Architects, Town Planners and Surveyors
246	Quality and Regulatory Professionals
311	Science, Engineering and Production Technicians
312	Draughtspersons and Related Architectural Technicians
313	Information Technology Technicians
321	Health Associate Professionals
351	Transport Associate Professionals
353	Business, Finance and Related Associate Professionals
355	Conservation and Environmental associate professionals
524	Electrical and Electronic Trades
531	Construction and Building Trades
Potential related STEM SOC codes	
111	Chief Executives and Senior Officials
342	Design Occupations
521	Metal Forming, Welding and Related Trades
522	Metal Machining, Fitting and Instrument Making Trades
525	Skilled Metal, Electrical and Electronic Trades Supervisors
533	Construction and Building Trades Supervisors

SIC definition

STEM Industrial Sectors (3-digit SIC)	
02.4	Support services to forestry
06.1	Extraction of crude petroleum
06.2 : Extraction of natural gas	
09.1	Support activities for petroleum and natural gas extraction
12.0	Manufacture of tobacco products
18.1	Printing and service activities related to printing
18.2	Reproduction of recorded media
19.2	Manufacture of refined petroleum products
20.1	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
20.2	Manufacture of pesticides and other agrochemical products
20.3	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
20.4	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
20.5	Manufacture of other chemical products
20.6	Manufacture of man-made fibres
21.1	Manufacture of basic pharmaceutical products
21.2	Manufacture of pharmaceutical preparations
24.5	Casting of metals
25.4	Manufacture of weapons and ammunition
25.6	Treatment and coating of metals; machining
26.1	Manufacture of electronic components and boards
26.2	Manufacture of computers and peripheral equipment
26.3	Manufacture of communication equipment
26.4	Manufacture of consumer electronics
26.5	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
26.6	Manufacture of irradiation, electromedical and electrotherapeutic equipment
26.7	Manufacture of optical instruments and photographic equipment
26.8	Manufacture of magnetic and optical media
27.1	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
27.2	Manufacture of batteries and accumulators
27.3	Manufacture of wiring and wiring devices
27.4	Manufacture of electric lighting equipment
27.5	Manufacture of domestic appliances
27.9	Manufacture of other electrical equipment
28.4	Manufacture of metal forming machinery and machine tools
28.9	Manufacture of other special-purpose machinery
30.1	Building of ships and boats
30.2	Manufacture of railway locomotives and rolling stock
30.3	Manufacture of air and spacecraft and related machinery
30.4	Manufacture of military fighting vehicles
32.9	Other manufacturing
33.1	Repair of fabricated metal products, machinery and equipment
33.2	Installation of industrial machinery and equipment
35.1	Electric power generation, transmission and distribution

STEM Industrial Sectors (3-digit SIC)	
35.2	Manufacture of gas; distribution of gaseous fuels through mains
35.3	Steam and air conditioning supply
36.0	Water collection, treatment and supply
37.0	Sewerage
38.1	Waste collection
38.2	Waste treatment and disposal
38.3	Materials recovery
39.0	Remediation activities and other waste management services
41.1	Development of building projects
41.2	Construction of residential and non-residential buildings
42.1	Construction of roads and railways
42.2	Construction of utility projects
42.9	Construction of other civil engineering projects
46.1	Wholesale on a fee or contract basis
46.7	Other specialised wholesale
52.2	Support activities for transportation
58.2	Software publishing
61.1	Wired telecommunications activities
61.2	Wireless telecommunications activities
61.3	Satellite telecommunications activities
61.9	Other telecommunications activities
62.0	Computer programming, consultancy and related activities
63.1	Data processing, hosting and related activities; web portals
63.9	Other information service activities
66.1	Activities auxiliary to financial services, except insurance and pension funding
66.2	Activities auxiliary to insurance and pension funding
70.2	Management consultancy activities
71.1	Architectural and engineering activities and related technical consultancy
71.2	Technical testing and analysis
72.1	Research and experimental development on natural sciences and engineering
74.9	Other professional, scientific and technical activities n.e.c.
75.0	Veterinary activities
84.1	Administration of the State and the economic and social policy of the community
84.2	Provision of services to the community as a whole
85.4	Higher education
85.5	Other education
86.1	Hospital activities
86.2	Medical and dental practice activities
86.9	Other human health activities
94.1	Activities of business, employers and professional membership organisations
95.1	Repair of computers and communication equipment

3 STEM employment in Scotland: industry

Introduction

3.1 This chapter presents a data-driven analysis of employment in STEM-related industries in Scotland. It uses the Standard Industrial Classification (SIC) definition outlined in Chapter 2 as the basis for the analysis. The analysis considers employment in STEM-related industries drawing on data from the Annual Population Survey (APS). We recognise that the Business Register and Employment Survey (BRES) is a more frequently-used measure of employment. However, BRES does not provide a gender breakdown of employment, which is important to consider in this analysis, given the known gender segregation in STEM employment. Further, APS allows for comparison across industry and occupation. Appendix 3 provides analysis of industry employment drawing on data from BRES, as well as further observations on the differences between BRES and APS data.

Employment within STEM sectors

3.2 Using the SIC-based definition agreed with the Short Life Working Group, the analysis of APS data shows there were 963,400 people in employment in STEM sectors in Scotland in 2016. This represents an increase of 70,500 (8%) from 2010 levels, and is double the overall increase in employment in the Scottish economy (4%). STEM employment accounted for 37% of all Scottish employment in 2016, an increase of one percentage point from 2010. This is considerably higher than the overall estimated 2015[16] Great Britain proportion of 32% of all employment being within STEM sectors, which has remained steady since 2010. The proportion for England was 31% in 2015, and 33% for Wales.

3.3 STEM employment was concentrated around Scotland's largest urban areas. The Glasgow and Lanarkshire regions account for the highest share of total STEM employment, both at 15%. This is followed by Edinburgh and Lothians at 14% and Aberdeen and Aberdeenshire at 12%. This is of course to be expected, as urban areas represent concentrations of population and, as a result, employment.

[16] 2016 data is not yet available at the Great Britain level.

Table 3.1: STEM sector employment by College Region, 2016

College Region	STEM Employment	Total Employment	STEM Share of Employment (%)	Location Quotient
Glasgow	139,800	379,900	37%	0.99
Lanarkshire	139,700	372,600	37%	1.00
Edinburgh and Lothians	137,200	343,600	40%	1.07
Aberdeen and Aberdeenshire	116,300	251,800	46%	1.24
Highlands & Islands	83,800	240,700	35%	0.93
West	78,600	207,300	38%	1.02
Tayside	67,900	196,300	35%	0.93
Fife	60,200	173,600	35%	0.93
Ayrshire	57,700	156,300	37%	0.99
Forth Valley	53,700	144,600	37%	0.99
West Lothian	32,200	87,900	37%	0.98
Dumfries and Galloway	19,600	69,400	28%	0.76
Borders	17,800	53,000	34%	0.90
Scotland	**963,400**	**2,581,000**	**37%**	**1.00**

Source: ONS, 2017

STEM sectors' share of total employment in Scotland

3.4 The STEM sector accounted for 37% of total employment in 2016 in Scotland. This had grown slightly from 2010, in the preceding six years the STEM share of employment had ranged between 35%-37%. However, there are significant variations in the share of employment between college regions. Employment share was highest in Aberdeen and Aberdeenshire at 46%. This is likely related to the importance of the oil industry in the area, even though the industry has seen a downturn in recent years. Edinburgh and Lothians also had a high STEM share at 40%. STEM share of employment is lowest in the more rural areas of Dumfries and Galloway at 28% and the Borders at 34%.

3.5 The Glasgow region had the highest number of people in STEM employment, and accounted for 15% of STEM employment in Scotland. STEM employment as a proportion of overall employment in Glasgow remained steady from 2010 to 2016 at 37%. Aberdeen and Aberdeenshire has seen the largest growth in the share of STEM employment, from 40% in 2010 to 46% in 2016. This is followed by an increase in STEM's share of overall employment over this period in Edinburgh and Lothian, from 35% to 40%, and West Lothian, from 33% to 37%. Forth Valley, Borders, Lanarkshire and Ayrshire also experienced small growths in their share of STEM employment. There was no overall change in the Glasgow, Highlands and Islands, West and Dumfries and Galloway regions. Elsewhere in Scotland, there were modest decreases in STEM's share of overall employment. In Tayside and Fife, the regions with the seventh and eighth highest number of STEM employment respectively; there were modest declines in the share of STEM employment from 36% to 35%.

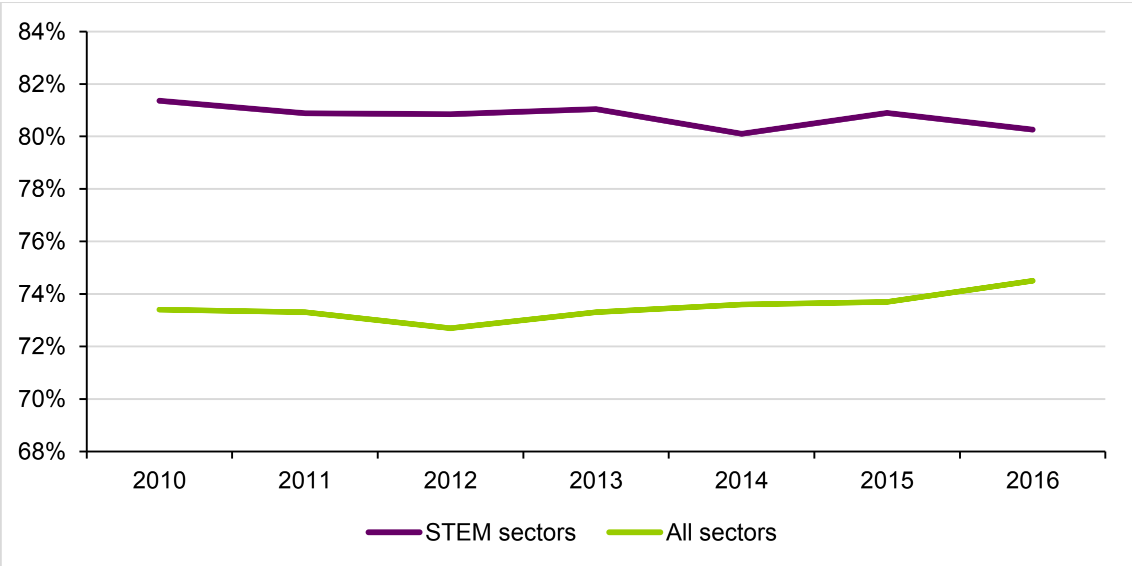
Geographical distribution of employment in STEM sectors

3.6 Location Quotients are a measure of the concentration or degree of specialism of a particular industry, occupation, or in this case industrial sector, in a local area or region in comparison to a larger geography – usually national, and in this case, Scotland. A Location Quotient of greater than 1 indicates a greater degree of specialism in the STEM sector in a particular area compared to the national workforce. The higher the score, the greater the specialism. As demonstrated in Table 3.1, Aberdeen and Aberdeenshire had a particularly high concentration of the STEM workforce, and this is likely related to the Oil & Gas industry. As with the STEM share of total employment, Edinburgh and Lothian also had a relatively high concentration of STEM employment, while Dumfries and Galloway and Borders were under-represented in STEM employment. The Glasgow and Lanarkshire regions were in line with the national average.

Sector employment by status for STEM

3.7 In 2016, 80% (773,000) of people working in STEM sectors worked full-time and 20% (190,000) part-time. This has remained fairly stable from 2009 when 81% (726,000) worked full-time and 19% (166,000) part-time. At 80%, the rate of full-time working in STEM was far higher than the national rate of 75%, although this has narrowed in recent years, as shown at Figure 3.1. This prevalence of full-time working may be a factor in the lower number of women working in STEM industries as women continue to carry the burden of caring duties.

Figure 3.1: Full-time employment in STEM sectors, 2010-2016



Source: ONS, 2017

Employment by STEM sub-sectors

3.8 The industry definition in Chapter 2 comprises 84 3-digit SIC codes. Table 3.2 shows the top ten sub-sectors (3-digit SIC codes) within the STEM industry in 2016. *861: Hospital activities* and *841: Administration of the State and the economic and social policy of the community* are the two largest sub-sectors within STEM industries, with around 115,000 people employed in each, accounting for 24% of the sector total. This is followed by over 71,000 people employed in *842: Provision of services to the community as a whole* (7%), and almost 60,000 in both *412: Construction of residential and non-residential buildings* and *854: Higher education* (6% each).

3.9 Collectively, these top five sub-sectors account for under half (44%) of employment in STEM industries.

Table 3.2: Employment in STEM sub-sectors in Scotland, 2016

STEM sub-sector	Employment	% of STEM employment
861: Hospital activities	115,000	12%
841: Administration of the State and the economic and social policy of the community	114,600	12%
842: Provision of services to the community as a whole	71,600	7%
412: Construction of residential and non-residential buildings	60,000	6%
854: Higher education	59,700	6%
711: Architectural and engineering activities and related technical consultancy	50,400	5%
620: Computer programming, consultancy and related activities	45,800	5%
869: Other human health activities	39,500	4%
091: Support activities for petroleum and natural gas extraction	37,000	4%
862: Medical and dental practice activities	26,700	3%
All other sub-sectors	337,600	35%
Total	**963,400**	**100%**

Source: ONS, 2017

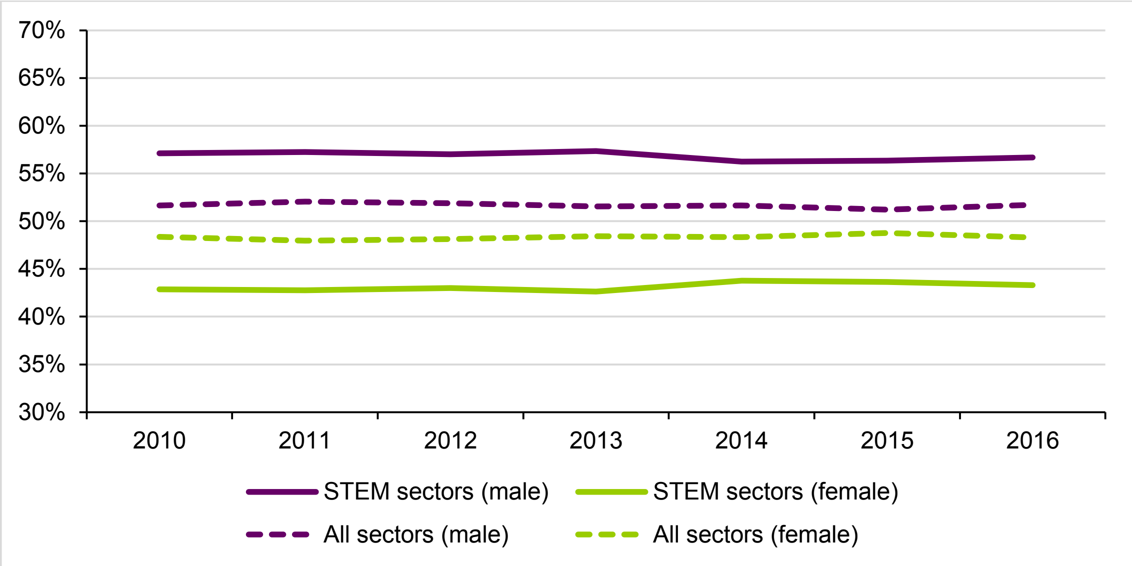
3.10 Following the profile of the wider STEM sector, a high proportion of jobs within the largest five employment sub-sectors are full-time. Three of the five sub-sectors have a full-time employment rate greater than the overall STEM average of 75%, and these are *412: Construction of residential and non-residential buildings* (92%), *842: Provision of services to the community as a whole* (86%) and *841: Administration of the State and the economic and social policy of the community* (76%). Whilst the proportion of full-time workers in *854: Higher education* (70%) falls below the STEM average, it remains above that of the wider Scottish economy (67%), while full-time employment in *861: Hospital activities* is marginally below at 66%.

Sector employment by gender for STEM

3.11 Males are more likely to be employed in STEM industries than female, and more so than the overall gender split for all sectors in the economy. As shown at Figure 3.2, males have consistently accounted for 56-57% of employment in STEM sectors since 2010, a considerably higher proportion than 51-52% for all sectors.

3.12 There are certain sub-sectors with significant employment where males or females are particularly over-represented. These tend to be high concentrations of male employment in the construction and engineering industries and of females in the care sector. In 2016, males were highly represented in *421: Construction of roads and railways* at 95%, *331: Repair of fabricated metal products, machinery and equipment* (89%), *412: Construction of residential and non-residential buildings* (84%), *091: Support activities for petroleum and natural gas extraction* (82%), and *711: Architectural and engineering activities* (81%). Conversely, females were particularly over-represented in *862: Medical and dental practice activities* at 82%, *861: Hospital activities* (80%), and *869: Other human health activities* (79%).

Figure 3.2: Employment in STEM sectors by gender, 2010-2016



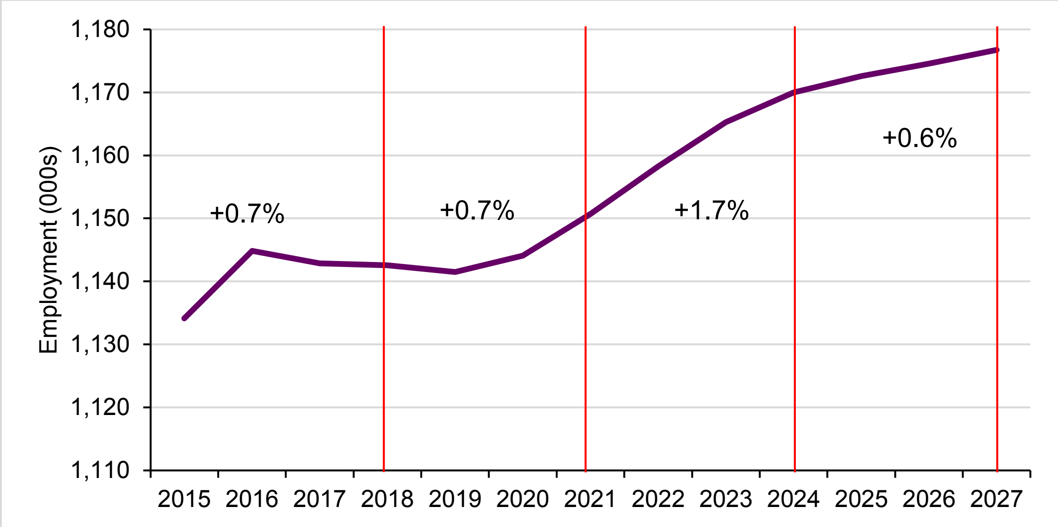
Source: ONS, 2017

Sector growth and demand forecasts

3.13 Using a SIC-based definition, forecasting work undertaken by Oxford Economics for SDS indicates that there will be a 4% growth in employment in Scotland in STEM sectors between 2015 and 2027. This increase amounts to approximately 42,600 jobs, meaning that in 2027 there would be just under 1,180,000 STEM jobs in Scotland. As shown at Figure 3.3, much of this growth is forecast to occur in the three year period between 2021 and 2024, 1.7% growth, or 19,300 jobs.

3.14 Due to data availability the definition used here is based on 2-digit SIC sections rather than 3-digit groups, so it is not as specific as the SIC definition used in the last section meaning that it reports a larger number of STEM employments. Modest growth in employment is accompanied by a larger, 23%, rise in Growth Value Added (GVA) for STEM industries between 2015 and 2027, indicating a predicted growth in productivity. This amounts to a growth in GVA of just over £12.5 billion, meaning that in 2027 GVA for STEM industries in Scotland would be close to £70 billion.

Figure 3.3: Forecast growth in employment in STEM industries, 2015-27



Source: Oxford Economics forecasting (2017)

3.15 Though there is steady overall growth projected for Scotland, there are mixed projections at a sub-national level. All regions are predicted to see a rise in GVA for STEM industries of at least 16% (and as high as 37% in Edinburgh and the Lothians). However, the projections for employment are less positive. Overall, four out of thirteen college regions are predicted to see a decline in employment in STEM industries between 2015 and 2027: Aberdeen and Aberdeenshire (4%), Borders (2%), Dumfries and Galloway, (2%) Ayrshire (1%). The largest predicted fall in absolute terms and proportionally is in Aberdeen and Aberdeenshire, where there is a forecast decline of almost 6,000 STEM jobs. This is likely related to the recent and prolonged downturn in the Oil & Gas industry. The projection data also show that growth in STEM industries will be concentrated in Scotland's largest urban areas. STEM employment is predicted to grow in Glasgow and Edinburgh & Lothians by 9% and 14% respectively. The only other areas with notable predicted growth are also in the Central Belt – West Lothian at 6% and Forth Valley at 5%.

Table 3.3: Forecast growth in employment in STEM industries, 2015-27, by College Region

College Region	Projected Change (000s)	Projected Change (%)
Edinburgh & Lothians	20,615	14%
Glasgow	16,238	9%
West Lothian	3,628	6%
Forth Valley	2,853	5%
Lanarkshire	2,360	3%
Fife	2,206	2%
Highlands & Islands	1,501	2%
Tayside	1,245	2%
West	1,244	2%
Ayrshire	-515	-1%
Borders	-520	-2%
Dumfries & Galloway	-838	-2%
Aberdeen & Aberdeenshire	-5,868	-4%

Source: Oxford Economics forecasting (2017)

3.16 There is also a mixed picture in terms of projected employment in broad industrial sectors in Scotland. Whilst every sector apart from Mining and quarrying is projected to see a GVA increase of at least 12%, the projections for employment change across industrial sectors are mixed. The largest forecast decline is in Mining and quarrying, which is predicted to decline by 38% in the period 2015-2027, though Mining and quarrying is already a relatively small sector. The most significant in absolute terms decline lies in manufacturing (almost 30,000). This may be partly due to greater innovation leading to a reduced need for labour and changes in sector composition for more advanced industries. Smaller declines are also predicted in Electricity, gas, steam and air conditioning supply (-5%) and Water supply, sewerage, waste management and remediation activities (-2%). Conversely, employment in Professional, scientific and technical activities is projected to grow by 21%. Significant absolute growth is also projected in Construction and Human health and social work.

Table 3.4: Forecast growth in employment in STEM industries, 2015-27, by sector

Sector	Projected Change (000s)	Projected Change (%)
Professional, scientific and technical activities	40,234	21%
Construction	26,635	15%
Information and communication	16,694	6%
Human health and social work	4,009	4%
Water supply, sewerage, waste management and remediation activities	-278	-2%
Electricity, gas, steam and air conditioning supply	-984	-5%
Manufacturing	-29,706	-15%
Mining and quarrying	-14,012	-38%

Source: Oxford Economics forecasting (2017)

3.17 As noted above, currently forecasting figures are only available at the 2-digit level. It is understood that SDS and Oxford Economics will explore the production of forecasts for STEM according to the agreed SIC- and SOC-based definitions for this study in future years.

Summary

- There were 963,400 people working in STEM sectors in Scotland in 2016. This amounted to an 8% increase from 2010 and a 37% share of total employment.
- In 2016 STEM employment tended to be concentrated in urban areas. Glasgow, Lanarkshire and Edinburgh and Lothians were the three college regions with the highest numbers of STEM employment. The STEM share of total employment was highest in Aberdeen and Aberdeenshire at 46%, likely due to the prevalence of the Oil & Gas industry.
- In terms of growth of STEM industries, from 2010 to 2016 the growth of STEM share of total employment was highest in Aberdeen and Aberdeenshire where it increased from 40% to 46%. This was followed by Edinburgh and Lothians where the STEM share increased from 35% to 40%.
- In 2016, 80% of STEM jobs in Scotland were full-time, compared with 75% across all industries. The higher rates of full-time working may be a barrier to women who continue to carry the burden of care of duties.
- Employment in STEM industries is skewed towards males, with 57% of jobs held by men in

2016. This has been steady since 2010, and is above the whole economy proportion of 52%.

- The largest STEM sub-sectors are employment in hospital activities and public administration activities. These are followed by employment in community services, construction and Higher Education. These sub-sectors have a high proportion of full-time working.
- Using a SIC-based STEM definition, it is projected that there will be a 4% growth in STEM employment in Scotland from 2015 to 2027. Much of this growth is forecast to be concentrated between 2021 and 2024.
- The more modest forecast growth in employment is accompanied by a 23% increase in GVA over the same period of time.
- Regionally, forecast employment growth is highest in Edinburgh and Glasgow at 14% and 9% respectively. At the other end of the scale, a 4% decline is projected in Aberdeen and Aberdeenshire. This likely reflects the downturn in the Oil & Gas industry.
- By sector, forecast growth is highest in Professional, scientific and technical activities at 21% whilst a 38% decline is projected for mining and quarrying.

4 STEM employment in Scotland: occupation

Introduction

4.1 Following on from the previous chapter's analysis of STEM-related industry employment, this chapter presents a data-driven analysis of employment in STEM-related occupations in Scotland. It uses the Standard Occupational Classification (SOC) definition outlined in Chapter 2 as the basis for the analysis. The analysis considers employment in STEM-related occupations drawing on data from the Annual Population Survey (APS).

Employment by STEM occupation in Scotland (SOC)

4.2 Table 4.1 presents the estimated total employment in STEM occupations in Scotland for 2016. As detailed in the occupational definition in Chapter 2, this is broken into core STEM SOC codes and potential related STEM SOC codes.

4.3 Available data using the core STEM occupational definition indicates that there were around 838,000 people employed in STEM occupations in Scotland in 2016. Core STEM occupations account for around on third (32%) of all occupations in Scotland. This is 14% less than the number of people employed in STEM industries, given in Chapter 3, as per the SIC code definition.

4.4 STEM *Professionals* is the largest occupational grouping, at over half (58%) of the total core STEM workforce in Scotland. This group includes occupations such as teaching and education, health, and information technology and telecommunications professionals.

Table 4.1: Employment by STEM occupation in Scotland, 2016

Occupation	N	%
Total core STEM occupations	**838,100**	**93%**
STEM Directors and Managers	*119,800*	*14%*
STEM Professionals	*483,900*	*58%*
STEM Technicians	*130,200*	*16%*
STEM Skilled Trades	*104,200*	*13%*
Total potential related STEM occupations	**61,600**	**7%**
Related Directors and Managers	*7,100*	*12%*
Related Technicians	*10,500*	*17%*
Related Skilled Trades	*44,000*	*71%*
Total core and related STEM occupations	**900,200**	**100%**

Source: Annual Population Survey, ONS, 2016. Figures may not sum due to rounding

4.5 When taking into consideration potential related STEM roles, this figure increases to over 900,000 people in employment. At 71%, this related group is dominated by *Skilled Trades* occupations, and these include metal forming, machining, fitting and skilled metal trades and construction and building trades supervisors.

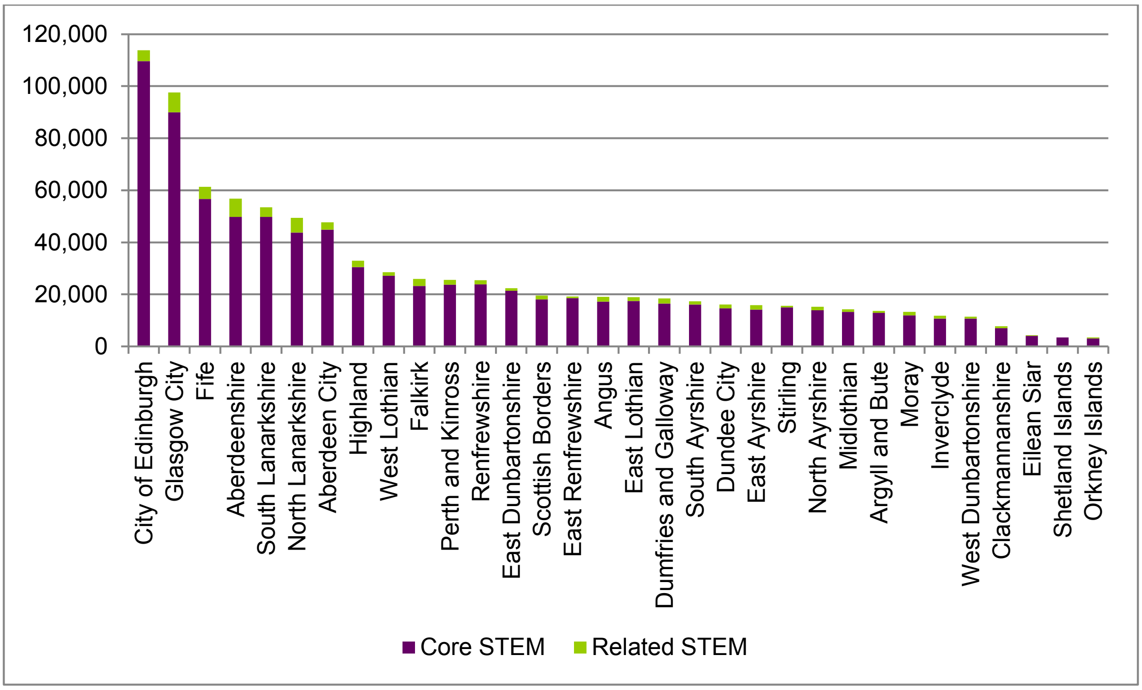
Geographical distribution of employment in STEM occupations

4.6 Employment in STEM occupations is highest in Scotland's urban areas. Edinburgh and Glasgow local authorities combined account for just under one quarter (23%) of total employment in STEM occupations in Scotland. However, this is significantly lower than their combined 34% share of national employment in STEM industries.[17] This suggests there are more non-STEM support occupations based in STEM industry companies in Edinburgh and Glasgow, likely to be due to the presence of large multinational organisations with large numbers of support staff, or Scottish-based companies with headquarters in one of the two cities.

4.7 In terms of other urban areas, South Lanarkshire accounts for 6% of employment in STEM occupations, while North Lanarkshire and Aberdeen City both account for 5%. There are some rural exceptions. Fife and Aberdeenshire, both more rural local authorities, account for 7% and 6% of all employment in STEM occupations in Scotland.

4.8 Glasgow and Aberdeenshire both have the largest numbers of people employed in related STEM occupations, at over 7,000 each.

Figure 4.1: Employment in STEM occupations by local authority, 2016



Source: Annual Population Survey, ONS, 2016

4.9 Table 4.2 examines the location quotient of STEM occupations in Scotland for 2016, with the local authorities from Figure 4.1 being grouped into Scotland's College regions. The location quotients show the relative concentrations of STEM occupations by region when compared to the national average.

4.10 Analysis in Chapter 3 on STEM industry employment and location quotients shows that STEM employment was concentrated around Scotland's largest urban areas, the Glasgow region, Edinburgh and Lothians and Aberdeen and Aberdeenshire, as expected due to these region's large proportion of overall population and employment. The concentration of STEM industry employment was particularly high in Aberdeen and Aberdeenshire.

4.11 The differences and key points to note with STEM occupations are that:

[17] Please note that care should be taken when comparing these datasets, as STEM industry employment relates to 2015 and STEM occupation employment relates to 2016.

- Edinburgh and Lothians, as well as having the largest number of core STEM occupations, has the greatest concentration of these occupations at 127% of the national average. This is driven by a high concentration in the City of Edinburgh local authority.
- Aberdeen and Aberdeenshire has a slightly higher concentration of STEM occupations than the Scotland average, though not as large as the region's STEM industry concentration.
- Despite having a STEM industry concentration in line with the national average, the Highlands and Islands region is under-represented in STEM occupations, at 85% of Scotland's average. This under-representation is true of all six local authorities within the region.
- As with employment in STEM industries, Dumfries and Galloway has the lowest concentration of employment in STEM occupations in Scotland, at 74% of the national average.

Table 4.2: Employment in STEM occupations by College Region, 2016

College Region	All core STEM occupations	*Directors and Manager*	*Professionals*	*Technicians*	*Skilled Trades*	All related STEM occupations	Location quotient[18]
Edinburgh and Lothians	140,357	18,955	83,298	19,721	9,462	6,731	1.27
Glasgow	129,945	14,251	78,074	21,757	10,779	9,242	1.06
Lanarkshire	115,050	16,679	60,750	13,557	19,134	10,335	0.96
Aberdeen and Aberdeenshire	94,681	11,340	57,414	13,660	9,012	9,773	1.16
Highlands & Islands	65,873	8,586	30,494	5,392	12,383	5,235	0.85
West	63,826	6,510	38,936	9,396	6,438	4,203	0.95
Fife	56,622	4,989	33,542	6,620	9,244	4,702	1.01
Tayside	55,620	7,778	29,089	7,727	7,523	5,246	0.88
Forth Valley	45,302	6,125	24,816	6,130	5,422	4,029	0.97
Ayrshire	44,283	6,133	22,943	6,650	6,375	4,127	0.88
West Lothian	27,155	4,209	14,984	3,435	4,148	1,373	0.96
Borders	18,060	3,342	9,253	1,374	2,859	1,488	1.06
Dumfries and Galloway	16,557	3,070	8,085	1,887	2,904	1,891	0.74
Scotland	**833,362**	**119,762**	**483,929**	**130,466**	**104,193**	**66,826**	**1.00**

Source: Annual Population Survey, ONS, 2016. Figures may not sum due to rounding

Employment in STEM occupations by gender

4.12 The gender split for STEM occupations is broadly similar to the gender split for employment in STEM industries. In 2016, 58% of core STEM occupations were held by males, a marginally higher proportion than the 57% for employment in industry.

4.13 Within core STEM occupations, by far the largest grouping, *Professionals*, is also the most gender balanced grouping, with 52% of females holding roles. However, this is more than off-set by the strong tendency for males to hold roles in *Skilled Trades* (97%) occupations, and also in *Director and Manager* (63%) and *Technician* (61%) roles.

4.14 The potential related STEM occupations have a much greater gender imbalance than core STEM roles, with 86% of occupations being held by men and, again, this is driven by male

[18] This is based on core STEM occupations and excludes the related STEM occupations.

dominance in related *Skilled Trades*. This gives an overall, core and related, STEM occupational gender split of 60% male and 40% female, as shown at Table 4.3.

Table 4.3: Employment in STEM occupations by gender, 2016

Occupation	2016	Male	Female
Total core STEM occupations	**838,100**	**58%**	**42%**
STEM Directors and Managers	*119,800*	*63%*	*37%*
STEM Professionals	*483,900*	*48%*	*52%*
STEM Technicians	*130,200*	*61%*	*39%*
STEM Skilled Trades	*104,200*	*97%*	*3%*
Total potential related STEM occupations	**61,600**	**86%**	**14%**
Related Directors and Managers	*7,100*	*68%*	*32%*
Related Technicians	*10,500*	*45%*	*55%*
Related Skilled Trades	*44,000*	*96%*	*4%*
Total core and related STEM occupations	**900,200**	**60%**	**40%**

Source: Annual Population Survey, ONS, 2016

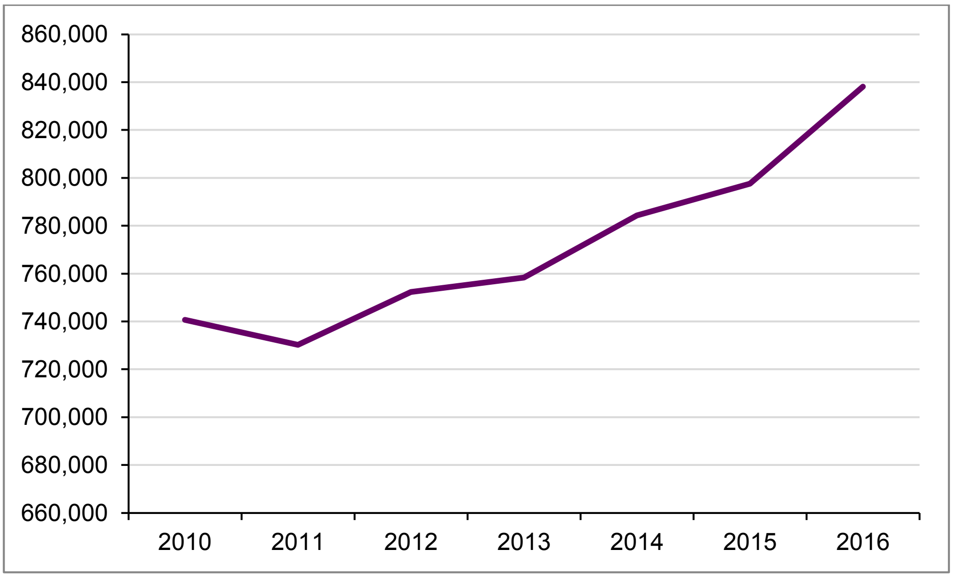
4.15 Within these occupational groupings, many *Skilled Trades* occupations, such as *531: Construction and Building Trades, 524: Electrical and Electronic Trades, 522: Metal Machining, Fitting and Instrument Making Trades,* and *521: Metal Forming, Welding and Related Trades* are dominated by males (all 94% or above). In contrast, some *Professional* occupations, such as *223: Nursing and Midwifery Professionals* and *222: Therapy Professionals* are heavily skewed towards women (both 92%).

4.16 Some occupational groups, however, do have a relatively balanced gender workforce. Roles in *353: Business, Finance and Related Associate Professionals* (with almost 55,000 occupations) and *242: Business, Research and Administrative Professionals* (almost 51,000 occupations) are accounted for by 50% and 45% of females respectively. Similarly, *342: Design Occupations* consists of 55% females, although this is a smaller occupational group with 10,000 roles.

Change in employment in STEM occupations

4.17 Employment in core STEM occupations has increased by 13% between 2010 and 2016, equivalent to an extra 97,000 roles. Despite a drop between 2010 and 2011, there was strong growth in core STEM occupations between 2011 and 2016, as shown in Figure 4.2.

Figure 4.2: Employment in STEM occupations over time, 2010-2016



Source: Annual Population Survey, ONS, 2016

4.18 However, this overall growth masks significant variances between different occupational groupings. As shown at Table 4.4, the overall growth in core STEM occupations is driven by the expansion of the number of *Professionals*, which grew by 71% over the period, equivalent to over 200,000 roles. Meanwhile, the number of *Directors and Managers* and *Technicians* fell between 2010 and 2016, by 38% (72,000 roles) and 22% (37,000 roles) respectively. There was small growth in core STEM *Skilled Trades* occupations.

Table 4.4: Employment in STEM occupation groupings over time, 2010-2016

Occupation	2010	2016	Change	% change
Total core STEM occupations	**740,600**	**838,100**	**97,500**	**13%**
STEM Directors and Managers	*191,700*	*119,800*	*-71,900*	*-38%*
STEM Professionals	*282,300*	*483,900*	*201,700*	*71%*
STEM Technicians	*167,000*	*130,200*	*-36,800*	*-22%*
STEM Skilled Trades	*99,700*	*104,200*	*4,500*	*5%*

Source: Annual Population Survey, ONS, 2016

4.19 By individual SOC codes, the largest growth has been in *213: Information Technology and Telecommunications Professional* (an increase of 41,600 occupations, a 153% growth), *242: Business, Research and Administrative Professionals* (20,000 roles, 65%), and *353: Business, Finance and Related Associate Professionals* (17,200 roles, 46%).

4.20 However, much of the growth in these occupational codes was off-set by significant declines in others. *321: Health Associate Professionals* fell by 60,300 roles, a reduction of 83%. Similarly, there were substantial declines in *115: Financial Institution Managers and Directors* (-25,300 roles, -84%), and *113: Functional Managers and Directors* (-24,200 roles, -30%).

4.21 In terms of the gender split of occupations, this has narrowed slightly over time. In 2010, 61% of core STEM occupations were held by males, and this has become more balanced over the years to 2016, where 58% of occupations were held by men. This is set over a period where the employment gender split in STEM industries has remained relatively stable, at 57% male and 43% female, as discussed in Chapter 3.

4.22 Although the number of *Directors and Managers* fell sharply between 2010 and 2016, the gender split at this level became slightly more balanced, from 66%:34% to 63%:37% for males and females. Core STEM *Professionals* also became slightly more gender balanced over the period, from 55%:45% to 48%:52%. However, there has been a significant shift in the composition of core STEM *Technicians* occupations. In 2010, females accounted for 56% of these occupations, but this fell to 39% to 2016. The gender split of *Skilled Trades* occupations remained highly skewed toward males over this period.

STEM occupations in STEM industries

4.23 Based on data requested from ONS, it is possible to estimate the number of STEM occupations within STEM industries, again using the SOC and SIC code definitions given in Chapter 2. This is shown in Table 4.5.

4.24 In 2016, 505,000 core STEM occupations were within STEM industries. This is 60% of all core STEM occupations in 2016. When examining different occupational groupings, this proportion varies slightly. 65% of STEM *Professionals* are employed in STEM industries, while this is a lower proportion for *Technicians and Skilled Trades* occupations (55%) and lower still for *Director and Managers* (50%).

4.25 40% of core STEM occupations were employed in non-STEM industries in 2016, equivalent to around 332,000 people. Those employed in potential related STEM occupations in 2016 were split fairly evenly between working in STEM industries and non-STEM industries, with around 28,000 in each.

Table 4.4: Employment in STEM occupations within STEM industries, 2016

Occupation	2010	2016	Change	% change
In STEM industries				
Total core STEM occupations	**418,200**	**505,100**	**86,900**	**21%**
STEM Directors and Managers	*97,500*	*60,400*	*-37,100*	*-38%*
STEM Professionals	*153,300*	*316,900*	*163,600*	*107%*
STEM Technicians and Skilled Trades	*167,400*	*127,900*	*-39,500*	*-24%*
Total potential related STEM occupations	**31,600**	**27,200**	**-4,400**	**-14%**
In non-STEM industries				
Total core STEM occupations	**321,400**	**332,400**	**11,000**	**3%**
STEM Directors and Managers	*94,000*	*59,300*	*-34,700*	*-37%*
STEM Professionals	*128,400*	*166,400*	*38,000*	*30%*
STEM Technicians and Skilled Trades	*99,100*	*106,600*	*7,500*	*8%*
Total potential related STEM occupations	**28,100**	**28,200**	**100**	**0%**

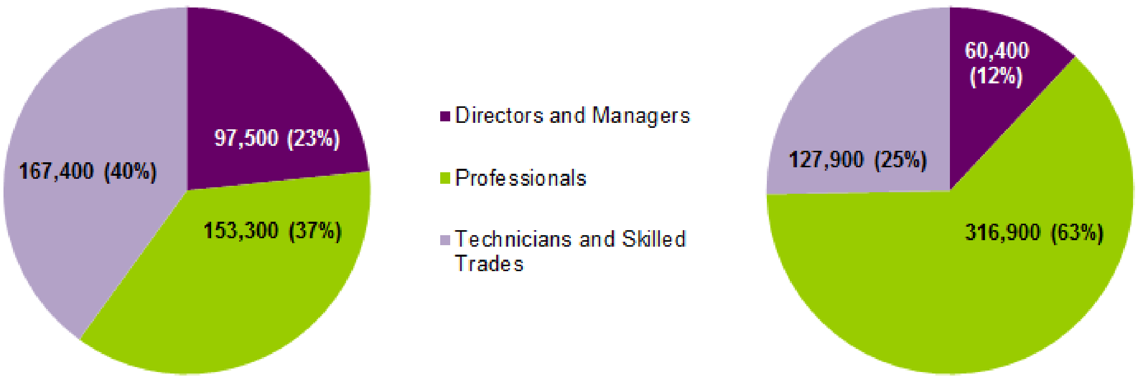
Source: Annual Population Survey, ONS, 2016

4.26 There has been significant change in the composition of the sectoral employment of STEM occupations in recent years. Table 4.4 and Figure 4.3 show how the composition of STEM occupations employed within STEM industries has changed over time since 2010.

4.27 In 2010, 418,000 core STEM occupations were employed within STEM industries. This was 56% of all core STEM occupations at the time, meaning that the proportion of STEM occupations in related industries has grown since 2010 – from 56% to 60%, a four percentage point growth.

4.28 There have also been changes in the different occupational groupings, as shown at Figure 4.3. The number of core STEM *Professionals* working in related industries more than doubled between 2010 and 2016, and now accounts for nearly two thirds (63%) of this cohort. Conversely, the number of core STEM *Technicians and Skilled Trades* and *Directors and Managers* working in related industries have both fallen in absolute terms, and now account for a much smaller proportion of this cohort (40% to 25%, and 23% to 12% respectively).

Figure 4.3: Core STEM occupations in STEM industries, 2010 (left) and 2016 (right)



Source: Annual Population Survey, ONS, 2016

Summary

- There were 838,000 core STEM occupations in Scotland in 2016, 14% less than the number employed in STEM industries.
- *Professional* occupations, such as teaching, education, health and information technology professionals, are the largest STEM occupational grouping, accounting for 58% of all core STEM roles.
- There was also an additional 62,000 people in Scotland employed in potential related STEM occupations, taking the total number in STEM related occupations to 900,000.
- STEM occupations are concentration in Scotland's urban areas, particularly around Edinburgh and Glasgow, although there are significant numbers in more rural areas such as Fife and Aberdeenshire.
- Edinburgh and Lothians region has the highest concentration of STEM occupations, at 127% of the national average, driven by a high representation in the City of Edinburgh authority, while Dumfries and Galloway is the most under-represented region.
- In 2016, 58% of core STEM occupations were held by males, and this is particularly so in *Skilled Trades*, *Director and Managers* and *Technicians* roles, although *Professional* occupations are slightly skewed towards females. This gender imbalance has narrowed from 61%:39% in 2010.
- Despite a drop between 2010 and 2011, employment in core STEM occupations has grown strongly by 13%, or 97,000 roles, since 2010.

- However, the make-up of the workforce has changed somewhat. *Professional* occupations have experienced very strong growth over the period (71%), while there have been substantial declines in *Directors and Managers* (-38%) and *Technicians* (-22%).
- In 2016, 505,000 people were employed in both core STEM occupations and in STEM industries in Scotland, accounting for 60% of all those in core STEM occupations. This cohort has grown both in size and proportionately since 2010. This proportion is higher for core STEM *Professionals*, at 65%, and this grouping has more than doubled since 2010.

5 Drivers of change and challenges for STEM

Introduction

5.1 This Chapter provides a review of the drivers of change and challenges for STEM skills. Firstly, it presents an overview of sector growth and demand forecasts, discusses the impact of technological change and innovation and considers STEM as an enabler of growth. It then discusses some of the challenges facing STEM sectors and presents an overview of the key policy responses and finally highlights some of the societal challenges facing STEM.

Sector growth and demand forecasts

5.2 As demonstrated by the analysis presented in Chapter 3, it is projected that STEM sectors will grow at a disproportionately fast rate.[19] As an area of growth and innovation – and particularly technological innovation – STEM will make an increasingly important contribution to the Scottish economy, and the focus on STEM training and education is therefore critical.

5.3 For the UK as a whole, UKCES projects growth across almost all areas of STEM to 2022. Importantly, this growth is forecast to be particularly high in higher level STEM occupations that require more complex skills and knowledge. Within these occupations, employment is projected to grow by 18% or approximately 500,000 jobs. At 18% this growth rate is approximately three times greater than that of UK employment as a whole. Particularly important sectors include Information and communications where there is a forecast growth rate of 25% and professional services where 20% growth is projected.[20]

5.4 Looking at particular sectors within STEM, forecasting reflects research which has suggested there is a skills shortage in particular, in higher-level STEM occupations. Evidence suggests that 39% of employers seeking STEM skills have had difficulties with recruitment, and the UK has a shortfall of 400,000 STEM graduates every year.[21] This particularly affects engineering and IT professionals. UKCES's Employer Skills Survey 2013 found a skill shortage to vacancy ratio of 43% for the Science, Research, Engineering and Technology professionals category.[22] The latest UKCES Employer Skills Survey from 2015 also reports issues of skill shortage within STEM industries. Electricity, Gas & Water and Construction were the sectors reporting the highest density of skill-shortage vacancies at 35% each.[23] Further, research by the Royal Academy of Engineering suggests that there is an 'engineering skills crisis' in the UK, in part caused by the supply of STEM skills failing to keep pace with demand.[24]

5.5 As well as skills shortages within particular STEM industries, the 2015 UKCES Employers Skills Survey also showed that STEM skills were cited by employers as being amongst those skills that are difficult to obtain from applicants. Overall, 30% stated it was difficult to find candidates with adequate computer literacy, and 27% found it difficult to find candidates with

[19] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*

[20] Ibid.

[21] IDOX (2017) *Building STEM Skills in the UK*

[22] UKCES (2013) *Employer Skills Survey*

[23] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/525444/UKCESS_2015_Report_for_web__May_.pdf

[24] Royal Academy of Engineering (2016) *The UK STEM Education Landscape*

advanced or specialist IT skills. Further, 24% listed complex numeracy/statistic skills as a difficult to obtain, and 20% identified basic numeracy skills as a challenge in recruiting.[25]

5.6 The ability of Scottish STEM skills supply to meet demand is recognised by employers to be a real issue. However, whilst the overall volume is likely to be available it will be more challenging for some STEM industries than others, e.g. IT where there is potentially a global job market for the individual with the right skill set.

5.7 In addition, employers must face a future with the potentially negative impact of Brexit i.e. out-migration of skilled workers with workers leaving to return to the EU which could create huge unmet demand for STEM skills and a reduced ability to recruit.

5.8 Consultation feedback raises the question of to what extent higher level and quality skills are present overall within the Scottish pipeline.

"Ultimately, there is a need for a sophisticated workforce".

5.9 There is an indication that senior managers and Masters/PhD level entrants and workers are in short supply and in many cases employers have to turn to overseas recruitment to fill these posts. However, there is limited understanding of what subjects are preferred by STEM employers. This is not covered by existing Employer Skills Surveys carried out by UKCES, though this may be covered in the forthcoming 2017 Employer Skills Survey delivered by the Department for Education.[26] ekosgen's recent analysis of Scotland's Digital Technologies Sector for SDS[27] identified demand for a wide range of subjects. Whilst nearly half of Digital Technologies employers (45%) prefer the graduates they recruit to have studied Computer Sciences subjects, a third (34%) prefer Engineering or Technology specialisms. Other subjects that are popular amongst employers are Mathematics (23%), Data Science (e.g. Statistics; 19%) and Creative Arts and Design (19%). Similar data for wider STEM employers is not available at present and this is something that SDS and partners may wish to consider exploring for future research. There is also value in exploring employers' perceptions of the value, quality and application of softer STEM skills delivered through CfE.

5.10 Despite recent policy initiatives to promote more vocational and technical routes into STEM employment, and employment more widely, the preference for university graduates persists. This is supported by findings from ekosgen's Digital Technologies work. However, in terms of typical routes into STEM careers, there is a perception that university education generates operational managers, whilst college education (HNC, HND and MAs) generates operational 'doers'. However, because of historic trends in young people pursuing university education, there is a big gap at the operational technician level in STEM. Some employers suggest that the supply pipeline that drives students towards academic degrees is therefore generating wasted talent.

5.11 Additionally, employers cite that softer skills are often overlooked but are in high demand. They want core skills and work ready young people, but these are often difficult to obtain. For example, ekosgen's Digital Technologies work found that Digital employers considered recruiting employees with the necessary employability or work readiness skills was a considerable challenge.[28] Whilst there is some evidence that employability and softer skills

[25] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/525449/UKC004_Summary_Report__May_.pdf
[26] http://www.skillssurvey.co.uk/index.htm
[27] ekosgen (2017) *Scotland's Digital Technologies: Research & Analysis Report*
[28] Ibid.

are forming part of college (vocational) education, there is consensus amongst stakeholders and employers that the development of softer skills is currently lacking at school and university and that work based learning can be beneficial to both potential employee and employer. Again, this is something worthy of exploration in future research.

5.12 The opportunities for career progression is also worthy of consideration. Anecdotal evidence from our consultations suggests that there is a current trend that in order to earn more, STEM technicians and professionals feel they need to move into management. This in turn can affect the retention and employment of STEM skills as e.g. good engineers move into management roles. There needs to be more recognition (financial and other) of the contribution that experienced technicians can make within a business and a need perhaps to rethink what career progression looks like.

Pace of technological change and innovation: Industry 4.0

5.13 The use and development of new technologies is key to economic growth via the STEM industries. Technological change and innovation have led to significant growth over the last few years. The UK Government has identified eight technologies in which the UK is set to be a global leader, based on existing research strengths and industrial capability. These are the Eight Great technologies[29]: big data; satellites; robotics and autonomous systems; life sciences, genomics and synthetic biology; regenerative medicine; agri-science; advanced materials and nanotechnology; and energy and its storage. Support to accelerate the commercialisation of these technologies has to date led to significant growth opportunities for the UK economy, and will continue to do so. Within these, there are clear opportunities for Scotland, particularly within Satellites, Big Data, and Life Sciences.

5.14 The pace of technological change is not expected to slow down. In fact, according to a recent survey of more than 3,100 IT and business executives, 86% anticipate that the pace of technology change will increase rapidly or at an unprecedented rate in their industry over the next three years.[30] This has been termed Industry 4.0, or the Fourth Industrial Revolution. This is a trend of manufacturing and production towards a more highly automated and computerised form, through the deployment of cyber-physical systems, big data, and cloud computing. It is characterised by higher levels of interoperability of machines, devices and people, large-scale aggregation of data, greater levels of technical assistance, and decentralised decision-making – greater automation and decision-making by cyber-physical systems.[31]

5.15 There are a number of workforce implications here, particularly for the continuing professional development (CPD) or career-long professional learning (CLPL) of the existing workforce. Skills of the current workforce will need to be kept current, and this will need to be at the same pace of technological change; investment in workforce development is a key priority. However, the STEM strategy is seeking to influence the future rather than the current workforce and so the CPD and CLPL needs in the existing workforce lies out with its scope.

5.16 Education provision will also need to track technological developments, so that the skills pipeline entering the market is adequately trained and able to adapt to changing skills requirements and this is of course within the scope of the STEM strategy. Equally important is

[29] https://www.gov.uk/government/publications/eight-great-technologies-infographics

[30] Ibid

[31] Hermann, M. et al. (2016) *Design Principles for Industrie 4.0 Scenarios, 2016 49th Hawaii International Conference on System Sciences (HICSS)*

the need for workforce entrants to be 'work ready' and have practical work experience through internships and work placements where possible, as discussed above. The Curriculum for Excellence already promotes the development of skills for work and this issue is further addressed in the Developing the Young Workforce (DYW) programme.

5.17 In its white paper, *Accelerating Workforce Reskilling for the Fourth Industrial Revolution*, the World Economic Forum (WEF)[32] identifies the key challenges facing skills demand and workforce development. As discussed, the speed at which jobs are changing as a result of technological change is significantly altering the skills demand and requirement of the labour market. This is creating a considerable mismatch between the current skills of the workforce, and the skills and qualifications required for roles both now, as they evolve, and in future. As a result, there is significant and increasing need for skilling, re-skilling and upskilling throughout a person's career. The WEF identifies a number of key priorities to meet the challenge of the Fourth Industrial Revolution:

- Take stock of and recognize existing skills;
- Understand skills demand;
- Adopt the right mix of financing instruments;
- Build and sustain motivation for adult learning through active labour market policies and accessible resources;
- Create shorter learning modules that foster continued learning;
- Determine the role of different stakeholders;
- Recognize and promote on-the-job training opportunities and maximize informal learning opportunities;
- Reach those who need it most – SMEs, lower-skilled workers and older workers;
- Customized teaching for adults; and
- Harness the power and scalability of blended online courses, enhanced with virtual and augmented reality when relevant.

5.18 This is broadly the approach being adopted for developing the STEM Strategy for Education and Training. However, there is a clear need for consideration of the skills development needs of the incumbent STEM workforce.

STEM as an enabler of growth

5.19 As outlined above, STEM is key to future economic growth in Scotland. Its role in driving high levels of productivity and innovation gives it a critical role in economic development.[33] For high wage economies, the development of knowledge-intensive industries and expertise are particularly important for maintaining competitiveness within an increasingly global market.[34]

5.20 At the heart of this growth is innovation and the continual development of technologies, as discussed above. The key area for economic development is 'the production and use of new

[32] World Economic Forum (2017) *Accelerating Workforce Reskilling for the Fourth Industrial Revolution: An Agenda for Leaders to Shape the Future of Education, Gender and Work*

[33] UKCES (2011) *Briefing Paper: The Supply of and Demand for High Level STEM Skills*

[34] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*

technologies' which will offer high quality products/exports as well as high wage employment.[35] The importance of STEM skills in economic growth does not lie just within the core STEM sectors. The development and use of technology can help improve outputs and productivity across the economy. Research has shown that the development and adoption of key technologies such as mobile phones, email and new software, has increased office worker productivity almost five-fold over the past 40 years. Further, the study states that productivity will rise by a further 22% in the next seven years as new high technology products are developed, allowing businesses to work smarter.[36]

5.21 As well as technology, STEM skills have been shown to be important in development and growth across a range of industries. The numeracy and reasoning skills of STEM graduates have been shown to be closely linked to innovation. For example 45% of graduate employees in innovative manufacturing firms have STEM degrees compared to 30% in non-innovative firms.[37]

5.22 The resilience of STEM and its ability to grow is also evidenced in the performance of STEM industries during the recession. Even during the recession period of 2008-2013, 25 out of 28 EU countries saw a growth in STEM employment.[38]

5.23 At the individual level, it is also important to comment on the opportunities and benefits offered by STEM skills. For example, experimental Scottish Government statistics indicate that Scottish STEM graduates can be earning an average of around £3,800 more than non-STEM graduates five years after graduation.[39] Generally people with STEM qualifications will earn more though this is more pronounced with technology, engineering and mathematics than science. Those working in the science, technology and engineering sectors earn nearly 20% more than those working outside of these sectors.[40]

Workforce demographics

5.24 There are a number of key challenges facing STEM industries and organisations with respect the profile of the workforce. Whilst current workforce issues are out with the scope of the STEM strategy, they are important in understanding the STEM workforce overall and to inform the development of future provision and the pipeline.

5.25 In response to the issues, there a wide range of policies, strategies and plans aimed at developing, supporting and addressing the skills challenges faced by individual STEM sectors and increasing the number of entrants into STEM industries and jobs.

5.26 The key, pertinent issues are discussed below.

Gender

5.27 There is gender segregation evident in the STEM workforce, as well as elsewhere in the economy. Women are under-represented in a range of STEM sectors, as identified by

[35] IDOX (2017) *Building STEM Skills in the UK*

[36] Centre for Economics and Business Research/O2 Business (2013) O2 Individual productivity Index

[37] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*

[38] European Commission (2014) *EU Skills Panorama 2014: Focus on STEM Skills*

[39] Scottish Government (2017) *Graduate outcomes by University and subject (LEO data) – Scotland (Experimental Statistics: data being developed)*

[40] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*

ekosgen's recent work on occupational segregation.[41] As well as impacting on individuals in terms of employment opportunities, income and career progression, employers are also affected. Social attitudes, both explicit and implicit, stereotype the roles women and men, girls and boys have in our society and can be set at an early stage. These attitudes influence behaviour and choice relating to the range of subjects to study, sector to enter and career to follow, and can also limit career aspirations. By definition, stereotypes are hard to address as they have become the social norm in many subjects and sectors and so are constantly being reinforced.

5.28 A Centre for Employment Research and Close the Gap study in 2015[42] found that early influences on children affect the industry they are likely to enter and the subject choices they make. The study, which focused on the manufacturing sector, found that while females are more likely to study biology and chemistry and males are more likely to study physics, overall, females are less likely to choose STEM-related subjects than their male counterparts and this can limit their options to enter certain roles and sectors.

5.29 Segregation is also driven by perceptions and assumptions about what is 'women's work', and what is 'men's work'. These traditional gender associations and stereotypes are prevalent in industries and roles such as construction, engineering, etc. (dominated by men), whilst caring and secretarial roles are dominated by women.

5.30 Research by TERU found that women were under-represented across a range of STEM sectors, such as Energy, Life and Chemical Sciences, Engineering, and ICT/Digital. The nature and organisation of STEM industries act as considerable barriers. Compared to other sectors, there is a relatively long qualification lead-in time, as well as a higher degree of career insecurity. STEM roles often have long or irregular working hours/patterns, and there is unwillingness amongst STEM businesses to consider part-time/flexible working patterns.[43]

5.31 Research by Equate Scotland on the construction industry has highlighted particular issues of gender segregation in the industry. Whilst the proportion of women in employment overall has increased, the number of women employed in the construction industry has stayed static since the 1990s. In 2015 less than 2% of construction trade workers were women and approximately 10% of construction professionals were women. The lack of female participation in the construction industry is related to a raft of issues around perceptions and realities of pay and conditions, a machismo culture and the perception that women do not have the required physical strength to work in certain roles. Equate Scotland's *Diversity in Construction* report highlights that as well as a more gender diverse workforce helping to improve construction industry working, it is also necessary to attract women into the industry if the skills shortage is to be tackled.[44]

5.32 Across all STEM industries[45], it is estimated that women make up 20% of the workforce. As well as their specific work on construction, Equate Scotland have also highlighted that achieving the necessary growth across all STEM industries in Scotland is going to be made even more challenging if women continue to be under represented. Proposed initiatives to

[41] ekosgen (2016) *Occupational Segregation in the Highlands and Islands, report for HIE*

[42] University of Strathclyde Scottish Centre for Employment Research/Close the Gap (2015) *Mapping of women's participation within the manufacturing cluster labour market in Scotland*

[43] TERU (2015) *Equalities in Scotland's Growth Economic Sectors: Final Report, report for SE*

[44] Equate Scotland (2015) *Diversity in Construction*

[45] It is worth noting here that this is according to a previous definition of STEM, which focuses on a much narrower set of industries, and necessarily differs from the wider definition used in this evidence base report

encourage female participation in STEM education and workforce include providing opportunities to school students to take part in industrial visits, forming networks for female STEM students at colleges and universities and providing flexible working options as standard in STEM companies.[46]

5.33 Cultural factors that relate to workplace attitudes within STEM also result in low levels of women in senior positions and, as found by a study by the Royal Society of Edinburgh[47], this is compounded by a lack of female role models.

5.34 Traditional gender roles mean that women are the main care providers in households. As a result of this, time out of the labour market and the need for flexible working to balance work and domestic responsibilities drive further gender segregation. Time out of the labour market can be detrimental to the career progression of women and lead to vertical segregation. They can miss out on promotions, training and career development opportunities. In some STEM sectors, developments can move so fast that spending any time out of the workforce, for example on maternity or parental leave, can mean that skills and knowledge quickly become outdated and so the employee loses their 'currency'. Such rapid changes can make re-entry difficult after even a short career break.

5.35 These factors all contribute to the 'leaky pipeline' effect – the high attrition rate of trained, qualified women from employment in STEM. Though there is limited data evidence on the scale of women dropping out from STEM education and careers, the *Tapping all our talents* report demonstrated that 73% of women graduates are lost from STEM industry, compared with 48% male graduates. Additionally, anecdotal evidence suggests that the drop-out rate for female students on MA frameworks is three times as high as for males (1 in 8 versus 1 in 25). Women either leave STEM sector early on in careers, or stay but are under-represented in top positions. Whilst some pursue STEM-related careers in other sectors, e.g. teaching or government, there is a loss of opportunity to individuals, economy and society. It is estimated that doubling women's high-level skill contribution to economy could be worth £170m per annum to Scotland's national income.[48]

5.36 There are a number of initiatives aimed at addressing such gender issues. Close the Gap's 'Be What You Want"[49] programme works in schools, with the aim of addressing occupational segregation by enabling young people to make informed decisions about subject and career choice and to broaden their outlook and encourage them to consider non-traditional jobs. The Improving the Gender Balance Programme (IGB)[50] is a three year programme running in six school clusters. A partnership between Institute of Physics, Skills Development Scotland and Education Scotland it aims to identify and tackle the challenges facing pupils due to gender stereotypes and help schools identify and address issues around gender and subject choice. It has a particular focus on STEM (science, technology, engineering and mathematics) subjects.

5.37 The WiRES Programme was developed in response to the renewables industry's skills shortage, and female participation in the sector. It recognised the male-dominated workplace in the energy sector, and worked to strengthen networking, knowledge and skills. This has

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46 Equate Scotland (2016) *Rising to the Challenge: How Scotland can recruit, retain and support women in STEM*

47 The Royal Society of Edinburgh (2012) *Tapping all our talents: Women in science, technology, engineering and mathematics: a strategy for Scotland*

48 Ibid.

49 www.bewhatyouwaqnt.org.uk

50 http://www.iop.org/education/teacher/support/girls_physics/igb_scotland/page_66766.html

positively impacted on career choices, career progression and network development for women in the energy sector.[51] Equate Scotland runs a Women Returners programme funded by the Scottish Government to support women to return to work in STEM sectors.[52]

5.38 More locally, Ayrshire College's #whatiactuallydo #ThisAyrshireGirlCan campaign is a social media campaign featuring a series of videos aimed at making STEM careers more appealing to young women. It is funded by SDS through the Equalities Challenge Fund as part of the Equalities Action Plan for Modern Apprenticeships. Videos feature women who are currently undertaking engineering Modern Apprentices and focus upon what they actually do and the tasks involved in their Modern Apprenticeship, rather than just saying they 'do engineering', which may have little meaning for young people. The videos aim to change perceptions of STEM careers and provide young women with role models to help encourage them into engineering.[53]

5.39 In terms of community learning, CoderDojo's work in addressing the gender balance in computer coding clubs is a good example of encouraging more females into IT.[54]

Age profile

5.40 Although issues in the existing STEM workforce are not within the scope of the STEM strategy, its demographic profile is pertinent to planning and resourcing the pipeline for replacement as well as expansion demand. In line with other sectors, the STEM workforce is ageing. However, there is an indication that because of this, fewer young people are establishing careers in STEM.[55] Recent research indicates a rise in the retirement age of scientists. There is a concern therefore that the large number of older scientists may crowd out younger scientists, and act as a barrier to new STEM entrants.[56]

5.41 There is recognition that an ageing workforce presents an increasingly stark challenge. Retiring STEM workers take skills, experience and knowledge thus creating replacement demand which requires higher level skills which are more difficult to find. Attraction and retention of young people in STEM is below what is required, which poses a threat to knowledge transfer, and ongoing capability of STEM sectors.[57] Further, research conducted by the International Longevity Centre indicates that there is a high drop-off rate of workers aged 60-64 in a number of STEM sectors, including ICT, Construction, Energy, and Professional, scientific and technical activities.

5.42 Immediate solutions such as extending working lives and supporting and nurturing younger talent, taking on migrant workers, and raising workforce productivity may not be sufficient on their own to meet the workforce gap.[58] The need to attract and retain talent in STEM sectors is

[51] Close the Gap (2015) *How women's networks and mentoring can address occupational segregation: What policymakers can learn from WiRES*

[52] https://www.airtransat.com/en-GB/air-transat-uk?search=flight&flightType=RT&gateway=LGW-YYZ-YYZ-LGW&pax=1-0-0-0&gclid=EAIaIQobChMIsLmsuMfZ1QIVab7tCh0pzgLoEAAYASAAEgKNvvD_BwE&gclsrc=aw.ds&dclid=CPPuzbrH2dUCFcEC0wodcxsO_A

[53] http://www1.ayrshire.ac.uk/news/news/2016/ayrshire-college-launches-whatiactuallydo-videos/

[54] http://coderdojoscotland.com/toolkit/gender-balance/

[55] https://arstechnica.co.uk/science/2017/04/scientists-have-stopped-retiring-us-sees-its-researchers-aging/

[56] Blau, D.M. & Weinberg, B.A. (2017) Why the US science and engineering workforce is aging rapidly, PNAS, 114 (15), pp.3879-84; doi: 10.1073/pnas.1611748114

[57] http://www.hrmagazine.co.uk/article-details/plugging-the-skills-gap-of-britains-ageing-workforce

[58] ILC/CIPD (2015) *Avoiding the demographic crunch: Labour supply and the ageing workforce*

therefore critical in meeting skills challenges, and in avoiding increased levels of skills shortages.[59]

Ethnicity

5.43 There is widespread evidence (e.g. UK Association for Science and Discovery Centres)[60] that there is considerable under-representation of people from a variety of backgrounds working in STEM, notably people from ethnic backgrounds and those living in areas high on the index of multiple deprivation.

5.44 One in five of the UK-domiciled university population in the UK studying STEM-related subjects comes from a Black, and Minority Ethnic (BME) background. Despite this, the STEM sectors have very low numbers of BME employees with BME men 28% less likely to work in STEM than white men[61]. The converse is true however for BME women and the reasons for this are unclear although it may in part reflect gender imbalances in some sectors overlaid with imbalances in sectors terms of ethnicity[62].

5.45 There is a data gap here regarding how many children from deprived areas progress to STEM careers, or indeed how many people living in deprived areas work in STEM careers. Similarly, there is a lack of data regarding those with disabilities or additional support needs. DYW also identifies care-experienced young people as a key group to support. For these groups, there is potential to determine the scale of employment in STEM, and this may be worthy of consideration in future research. Whilst at present there are few statistics available, groups such as the STEM Disability Advisory Committee was established to remove barriers and strengthen the inclusion of disabled people in STEM.[63]

5.46 Nevertheless, whilst the STEM Strategy for Education and Training is not concerned with the makeup of the existing workforce, considering how to attract under-represented groups in to STEM-related subjects and occupations will be within its scope. Other approaches can also help to address issues of inequality too. CLD's principle of promoting equality of engagement and access to learning opportunities means that CLD services work toward overcoming that balance.

Societal challenges facing STEM

Profile of STEM

5.47 There is overwhelming feedback that there is further work to be done in terms of repositioning and rebranding STEM and overcoming outdated and misplaced perceptions which still exist about STEM careers and skills. This can be exacerbated by a number of factors and research undertaken by Kings College London's ASPIRES research, that ethnicity, SIMD and gender are all adversely affected by lack of 'science capital' (science-related qualifications, understanding, knowledge about science and 'how it works', interest and contacts) in the household growing up. This means that people from BAME backgrounds, girls, care

[59] Energy and Utilities Skills (2017) *Many Skills One Vision: Renewal and Skills Strategy 2020*
[60] http://sciencecentres.org.uk/events/2015_Education/Penny%20Fidler.pdf
[61] https://race.bitc.org.uk/issues_overview/ethnicity-and-stem
[62] https://raceforopportunity.bitc.org.uk/sites/default/files/rfo_sector_factsheet_set_vfinal_new_2.pdf
[63] http://www.stemdisability.org.uk/

experienced children and those from socio-economically disadvantaged backgrounds are less likely to choose STEM-related subjects, and therefore less likely to consider a STEM career.[64]

5.48 There is a lack of any 'real' or consistent image. The current mainstream perceptions of STEM impacts adversely on recruitment as it discourages people from considering it as a career; overcoming the persistent view of STEM as a vocation that is 'hard' rather than a good, rewarding career choice is a key challenge for employers, educators and careers advice professionals alike.

5.49 The portrayal of STEM and Science in the mainstream and social media can also contribute to the misconceptions of STEM as does the language and terminology used to describe activities, achievements and careers. There is a need to better demonstrate the value of STEM careers, e.g. explaining that it is about generating solutions and addressing problems rather than 'doing science', or 'doing engineering'. Awareness raising messaging and activity in general, needs to be a priority going forward.

5.50 Employers have a key role to play in creating positive perceptions of STEM jobs and careers. Businesses conducting open days, giving talks at schools, colleges and universities, providing more internships and work placements are all ways to positively engage young people and graduates. Employers should also seek to broaden their Corporate Social Responsibility through wider CLD engagement, and promoting adult and community learning in STEM.

5.51 They also have a key role to play in addressing gender segregation which was discussed above. Some sectors are recognised as creating barriers and excluding individuals and a culture change may be necessary to correct a heavy male workforce bias in some industries, so changing perceptions and stereotyping of STEM is a necessary first step. There is evidence, however of some employer attitude shift; larger organisations in particular are becoming more open to more diverse workforces so the challenge is to change perceptions and attitudes of the individual be it school pupil, student, parent or practitioner.

Influencing the influencers – parents, peers and practitioners

5.52 Targeting parents and community groups (and to a lesser extent peers) as key influencers has been recognised as a key priority in improving the flow of young people into STEM and STEM careers and this is also recognised in the DYW programme. Communities, families and individuals often lack confidence to engage with STEM-related subjects. Consequently attitudes towards STEM can be negative, due in part to limited understanding of how STEM can have a positive impact on people and communities.

5.53 Unlike practitioners, these more informal influencers are better placed to be influencers in terms of time and motivation and there is a perception that they have more, or at least different credibility. It is important therefore to influence them to better understand the pace and scale of technological change and the increasing technical and scientific nature of the economy so that they understand the jobs that are likely to be available and that their children are likely to be able to do. One avenue to achieve this is through Community Learning and Development (CLD). CLD is arguably well-placed to engage families and communities on STEM issues, and help to broaden knowledge and understanding of STEM. One example of how this may be achieved is a resource currently being jointly developed by the Workers Educational

[64] http://www.ucl.ac.uk/ioe/departments-centres/departments/education-practice-and-society/aspires

Association and Glasgow Clyde College. *Science for a Successful Scotland* is aimed at adult learners, and explores STEM issues related to Scotland's key growth sectors.[65]

5.54 Overcoming the persistent preference for academic learning versus technical or professional learning and development especially amongst parents is an ongoing challenge. Parents need to be made more aware of the choices available and more appreciation established for vocational, technical and professional qualifications. Equally challenging is the acceptability of innumeracy, e.g. it is still socially acceptable to be "rubbish at maths" even though illiteracy is no longer acceptable. In this instance CLD can help to overcome perceptions that STEM-related subjects or topics are too difficult or too academic, and somehow unrelated to people's everyday lives. Community and adult education can promote awareness and appreciation in a number of ways.

5.55 For example, it can help to tackle STEM matters and engage communities on specific issues, such as environmental issues through initiatives like *Counting On a Greener Scotland*.[66] It is a learning pack developed by the Workers' Educational Association and Heather Reid, in collaboration with Education Scotland. The resource aims to provide opportunities for learners to develop their knowledge, skills and understanding of numeracy, in the particular contexts of weather, climate change and energy. Adult education approaches can also help to engage people more broadly on STEM issues. *Science Lates*[67] is an ongoing series of adult-only events at Glasgow Science Centre that deliver exhibits, live demonstrations, and science talks.

5.56 Influencing practitioners is equally important, as there is a clear need to stimulate interest in STEM-related subjects throughout school ages. There is a need for ongoing upskilling and updating of practitioners' knowledge of the opportunities in STEM careers and industries. Changing the perceptions and approaches of influencers is a key recommendation in the Kings College London ASPIRES report[68] (ASPIRES 2 is being delivered by University College London). It states that the vision of 'science for all' should be promoted and that there should be investment in and prioritisation of CPD for science teachers to embed and deliver STEM careers awareness in their teaching. The Wood Foundation's RAiSE (Raising Aspirations in Science Education) programme is run in partnership with the Scottish Government. RAiSE aims to deliver improvements in science teaching in Primary Schools, by developing the confidence and competence of teachers to provide highly engaging and motivating learning opportunities. Its objective is to equip learners with skills for learning, life and work to enable them to access a wide range of stimulating and rewarding careers including those within science and STEM sectors.[69] Another key programme is the Improving the Gender Balance Programme (IGB) mentioned above.[70]

5.57 SDS's Equalities Action Plan is committed to influencing influencers to achieve more equalities across the MA Frameworks. This is discussed in more detail later in this section. My World of Work (see below) also has a role to play here. The role of practitioners is discussed further in Chapter 7.

[65] Creative Industries (including digital), Energy (including renewables), Financial & Business Services, Food & Drink, Life Sciences, Sustainable Tourism

[66] http://www.i-develop-cld.org.uk/enrol/index.php?id=74

[67] http://www.glasgowsciencecentre.org/special-events/sciencelates.html

[68] https://kclpure.kcl.ac.uk/portal/en/publications/aspires-report(a0237ac7-cb43-473e-879a-1ea0addff0e3).html

[69] https://www.thewoodfoundation.org.uk/developing-young-people-in-scotland/raise/

[70] http://www.iop.org/education/teacher/support/girls_physics/igb_scotland/page_66766.html

5.58 As mentioned already industry has a responsibility to better explain the job types, the work requirement, and the career progression opportunities that are available, to young people, and practitioners and parents. SMEs in particular are perhaps not very good at selling STEM jobs as a career prospect.

Policy drivers

5.59 The global importance of Science, Technology, Engineering and Mathematics (STEM) is evidenced in the number and variety of policy documents dedicated to its development. Across the world it is recognised that STEM will be increasingly important to economic growth. STEM is fundamental to innovation, and drives high levels of productivity, which means it contributes disproportionately to Gross Value Added (GVA). In high wage economies such as the UK knowledge intensive STEM sectors are also important for maintaining competitiveness.[71] As a result a number of governments worldwide have developed or are developing various STEM strategies.[72] Clearly, at the time of writing, Scotland's is still in development.

5.60 There are a large number of policies and initiatives implemented at the Scotland level related to STEM, and to individual STEM sectors, and these are outlined below.

The STEM Strategy

5.61 In November 2016 the Scottish Government released the first draft *STEM Education and Training Strategy for Scotland* document for consultation. STEM is recognised as vital to growth and the Strategy seeks to address the way in which education and training can be improved so as to meet growing demand for STEM skills. In recognition of the growing importance of STEM to the Scottish economy, the Scottish Government set up a new dedicated STEM Strategy Reference Group to develop the STEM strategy in March 2017.[73]

5.62 In order to improve education and training so that the STEM skills supply can meet demand and contribute to growth, the draft strategy outlines two key aims. These are: to improve levels of STEM enthusiasm, skills, and knowledge in order to raise attainment; and to encourage uptake of more specialist STEM skills required to gain employment in the growing STEM sectors of the economy, through further study and training. These key aims are supported by the following four priorities that look to address current challenges:

- **Excellence**. Raising the levels of STEM skills and knowledge (including numeracy and digital skills) for all throughout their education, lifelong learning and training experiences.
- **Equity**. Taking action to reduce equity gaps, particularly in relation to deprivation and gender.
- **Inspiration**. Ensuring young people and adults are enthused and inspired to study STEM and to continue their studies to obtain further, more specialised, skills.
- **Connection**. Matching the STEM education and training offer to labour market need both immediate and in the future to support improved productivity and inclusive economic growth and aspirations in learning, life and work.

[71] UKCES (2011) *Briefing Paper: The Supply of and Demand for High Level STEM Skills*

[72] e.g. Welsh Government (2016) *Science, Technology, Engineering and Mathematics (STEM) in education and training: A delivery plan for Wales*; Office Of The Chief Scientist (Australia) (2013) *National STEM Strategy: Science, Technology, Engineering and Mathematics in the National Interest: A Strategic Approach*

[73] https://news.gov.scot/news/the-way-forward-for-stem

5.63 More specific proposed actions include promoting excellence through the development of continuous professional learning for educational practitioners; promoting equity through funding initiatives aimed at increasing the number of women working in STEM industries; promoting inspiration through supporting science centres and festivals to engage children and parents; and promoting connection through work with Developing the Young Workforce regional groups to help improve partnerships between schools and STEM employers.[74] As part of its strategic approach to addressing gender imbalances in Modern Apprenticeships, SDS prepared its Equalities Action Plan for Modern Apprenticeships.[75] It encompasses a range of activities, for example SDS's Equality Challenge Fund which funds innovative projects that aim to get more young people from under-represented groups onto Modern Apprenticeships. It also includes 'Modern Apprenticeships for All' which is aimed at influencing key influencers from ethnic minority groups and attracting more people from these groups in to STEM-related subjects and sectors. It also supports employers to recruit young people for Modern Apprenticeships from under-represented groups.

Scotland's Economic Strategy

5.64 The proposed STEM strategy is integral to the Scottish Government's broader economic strategy, which is focused around four priorities: innovation, inclusive growth, investment and internationalisation. The development and improvement of STEM education and training contributes particularly to innovation and inclusive growth – the 'Four Is'. Innovation, raising the level of STEM skills will mean that this particularly innovative and competitive sector can continue to grow and develop in Scotland. In terms of inclusive growth, the document also sets out strategies for reducing inequalities within STEM education and training meaning that STEM can become a growth area that is accessible, providing economic benefits and jobs across Scottish society.

5.65 The innovation priority of the Scottish Economic Strategy (SES) is particularly important for STEM. The innovation priority encompasses policy areas around business innovation and entrepreneurship and workplace innovation and digital. STEM industries and skills are particularly important for encouraging innovation and the development of business and are of course integral to improving digital skills and capacity.[76] The Scotland CAN DO Innovation Forum is an important contributor towards the innovation priority. Within the initial framework 'the conversion of science and technology ideas into new products and services' is mentioned as a way to develop the Scottish economy. Further reference is made to Scottish Science Advisory Council recommendations including that commercial skills should be embedded within STEM degrees.[77]

5.66 Specific policy implementation includes focus on the development of better STEM education through improving practitioner recruitment; developing opportunities around STEM modern and foundation apprenticeships; a number of actions to address inequalities in STEM, particularly around the participation of women, minority ethnic communities, disabled people, and those from disadvantaged backgrounds; extending provision of information around STEM in school careers advice; and promoting links between schools and STEM employers.[78]

[74] http://www.gov.scot/Resource/0050/00509522.pdf
[75] https://www.skillsdevelopmentscotland.co.uk/news-events/2015/december/plan-to-tackle-inequality-in-apprenticeships/
[76] http://www.gov.scot/Topics/Economy/EconomicStrategy
[77] Scotland CAN DO Innovation Forum (2013) *The Scotland CAN DO Framework*
[78] http://www.gov.scot/Publications/2016/11/4147

Sector-specific strategies and action plans

5.67 There are a wide range of plans and strategies in Scotland that focus on or are relevant to STEM skills. For example, the National Clinical Strategy for Scotland sets out ideas on how NHS Scotland can ensure that the provision of health and social care services are fit for the future. It is particularly concerned the skills needed to meet the changing and complex needs of communities, and to make best use of technological innovation in delivering health and social care.[79] As another example, the recently established FinTech Strategy helps to identify the skills requirement for the growing FinTech sector in Scotland.[80]

5.68 It is not within the scope of the study, and it would not add any material value to the research, to include a description of all of the activities, plans and strategies relating to STEM. However, the following sections set out the key strategies driving changes in Scotland's economy.

Scotland's Energy Strategy

5.69 Aligned to the SES is the emerging Energy Strategy for Scotland. This sets out the intended transition to a low-carbon economy and the focus on renewable and smart energy technologies, a decentralised energy system, and the ambitious new 2030 target of 50% of Scotland's energy consumption to be met by renewable energy.[81] As part of the Energy Strategy, there is a recognised need to increase the provision of high-level skills in STEM, to support the increasing demand for skills in new energy technologies, and required grid and energy infrastructure works, as investment in new energy technologies increases. Additionally, skills will be needed to help facilitate the transfer of skills and knowledge from established sectors such as Oil & Gas to new and emerging sectors, such as offshore wind and hydrogen.

Scottish Life Sciences Strategy

5.70 The new *Life Sciences Strategy for Scotland: 2025 Vision*[82] aims to "make Scotland the location of choice for life sciences businesses, researchers, healthcare professionals and investors whilst increasing the sector's contribution to Scotland's economic growth." It aims to build on the Scottish Life Sciences Strategy 2011[83], which set out the steps required to develop and expand the life sciences sector in Scotland. In particular, its ambition was to double turnover and GVA of the sector to £6.2 billion and £3 billion respectively by 2020.

5.71 *2025 Vision* recognises the importance and strength of the Life sciences sector to Scotland, and its capacity for continued growth. With this in mind, its mission is to increase the life sciences' industry contribution to the Scottish economy to £8 billion by 2025. This will be achieved by:

- **Internationalising** the local sector by increasing the number of Scottish companies and organisations successfully operating overseas and promote Scotland as a location of choice.
- **Improving the business environment** by focusing on those areas that are critical to support the sector's growth, a central component of which is skills. In relation to this, it specifically refers to the Skills Investment Plan for Life sciences.

[79] http://www.gov.scot/Publications/2016/02/8699
[80] Unpublished strategy document
[81] http://www.gov.scot/Topics/Business-Industry/Energy/energystrategy
[82] Scottish Enterprise/Life Sciences in Scotland (2017) *Life Sciences Strategy for Scotland: 2025 Vision*
[83] Life Sciences Scotland (2011) *Scottish Life Sciences Strategy 2011*

- Capitalising on the work of the **innovation** and excellence centres, supporting scale-up operations and growing and strengthening Scotland's entrepreneurial base.
- Continuing to support the move to **sustainable production** of life sciences' products in Scotland.

5.72 Specific objectives focus on encouraging collaboration and innovation in work between the private sector, public sector, and universities; attracting international partnership and investment; retaining the current business and talent base and attracting new innovative companies to Scotland; and supporting improved training and skills development.

Platform for Growth: A Strategic Plan for the Chemical Sciences in Scotland in 2012

5.73 *Platform for Growth: A Strategic Plan for the Chemical Sciences in Scotland*[84] sets out the steps required to grow and develop the chemical industry in Scotland and, in particular, increase manufactured Chemical Science exports by 50% by 2020. Proposed actions to achieve these aims include promoting collaboration between industry and universities as a method to develop innovation. There is also a wider emphasis on promoting the industry and Scotland to several different audiences. This includes attracting international chemical companies to Scotland as a location for inward investment, and school engagement work to promote Chemical Science careers to students. There are also actions relating to work with bodies including Scottish Qualifications Authority (SQA) and Scottish Funding Council (SFC) to improve educational programmes and employee skills.

Life and Chemical Sciences Manufacturing Strategy

5.74 The Life and Chemical Sciences Manufacturing Strategy[85] is seen as a supplementary document to the Life and Chemical Science Strategies set out above. The aim of the plan is to achieve the objectives of the strategies for both Life and Chemical Sciences by increasing the contribution manufacturing makes to both sectors. It has five key themes – Leadership confidence and promoting manufacturing; Research Commercialisation; Technology Development and Scaling; Supply Chains and Re-shoring; and Investing in Scotland. Underpinning these are a number of calls to action, including cross-sector collaboration to ensure a skills pipeline to enable the Life and Chemical Sciences sectors to thrive.

National Plan for Industrial Biotechnology

5.75 The National Plan for Industrial Biotechnology[86] (IB) aims to transform the competitiveness and sustainability of multiple industries in Scotland, which will grow industrial biotechnology-related turnover. Its overarching mission is to see industrial biotechnology related turnover in Scotland reach £900m by 2025. As part of this plan, skills provision is recognised as a priority – IB is reliant on a combination of life sciences, chemical sciences and engineering skills, and sees the provision of relevant cross-disciplinary training as a key priority. The plan therefore aims to enhance the portfolio of training for IB skills, and explicitly through the Skills Investment Plans for Chemical Sciences, Life Sciences, and Engineering. Since the publication of the IB Plan in 2013, the sector has increased its turnover by 18% to £250m in

[84] Scottish Enterprise (2012) *Platform for Growth: A Strategic Plan for the Chemical Sciences in Scotland*

[85] Chemical Sciences Scotland/Life Sciences Scotland (2013) *Life and Chemical Sciences Manufacturing Strategy for Scotland*

[86] Chemical Sciences Scotland/Life Sciences Scotland (2013) *National Plan for Industrial Biotechnology: Towards a Greener, Cleaner 2025*

2015, seen the opening of the IBioIC Scottish Innovation Centre for Industrial Biotechnology, and the sector has developed IB, HND, MSc and PhD programmes.[87]

Engineering, manufacturing and construction action plans

5.76 While there is no overarching national strategy for Engineering, there are sector-specific action plans for sector strengths in Scotland. SE's Subsea Engineering Action Plan[88] identifies key actions to help position Scotland as a global leader in subsea engineering, develop Scotland's subsea innovation infrastructure, and increase investment in innovation to grow Scotland's market share in Oil & Gas and support diversification into other sectors. Actions around innovation, disruptive technologies, and technological challenges in the sector will invariably require adequate skills provision to ensure that Scotland is able to maximise opportunities in international markets.

5.77 *A Manufacturing Future for Scotland*[89] sets out a range of priority actions to complement the growth strategies developed by key manufacturing sectors, such as the Life and Chemical Sciences Manufacturing Strategy outlined above. It recognises that close co-operation between organisations involved in delivering the Manufacturing Action Plan and the various sector leadership groups will ensure alignment between this overarching plan and each industry strategy. It will also address key sectoral challenges, and maximise the impact of Scotland's manufacturing sector. In terms of skills, key actions aim to:

- Deliver concrete initiatives to boost productivity including leadership, employee engagement and skills, energy efficiency and the adoption of circular economy approaches across the manufacturing sector; and
- Address anticipated skill demands by promoting STEM-related subjects throughout the school curriculum and improving engagement between industry and education.

5.78 There are also some specific strategic investments in manufacturing. For example, the recently-announced Lightweight Manufacturing Centre (LMC) will aim to give Scotland a competitive edge in manufacturing processes for materials such as titanium and carbon fibre, ultimately producing lightweight materials which are increasingly being used in the Aerospace, Automotive, Oil & Gas and Renewables industries to increase efficiency and performance and help reduce carbon emissions. This is seen as a key step in the creation of the National Manufacturing Institute for Scotland (NMIS). It is anticipated that this development will drive the establishment of a Manufacturing Innovation District for Scotland.

5.79 The £12 million Oil & Gas Transition Training Fund, administered by SDS, seeks to support unemployed O&G workers to retain and enter a new sectors and occupations and these are often in the STEM field. For example, the fund has supported 19 former Oil & Gas workers to retrain as STEM teachers in 16/17. Similarly, the Decommissioning Action Plan[90] seeks to exploit Scotland's strengths in Oil & Gas decommissioning. It sets out six key objectives to support the development of decommissioning capabilities in Scotland. These cover:

- Improve **information and intelligence** available to stakeholders across the sector and supply chain;

[87] Chemical Sciences Scotland/Life Sciences Scotland (2013) *Building on success: Scotland's Industrial Biotechnology Plan 2015-2025 progress report*

[88] Scottish Enterprise (2017) *Subsea Engineering: Our Action Plan*

[89] Scottish Government (2016) *A Manufacturing Future for Scotland*

[90] Scottish Enterprise (2017) *Decommissioning Action Plan*

- Promote and develop decommissioning **knowledge and capabilities** of Scottish-based supply chain companies;
- Support development and deployment of **technology and innovation** contributing to cost-effective solutions;
- Encourage development of appropriate port and onshore yard **infrastructure**;
- Develop **skills and training** to achieve a flexible, safe and efficient workforce recognised for competency across the breadth of decommissioning activities; and
- International opportunities – identify and develop opportunities for **international trade** and potential **inward investment**.

5.80 As part of the actions for skills and training for Oil & Gas, it is recognised that there is a need to understand the knowledge transfer and wider skills requirements of employers to maximise their potential to adapt or modify their expertise to Oil & Gas decommissioning. This includes the promotion of a new, high-profile MSc in Decommissioning, delivered by the University of Aberdeen and Robert Gordon University.[91]

5.81 The Farmer Review of the UK Construction Labour Model[92] highlights the need for major reform in the construction industry. It makes 10 recommendations on strategic and operational changes required to modernise the industry. The review is a catalyst for reform of the Construction Industry Training Board (CITB), and is driving a technological change in the industry. It is having an immediate impact on the content of training provision, to adapt to technological innovations within construction, such as Building Information Modelling (BIM) and off-site modular construction. It is also helping to identify what a future modernised construction industry may need.

5.82 Other developments such as the Construction Scotland Innovation Centre are helping to drive innovation in the construction industry in Scotland by connecting construction businesses to academic expertise.[93]

Scotland's Digital Future

5.83 *Scotland's Digital Future: A Strategy for Scotland*[94] sets out the steps required to ensure Scotland is equipped to take full advantage of the opportunities offered by the fast growing sector and the increasing demand for digital products and services, including supporting the skills needs of current and future digital technology employers. In particular, it highlights the role that colleges and higher education institutes need to play in supporting the development of a skilled workforce for the digital economy. This includes ensuring that the workforce has the skills required by industry, through both the courses provided and through supporting initiatives such as the E-Skills Placement Programme, where students from universities and colleges across Scotland are placed in IT companies.

Other digital initiatives

5.84 There are a number of initiatives aimed at stimulating the uptake of digital skills, particularly amongst school pupils. One such scheme is the *Digital Xtra Fund*, a new fund that aims to

[91] Ibid., p.21

[92] Cast Consultancy/Construction Leadership Council (2016) *Modernise or Die: Farmer Review of the UK Construction Labour Model*

[93] http://www.cs-ic.org/

[94] Scottish Government (2011) *Scotland's Digital Future A Strategy for Scotland*

widen access for young people to extracurricular computing related projects in Scotland. A partnership of SDS, HIE, Education Scotland and ScotlandIS developed the fund as part of a programme of activity dedicated to developing skills and making extracurricular computing clubs accessible to all young people aged 16 and under in Scotland. It originally had a £250,000 budget, which has since been increased to £400,000. The *Digital World* initiative, led by SDS and the Digital Scotland Business Excellence Partnership, is aimed at promoting careers in the Digital Technologies industry, and the variety of opportunities for careers in these roles. SDS and SFC have also formed a Digital Skills Partnership as part of priority actions around science, technology, engineering and mathematics within an emerging strategy for education and training.

Skills Investment Planning

5.85 Underpinning the workforce and skills requirements of various sector strategies and action plans are Skills Investment Plans (SIPs). They articulate economic and labour market characteristics of key sectors and regions in Scotland, trends in skills and qualification supply, and employers' perspectives on the big skills issues affecting growth. They also set out key recommendations and actions for addressing skills challenges. The SIPs are developed by SDS in partnership with Industry Leadership Groups, development agencies and other key partners.[95]

5.86 There are currently SIPs that are relevant for STEM skills and the STEM Strategy, such as for Chemical Sciences, Engineering, Life Sciences, Engineering, ICT and Digital Technologies, and Construction. Other SIPs that cover STEM skills issues include Food & Drink, Financial Services, and Creative Industries. There is also a SIP for the Highlands and Islands. While each SIP deals with sector-specific issues, or region-specific challenges in the case of the Highlands & Islands SIP, there are a number of commonalities across the SIPS in terms of raising attainment, hard skills levels, improving softer employability skills, and meeting the actual or anticipated skills gaps in the respective industries.

Enterprise and Skills Review Phase 2

5.87 In May 2016 the First Minister announced an end-to-end Enterprise and Skills review[96] to ensure that all public agencies are delivering the joined-up support that young people, universities, colleges, training providers, businesses and the workforce need. The overarching aim was to ensure a simpler and more coherent enterprise and skills support system. The Phase One Report contained 10 recommendations which focused on ensuring coherence and a simpler, more flexible and cost-effective system of national and local support. Phase 2 of the Review commenced in November 2016, with nine projects being established in order to take forward the Phase One Report recommendations.

5.88 There are two projects of relevance to this study:

- **Skills alignment**: The ambition driving this project is to develop a high performing and responsive skills system which meets the changing needs of learners and employers. The purpose of this project is to improve the alignment of services supporting the development of skills in Scotland. In particular, this will involve joint working between SFC and SDS to improve alignment of their functions to enhance planning of further and higher education and skills and to provide better outcomes for learners and employers. It will involve identifying

[95] http://www.skillsdevelopmentscotland.co.uk/what-we-do/partnerships/skills-investment-plans/

[96] Scottish Government (2017) *Enterprise and Skills Review: Report on Phase 2*

skills needs in partnership with industry and working with colleges, universities and training providers to respond to these skills needs. It will also co-ordinate and consider the effectiveness of investment in further and higher education and skills to ensure there is the right balance of provision across age groups.

- **Learner Journey**: The purpose of this project is to review education provision for all 15-24 year olds so their learning journey is as efficient and effective as possible and provides stepping stones to success for those needing most support. This aims to provide clearer routes for learners into employment or further study and to maximise its contribution to productivity and inclusive growth.

Youth Employment Strategy

5.89 Scotland's Youth Employment Strategy was published by Developing the Young Workforce, a Scottish Government Commission, in 2014. The strategy sets out the findings of the Commission for Developing Scotland's Young Workforce and includes a series of recommendations on how best to overcome youth unemployment in Scotland through actions around schools, colleges, apprenticeships and employers. Embedded in the YES is addressing gender segregation and other inequalities in apprenticeships.

5.90 The strategy contains a number of plans of relevance to STEM industries and skills. In particular there is an emphasis upon colleges and vocational education being shaped to address the needs of the economy and, where appropriate, STEM industries. There is also a focus on increasing STEM apprenticeship opportunities, for Higher Level apprenticeships – offering a work-based degree level qualification – and Modern Apprenticeships. Another implementation point of relevance to STEM is plans to develop partnerships between STEM employers and school to help offer a sense of real-life background to STEM learning and teaching. The strategy also discusses issues around gender stereotyping which are of relevance to STEM skills and industries. Planned implementations to tackle this include the development of plans on how to reduce gender imbalance on college courses.[97]

SDS Career Education Standard

5.91 A key part of the DYW programme, the Career Education Standard is guidance on career education for schools and their partners produced for practitioners working with children aged 3-18 developed by Skills Development Scotland, Education Scotland, the Scottish Government and other national bodies, delivered as part of DYW. As well as a document outlining the guidance, a suite of resources has been produced for practitioners working with children aged 3-18. The resources are intended to stimulate reflection on areas of strength and development for career education. They can be used by individuals or in a group for discussion or career-long professional learning (CLPL). It is intended that more resources will be added to the programme as it grows.[98]

5.92 This is an important initiative for STEM as it will help to promote and develop career education across the educational spectrum. This could potentially help to improve understanding amongst children and young people of the STEM careers available to them and how the STEM skills they have learned in an educational environment can be translated into the labour market. The STEM strategy refers to the Careers Education Standard as being a method

[97] http://www.gov.scot/Resource/0046/00466386.pdf

[98] https://education.gov.scot/improvement/dyw23-career-education-standard-learning-resources

through which to increase knowledge of STEM careers across STEM education and training programmes.[99]

Governance Review

5.93 The Scottish Government's Governance review took place over 2016/17 with the aim of reviewing how education – from early years through to secondary school – is run including, who should take decisions in relation to the education of children and young people and how the funding of education can be made fairer. It also sought to understand how teachers and practitioners can be better supported to do their jobs. After releasing an initial document in September 2016 to seek views on educational governance and set out possible reforms, a period of consultation took place from September 2016 to January 2017, which was followed by the release of a next steps document in June 2017.

5.94 The 'Next Steps' document outlines a number of planned reforms which could benefit STEM in Scotland. Reforms include enhancing the role of pupils and parents in the running of schools through provisions such as enhanced parent councils that will have a role in matters including school improvements and policies. One of the most important next steps from the review is the focus on an increased role for schools and practitioners in decision making.[100]

5.95 From a STEM perspective these reforms could provide a series of benefits. Increased involvement of parents and pupils may help to increase involvement of parents in education as a whole and thus improve their understanding of changing educational and work landscapes with relation to STEM. The impact of moving learning and teaching leadership to school level may depend upon the individual background of practitioners and head teachers and their own prioritisation of STEM. Regional collaborations may help to support schools and practitioners in their delivery of STEM as well as allowing collaboration between different bodies.

National Improvement Framework

5.96 The National Improvement Framework was first announced by the Scottish Government in September 2015 with the first report being launched in January 2016. It is at the centre of Scottish education policy and sets out four key priorities for improvement:

- Improvement in attainment, particularly in literacy and numeracy;
- Closing the attainment gap between the most and least disadvantaged children;
- Improvement in children's and young people's health and wellbeing; and
- Improvement in employability skills and sustained, positive school leaver destinations for all young people

5.97 In order to make improvements in these areas six key drivers for improvement were identified, these are:

- School leadership
- Teacher professionalism
- Parental engagement

[99] http://www.gov.scot/Resource/0050/00509522.pdf
[100] http://www.gov.scot/Publications/2017/06/6880/1

- Assessment of children's progress
- School improvement
- Performance information[101]

5.98 In December 2016 the 2017 National Improvement Framework and Improvement Plan was published. This report aimed to secure clarity by bringing together one document setting out improvement plans from the Delivery Plan for Scottish Education, which was published in June 2016, and the Curriculum for Excellence Implementation, which was published in September 2016, along with more strategic improvement plans.[102]

5.99 The National Improvement Framework will have an important impact across all educational areas, including STEM, as it seeks to make across the board improvements and help to engage children and parents. At the strategic level, improvements in numeracy will help improve STEM skills and closing the attainment gap is another important issue for improving the quantity and quality of STEM skills. Employability skills and positive destinations may also be related to STEM skills due to the growth of employment within STEM industries and the importance of STEM skills across all jobs. In terms of actual delivered activities, the Transition Training Fund, which has provided investment for people from the Oil & Gas sector in the North East to become STEM practitioners, has been particularly important for STEM.[103]

5.100 Aligned to the National Improvement Framework, the Digital Learning and Teaching Strategy[104] for Scotland aims to support Scotland's educators, learners and parents to take full advantage of the opportunities offered by digital technology in order to raise attainment, ambition and opportunities for all, across four objectives:

- Develop the skills and confidence of teachers;
- Improve access to digital technology for all learners;
- Ensure that digital technology is a central consideration in all areas of curriculum and assessment delivery; and
- Empower leaders of change to drive innovation and investment in digital technology for learning and teaching.

The STEM Improvement Framework

5.101 The STEM Improvement Framework is part of proposals made within the overall draft STEM Education and Training Strategy. It was developed by Education Scotland and has been piloted in a number of schools clusters. It seeks to promote continuous improvement across a whole school/cluster against nine criteria including leadership, equalities, skills/careers, professional learning, measurement and partnerships with employers. It is proposed that the STEM Improvement Framework will be published to provide a clear approach for improving STEM learning and teaching within early learning and schools settings through working with further and higher education institutions and employers.[105] This may provide an important link

[101] https://education.gov.scot/improvement/Pages/nifnationalimprovementframework.aspx
[102] http://www.gov.scot/Publications/2016/12/8072/1
[103] http://www.gov.scot/Publications/2016/12/8072/6
[104] http://www.gov.scot/Publications/2016/09/9494
[105] http://www.gov.scot/Resource/0050/00509522.pdf

between schools, employers and further/higher education providers, helping to ensure learners are aware of STEM educational and employment opportunities.

My World of Work

5.102 Whilst not a strategic driver, it is useful to consider the role of My World of Work, a web based service provided by Skills Development Scotland, delivered as part of the DYW programme. It provides services to users to help match them to suitable careers based on their interests, qualifications and ambitions as well as search tools for courses, jobs and modern apprenticeships. My World of Work also provides support and advice for CV writing and interviews. This online service has been designed to complement Skills Development Scotland's Career Management Skills framework[106], which informs the development and delivery of careers information, advice and guidance services delivered in schools and other centres across Scotland.

5.103 The My World of Work service is constantly being developed by Skills Development Scotland working in partnership with industry and education. My World of Work Live is a good example of this. It comprises a set of interactive exhibits and activities designed to bring STEM careers to life for young people, their parents and practitioners. These interactive displays can be found in the Glasgow Science Centre, the Inverness Digital Studio and Careers Lab, Mareel Arts Centre in Shetland and the National Museum of Scotland in Edinburgh as well as via a mobile unit.

5.104 From a STEM perspective My World of Work aims to help users connect their skill set and interests with potential STEM careers and provide information on the available STEM opportunities.[107]

5.105 There are other similar initiatives designed with the same aim, e.g. The Big Bang, the UK Young Scientists and Engineers Fair which is an award-winning combination of theatre shows, interactive workshops and exhibits and careers information from STEM professionals. Whilst immensely popular and attracting some 70,000 visitors last year, it is reported that whilst the Fair sees a reasonable gender balance in terms of visitors and competition entrants, this does not seem to translate into STEM-related subject choices at school.

Making Maths Count

5.106 Making Maths Count is a Scottish Government initiative that aims to overcome negative public attitudes around maths. This is seen to be particularly important given the increasing need for maths in jobs and the wider economy as digital and other STEM sectors continue to grow. The Final Report of the Making Maths Count group was published in September 2016 and it outlines three key areas for promoting maths in Scotland:

- Transforming public attitudes to Mathematics;
- Improving confidence and fluency in Mathematics for children, young people, parents and all those who deliver maths education to raise attainment and achievement across learning; and
- Promoting the value of Mathematics as an essential skill for every career.

[106] https://www.skillsdevelopmentscotland.co.uk/media/40428/career-management-skills-framework.pdf
[107] https://www.skillsdevelopmentscotland.co.uk/what-we-do/our-products/my-world-of-work/

Within these key areas ten recommendations are made. These include commissioning a sustainable culture change strategy; promoting access to career long professional learning for educational practitioners to help enhance individual confidence and overall maths teaching; and Developing the Young Workforce Regional Groups developing and implementing a plan to promote maths as a necessary skill for work.[108] Making Maths Count and the recommendations made in the report have clear implications for helping to improve STEM skills across the Scottish population and emphasising the increased importance of numeracy economically.

Other considerations

5.107 As can be seen from the above section, there is currently a multitude of policies, strategies and plans aimed at developing, supporting and addressing the skills challenges faced by individual STEM sectors and increasing the number of entrants into STEM industries and jobs.

5.108 Skills planning (and subsequent monitoring) activities appear to be carried out to a certain extent in a silo fashion with e.g. standalone sector or regional Skills Investment Plans (SIPs). Adopting a matrix approach to skills planning i.e. ensuring a better alignment between SIPs, Regional Skills Assessments and Sector Action Plans, would perhaps provide for greater alignment of skills needs across all sectors.

5.109 Implementation of the various strategies and plans have resulted in a wide range of initiatives, programmes, activities and partnerships at school, college, University, industry and sector levels which makes for a crowded and sometimes confusing STEM landscape. Feedback suggests that there could be much better alignment, joining up, and perhaps even simplification of approaches to maximise the benefits and impact resulting from information provision and guidance about STEM education and training, careers, skills and sector opportunities.

5.110 There is also a need to reflect on whether national policies always translate well to meet particular geographic needs e.g. in the Highlands and Islands. It is felt that very often national response does not translate to rural (Highland) areas.

Summary

- One of the most significant drivers of change for STEM is that it is projected to grow at a faster rate than the economy as a whole. In the UK as a whole it is projected that STEM employment will grow at three times the rate of the economy as a whole in the period to 2022.
- The growth rate of STEM has also meant that there are skills shortages, particularly for engineering and IT professionals. In 2013 the UK skill shortage to vacancy ratio for the Science, Research, Engineering and Technology professionals category was 43%.
- The development of new technologies is key to the economic growth of STEM industries as a whole. There is a need for those currently in the workforce and future entrants to have the relevant skills for making use of current and developing technologies.
- STEM skills will be key to enabling growth within the Scottish economy. This is both in terms of STEM industries and also STEM skills more generally as they will help to drive productivity, innovation and the development of new technologies.

[108] http://www.gov.scot/Publications/2016/09/3014/2

- The STEM skills shortage is compounded by the profile of the workforce. In particular gender segregation is significant within the STEM workforce, as demonstrated in Chapters 3 and 4. It is estimated women make up just 20% of the STEM workforce and 73% of female STEM graduates go on to work in other industries.
- The STEM workforce is also ageing. This may prevent new STEM entrants to the workforce and will also lead to replacement issues.
- There is also an underrepresentation of people from minority ethnic backgrounds working in STEM industries. Despite 20% of the UK-domiciled university students studying STEM-related subjects at UK HEIs coming from a BME background, BME men are 28% less likely to work in STEM industries than white men.
- A key challenge for STEM is its profile and negative mainstream perceptions around STEM careers and skills.
- The Scottish Government released its draft STEM Education and Training Strategy for Scotland to consultation in November 2016. The strategy underlines the importance of STEM for economic growth and the need to improve training and education to meet demands for STEM skills.
- The proposed STEM strategy is important to the overall Scottish Economic Strategy. STEM can contribute to all four Is: innovation, inclusive growth, investment and internationalisation. Both the STEM sector and skills can particularly contribute to developing innovation.
- More specific strategies from key industries including Life Sciences, Chemical Sciences, Biotechnology, Engineering, Manufacturing and Digital offer initiatives for policy and development that can contribute to the overall STEM strategy. Skills Investment Planning also helps industry to articulate the skills challenges faced by industry, and helps to strengthen the link between education and industry.
- There are a number of programmes and strategies currently in place to offer support, guidance and development around issues of careers guidance and skills. These include Career Education Standard, an initiative to develop career education in schools and their partners, and My World of Work, which are part of the DYW programme. The Youth Employment Strategy also includes important implementation plans for STEM including increasing STEM apprenticeship opportunities and shaping college and vocational education to the needs of STEM industries where appropriate.
- There are also a number of more general education initiatives, including the Governance Review of Education Authorities. Its emphasis on putting schools and practitioners at the heart of education will have important impacts for STEM teaching in schools. The National Improvement Framework is central to Scottish Government education policy. Its strategic focus on numeracy skills and engagement with parents are important for the development of STEM skills.
- The plethora of programmes, strategies and initiatives could lead to silo working and duplication of effort. There is evidence to suggest that there could be better alignment and perhaps simplification to maximise the benefits and impact resulting from support for STEM education and training.

6 STEM education and training provision

Introduction

6.1 This chapter provides an overview of STEM education and skills provision in Scotland, using the definitions outlined in Chapter 2. It looks first at the types of qualifications, awards and training available to workers (and prospective workers) within the sector, and then considers current levels of provision in key areas of school and college provision, apprenticeships and university provision.

6.2 The chapter draws on data from the Scottish Qualifications Authority (SQA), Scottish Funding Council (SFC), Higher Education Statistics Agency (HESA) and SDS regarding provision, as well as desk research into the range of qualifications and awards? available.

6.3 There are recognised limitations on education and training data, such as its retrospective nature, and the fact that data is collated for policy development and for a greater understanding of sectors rather than specifically to identify skills supply and demand mismatches. Further, it should be recognised that there is a wide variety of qualifications being delivered through various teaching/training models, and as such any comparison is not like-for-like.

6.4 It should also be noted that there will be a degree of overlap across the various levels of education. For example, College data will overlap with MA data to an extent, since much SVQ delivery for MAs will be college-based. School college provision is may also be counted twice. Associate students will also be counted at both College and HEI.

6.5 The chapter has been prepared recognising these limitations to provide an overview of education and training activity within STEM-related subject areas at a variety of qualification levels. It does not attempt to present a total potential pipeline figure for STEM at this stage.

Qualifications and Awards

6.6 There are a range of qualifications and awards which can be undertaken by individuals to support the development of the STEM skills required specifically in STEM sectors and for application across the economy. Due to the wide range of STEM-related roles available (as outlined in Chapter 4), and the specialised skills required for many of these, many qualifications are tailored to specific skills or job roles. There is however an increasing focus on transferable numeracy, analytical and problem solving skills within STEM-related subjects and qualifications. The core qualifications offer is summarised below with details of the scale of provision and subject areas covered later in the chapter. A number of these qualifications – SVQs, HNQs and PDAs – are not specifically identified within the rest of this chapter. This is because they are subsumed within the wider college data.

National, Higher, and Advanced Higher level qualifications

6.7 National, Higher and Advanced Higher qualifications are secondary level education qualifications. For STEM-related subjects, these are offered within the broad fields of Mathematics, Sciences, and Technology. National level qualifications are offered at Scottish Credit and Qualifications Framework (SCQF) Levels 1 to 5, Higher level subjects are offered at SCQF Level 6, and Advanced Highers are offered at SCQF Level 7.

Scottish Vocational Qualifications (SVQs)

6.8 Scottish Vocational Qualifications (SVQs) are accredited qualifications based on National Occupational Standards (NOS) and result in a certificate of vocational education. They provide practical, vocational skills for both people already working in the sector and those looking to move into it. For STEM-related subjects, they are developed by the relevant Sector Skills Council, informed by industry and the awarding body. SVQs are provided by colleges and training providers and assess workplace competencies in relation to a specific job role.

6.9 SVQs are available at SCQF levels 4 to 8 (SVQ 1-5), meaning they are suitable for learners in a variety of job roles within STEM industries. The qualifications and their content are split by the purpose of the qualification and the needs of the learners, ranging from 'users' to 'professionals'. SVQs are designed to be undertaken by people working or seeking to work in STEM occupations.

National Qualification Group Awards (NQGAs)

6.10 National Qualification Groups Awards (NQGA) encompass both National Certificates (NC) and National Progression Awards (NPA). They are designed to prepare people for employment or progression to study at HNC/HND level and aim to develop transferable knowledge, including core skills. They are aimed at 16 to 18 year olds or adults in full- or part-time education and are available at SCQF levels 2-6. As identified in Chapter 2, because of the limited availability of detailed data on subject-specific NQGAs, these have been excluded from the definition, though there is scope for future consideration of inclusion.

Higher National Qualifications (HNQs)

6.11 HNQs provide practical skills and theoretical knowledge that meet the needs of a specific sector. They are awarded by the Scottish Qualifications Authority (SQA). Higher National Certificates are at SCQF level 7, and Higher National Diplomas at SCQF level 8. They are available in a number of STEM-related subjects.

6.12 HNCs and HNDs are suitable for those in technical-level and first-line management roles, and some HNDs enable learners to progress into the second or third year of university degrees. They are delivered by colleges, some universities and many independent training providers, and many enable learners to progress from HNC or HND provision onto a degree course, either at college or at university, to further their studies.

Apprenticeships

6.13 Apprenticeships are a key part of the Scottish Government's strategy to tackle the skills gap in Scotland. They enable employers to develop their workforce and allow individuals to gain qualifications whilst in paid employment. The training provided prepares learners for a role in the sector and equips them with the skills required by employers to work in a range of roles. Individuals learn on-the-job and undertake off-the-job learning, usually through colleges or training providers.

6.14 Apprenticeships are available at a variety of SCQF levels. Modern Apprenticeships (MAs) are available at SVQ 2-4 (SCQF levels 5-7) and Technical Apprenticeships are available at SVQ level 5 (SCQF level 8). Graduate Apprenticeships have also recently been launched, providing learning up to SCQF level 11. In addition, Foundation Apprenticeships are a new, work-based learning qualification for pupils in S4 to S6 to complete elements of a MA while they are at school.

6.15 Apprenticeship frameworks are developed for STEM sectors by Sector Skills Councils in partnership with employers and awarding bodies. Modern Apprenticeship frameworks include Engineering Construction, IT and Telecommunications, Life Sciences and Related Science Industries, and Rail Engineering. Foundation Apprenticeship frameworks include Civil Engineering, Hardware and System Support, Scientific Technologies, and Software Development. Graduate Level Apprenticeship frameworks include IT Software Development and Engineering Design and Manufacture.

6.16 Diplomas are developed in line with apprenticeship frameworks to provide competence-based qualifications in line with apprenticeship learning in the workplace.

Professional Development Awards (PDAs)

6.17 PDAs provide qualifications for individuals already working within the sector to enhance their skills. The qualifications are delivered by colleges, training providers and some employers. They include Higher National units and are delivered through a variety of learning mechanisms which can include taught learning, self-directed study, research and practice-based learning. The inclusion of HN units means that candidates can progress from PDAs to complete full HN or SVQ qualifications.

6.18 Reflecting the wide range of STEM occupations, a large number of PDAs are available, providing specialist skills in a number of areas and supporting continuous professional development and improved professional practice. PDAs are available at SQCF levels 6-11, with credit values ranging from 16-64 credits, reflecting the level of content in each PDA and the number of learning hours required to complete them.

Degrees

6.19 There is a vast array of degree subjects which can lead into a career in STEM roles and industries, with the majority of these courses available at both undergraduate and (taught) postgraduate level. These include degrees in Medicine and allied subjects, Biological, Physical and Chemical Sciences, Mathematics and Computer Sciences, Engineering, and Architecture and Planning.

6.20 Higher level qualifications enable individuals within STEM sectors or seeking employment in a STEM sector to significantly enhance their knowledge and specialist skills and Higher Education Institutes (HEIs) provide valuable skilled workers required by the sector.

School Provision

Entries and passes

6.21 Table 6.1 sets out STEM entries and qualifications for Scottish school pupils from 2010 to 2016.[109] In 2016, there were 162,026 passes at SCQF Levels 3 to 5 (National level), 48,741 at SCQF Level 6 (Higher) and 9,145 at SCQF Level 7 (Advanced Higher). Between 2010 and 2016, there has been a marked decline in the number of passes at National level and the pass rate has also declined (though there has been a small increase since 2015). In 2015, Scotland's scores in the PISA assessments were similar to the OECD average in science,

[109] Analysis throughout this section draws on SQA data, which includes state and private schools

maths and reading.[110] The gender breakdown of entries and passes over the 2010 to 2016 period is given at Appendix 4.

6.22 This is in a context of a declining overall school pupil population, and a declining population of school pupils at S4-S6 and a senior phase model which requires a more holistic approach to be taken, rather than viewing individual school years in isolation. In the period 2010-2016, the S4-S6 population declined by around 6% from 135,405 to 127,851, though at S6 level there was a small increase of 4% – a real-term increase of 1,217 to 32,745.111 This will have had some bearing on entry and pass levels. At National level (SCQF Level 3-5), changes to subject choices, qualifications and examinations implemented through Curriculum for Excellence have meant that there is a greater focus on blended and interdisciplinary learning and greater flexibility in the senior phase S4 whereby learners could take a range of qualifications throughout S4 to S6. For some learners this would mean taking fewer subjects in S4 but possibly picking up further SCQF level 3-5 qualifications in subsequent years Therefore, comparing a single year (2016) with a previous single year (2010) not necessarily that helpful and will be increasingly inappropriate in years to come.

6.23 However, the impact at Higher and Advanced Higher level appears to be less pronounced. The number and proportion of passes in STEM-related subjects at Advanced Higher level increased between 2010 and 2016. At Higher level, the number of passes has stayed stable since 2010, peaking in 2015, although the pass rate fell from 2010 to 2016, while at Advanced Higher level the number of passes has increased by 17%. This is in a context of an overall increase in Higher and Advanced Higher entries of 3% and 13% respectively in the period 2010 to 2016. For Higher the subjects contributing to the increase in entries were primarily Human Biology, where entries increased by 47%, and Graphic Communication, where entries increased by 13%. For Advanced Higher the largest increases in entries took place in Chemistry (17%) and Mathematics (14%). It should be noted that data for 2015 and 2016 suggests that, despite recent positive progress, both the number of entries and passes during the most recent year for which data is available have fallen across all qualification levels. Entry and pass data for individual subjects at the three different levels is given at Appendix 5.

[110] Scottish Government (2016) *Programme for International Student Assessment (PISA) 2015: Highlights from Scotland's Results*

[111] http://www.gov.scot/Topics/Statistics/Browse/School-Education/dspupcensus

Table 6.1: STEM entries and qualifications for Scottish school pupils, 2010-2016[112]

	2010	2011	2012	2013	2014	2015	2016	% or p.p.[113] change 2010-2016	% or p.p. change 2015-2016
SCQF 3-5									
Entries	223,423	221,308	222,601	216,227	208,358	205,783	202,797	-9%	-1%
Passes	199,152	198,723	198,393	193,765	165,771	164,174	162,026	-19%	-1%
Pass rate	89.1%	89.8%	89.1%	89.6%	79.6%	79.8%	79.9%	-9.2 p.p.	0.1 p.p.
SCQF 6[114]									
Entries	65,652	66,582	66,670	67,115	70,083	71,027	67,363	3%	-5%
Passes	48,554	49,612	50,155	50,052	51,145	51,759	48,741	0%	-6%
Pass rate	74.0%	74.5%	75.2%	74.6%	73.0%	72.9%	72.4%	-1.6 p.p.	-0.5 p.p.
SCQF 7[115]									
Entries	10,410	11,143	11,686	11,881	12,099	12,388	11,805	13%	-5%
Passes	7,829	8,574	9,029	9,353	9,206	9,510	9,145	17%	-4%
Pass rate	75.2%	76.9%	77.3%	78.7%	76.1%	76.8%	77.5%	2.3 p.p.	0.7 p.p.

Source: SQA, 2017

STEM's relative performance

6.24 In comparison to the overall SCQF pass trends in Scotland over the period from 2010, the decline of STEM passes at National levels 3-5 has not been as severe (a 27% decrease vs 19% decrease respectively), as shown at Figure 6.1. As stated previously, the decline in National passes overall can in part be explained by the fact that through the Curriculum for Excellence pupils are, on average, now being entered for fewer subjects in S4 than they would have been previously, and some schools are changing their entry patterns, as discussed above. Despite strong initial growth in STEM passes at Advanced Higher, this has since levelled out and slowed to the rate of all Advanced Higher passes. However, the flexible senior phase is opening up new learning pathways, and it is anticipated that this will not result in reduced numbers of STEM qualifications when considering the senior phase as a whole.

6.25 It is at SCQF Level 6 (Higher) that STEM passes have failed to keep pace with advances across all subject areas. Higher STEM passes have recently reverted back to 2010 levels, despite a 15% rise in Higher passes across all subject areas over the period.

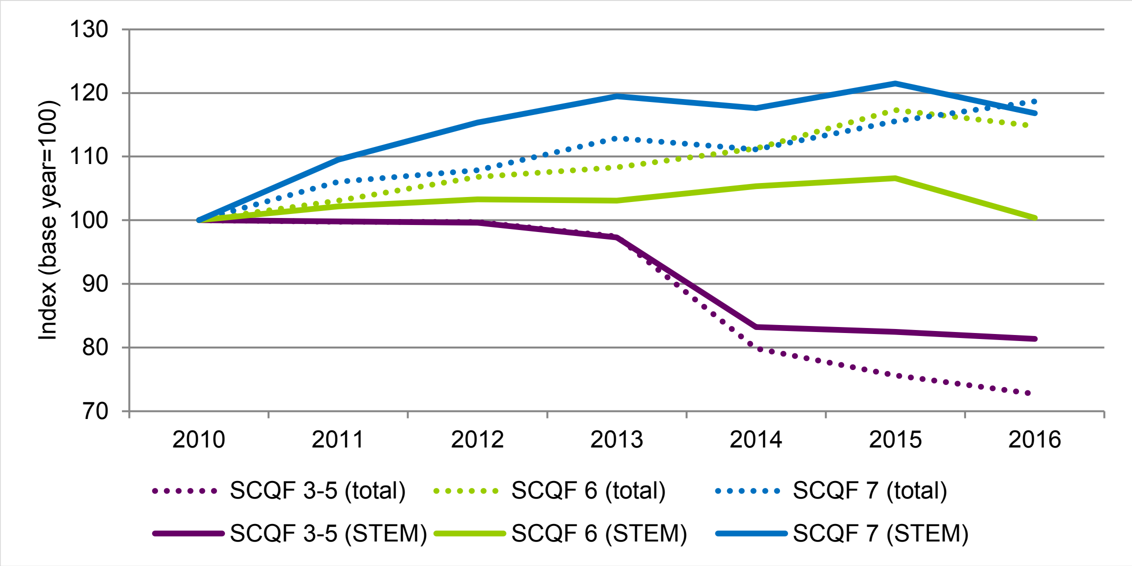
[112] The exclusion of standard level qualifications accounts for the disparity between 2013 and 2014 data

[113] Percentage point

[114] SCQF level 6 data contains both Highers and previous Highers in 2015. Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015. Human biology only available at SCQF level 6.

[115] Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015

Figure 6.1: Total passes and STEM passes for Scottish school pupils, 2010-2016



Source: SQA, 2017

6.26 It is also helpful to note: that

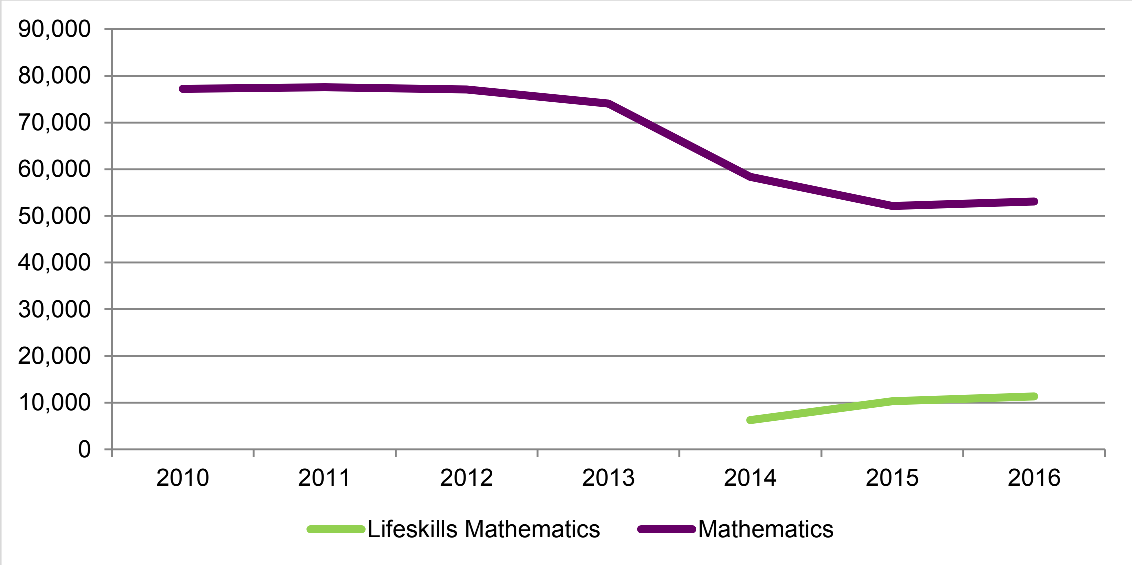
- Having no growth in STEM Higher passes and strong growth in Advanced Higher passes over the six year period suggests that a higher proportion of pupils with STEM Higher passes are continuing on to Advanced Higher attainment.
- Attainment statistics are set in the context of a small decline in school aged residents. The population of 3-18 year olds in Scotland fell by 1%, or almost 14,000 people, between 2010 and 2016, meaning that overall school provision over this period will have fallen slightly.[116]

Contributors to change – SCQF Level 3-5 (National level)

6.27 The most significant contributing factor to the 9.2 percentage point decline in STEM passes at National level between 2010 and 2016 has been the decline in entries and passes in *Mathematics* (Figure 6.2). Passes in *Mathematics* have fallen by nearly 25,000 (31%), though it should be noted that the decline is exaggerated by the exclusion of Standard Grade level qualifications from the data for 2014 onwards. The introduction of *Lifeskills Mathematics* at National level in 2014 has offset some of the decline with 11,321 passes in *Lifeskills Mathematics* National Qualifications in 2016.

[116] https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/mid-year-population-estimates/population-estimates-time-series-data

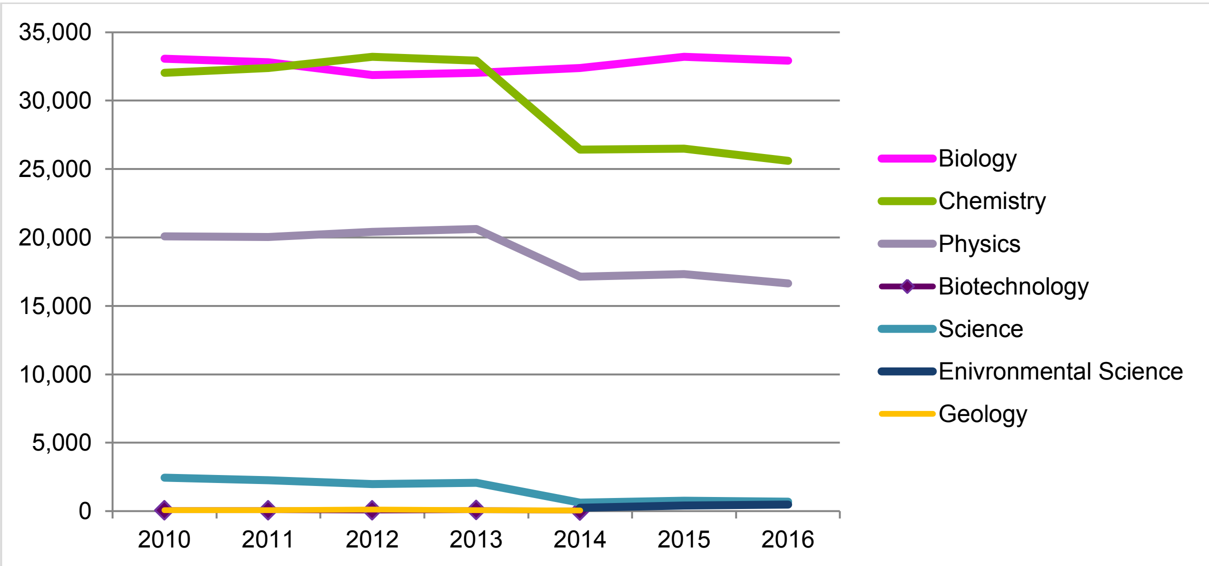
Figure 6.2: STEM passes for Mathematics subjects at National level, 2010-2016



Source: SQA, 2017

6.28 In terms of Science subjects, as shown in Figure 6.3, there has been a significant fall in passes in *Chemistry* at National level, contributed to by a decline in entries, and a smaller fall in the number of *Physics* passes. Figure 6.3 also shows that declines in passes have been recorded since 2014, though prior to this there had been a modest increase in *Chemistry* and *Physics* passes at SCQF Levels 3-5. Against the trend, *Biology* (both *Biology* and *Human Biology*) passes at National Level have stayed stable from 2010 to 2016.

Figure 6.3: STEM passes for Science subjects at National level, 2010-2016[117]



Source: SQA, 2017

6.29 It is more difficult to draw specific trends from National level passes in Technology subjects as there have been a number of curriculum changes, including the withdrawal of some subjects and others being newly introduced. However, the overall trend is a decrease in the number of

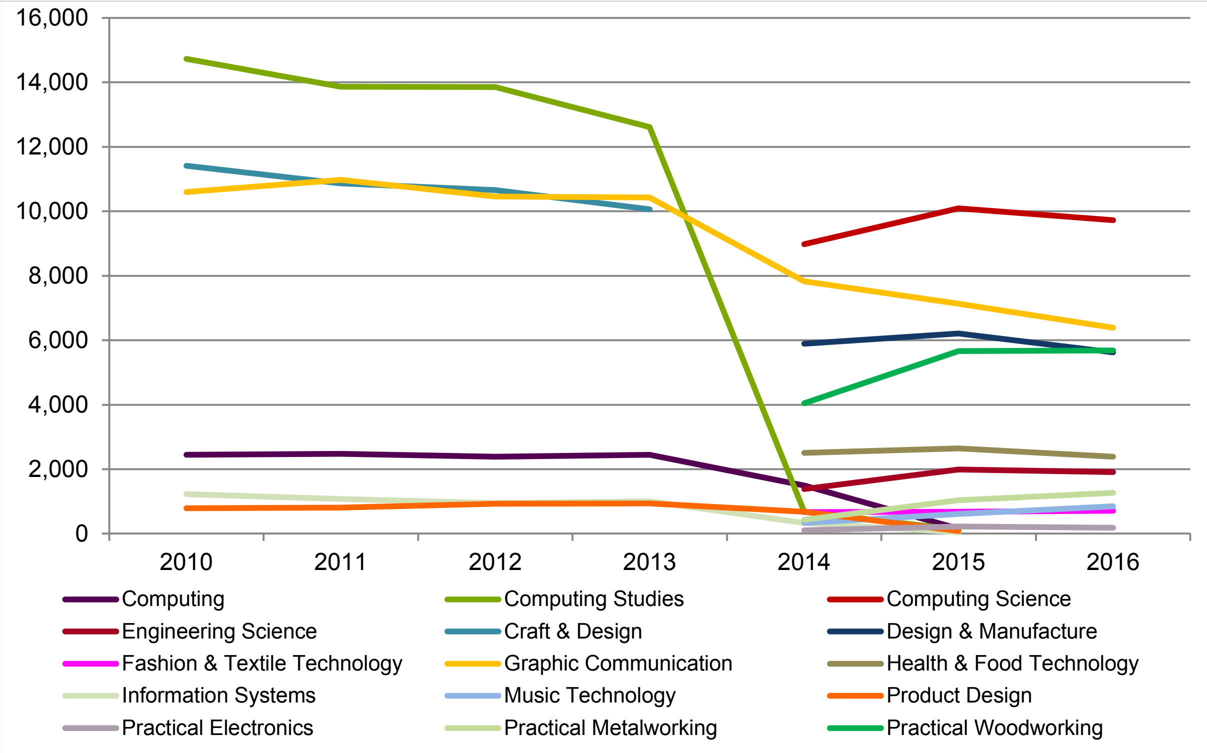
[117] It should be noted that Geology is no longer offered at National level.

passes in Technology subjects between 2010 and 2016 of around 16% (41,199 to 34,726), a greater fall than the decrease in the number of entries over the period of around 8% (44,073 to 40,730).

6.30 As shown in Figure 6.4, there has been a significant decline in *Graphic Communication* passes at National level from 2010 to 2016, over 4,000 in absolute terms and nearly 40% proportionally. Whilst the sharp decline in *Computing Studies* passes is explained by the qualification ceasing to be offered beyond 2014, the new *Computing Science* course has not fully compensated for the previous *Computing* and *Computing Studies* courses. However, *Practical Woodworking* has seen a growth in passes from just over 4,000 in 2014 to over 5,500 in 2016.

6.31 Not considered in the analysis at this stage is the number of school pupils leaving school without a STEM qualification. Given the trends in STEM passes for school pupils in Scotland discussed above, this may be something worthy of consideration in future research.

Figure 6.4: STEM passes for Technology subjects at National level, 2010-2016



Source: SQA, 2017

6.32 The key observations at National level are that:

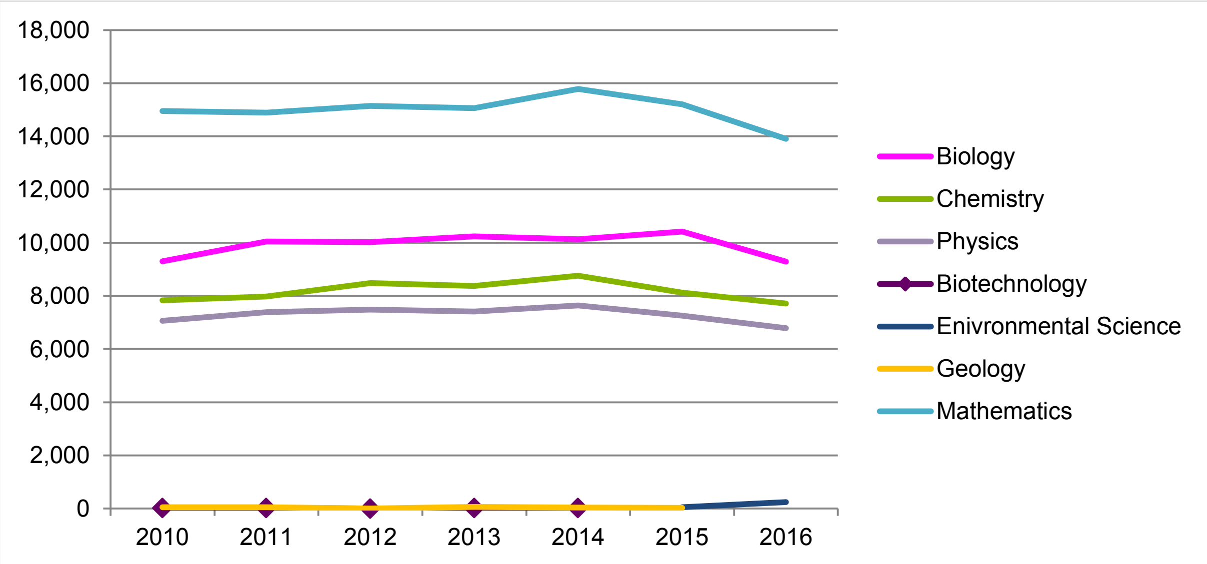
- Declines in *Mathematics* entries and passes have been the primary contributor to overall STEM declines at National level between 2010 and 2016.
- Overall, the number of passes has also declined in Science and Technology subjects.
- Declines in passes across all subject areas have been most pronounced since 2013.
- While there are fewer pupils studying STEM-related subjects across all National levels, a greater proportion of those that do continue to take it at a higher level. Progression occurs

across a wider range of subjects, suggesting a greater degree of specialism at school, particularly at Higher and Advanced Higher level.

Contributors to change – SCQF Level 6 (Higher level)

6.33 A closer look at the data for Science and Mathematics Higher level subjects indicates that the decline in STEM-related subject passes occurred from 2014 onwards (Figure 6.5). Until this point, there had been a modest increase across all subjects. There is a notable decline in the number of *Mathematics* passes from 2014 onwards along with modest declines in *Biology*, *Physics* and *Chemistry* passes. In contrast, passes in *Environmental Science*, which was introduced in 2015, grew over the year to 2016.

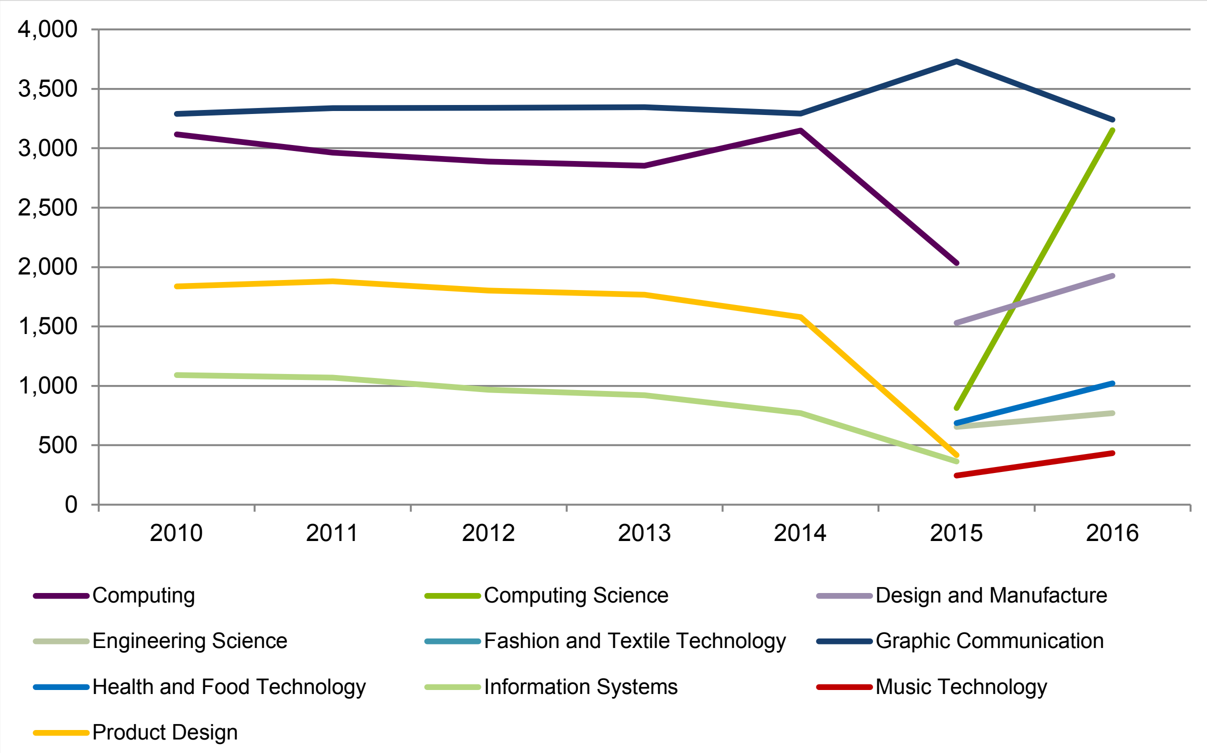
Figure 6.5: STEM passes for Science and Mathematics subjects at Higher level, 2010-2016



Source: SQA, 2017

6.34 As with National Level, it is more difficult to draw out subject level trends with Higher *Technology* passes due to changes in subject provision. However, Figure 6.6 shows that *Technology* passes at Higher Level have been more stable, and over the time period there has been a gradual increase, of around 1,500 passes in total (16%). For example, passes in *Computer Science* in 2016 were higher than the number of *Computing* passes (under any course titles) in any year from 2010 to 2014. *Design & Manufacture* has also seen an increase of nearly 400 passes from 2015 to 2016 with the number of passes in all subject areas increasing between 2015 and 2016, due to a strong rise in entries as new subjects have gained popularity.

Figure 6.6: STEM passes for Technology subjects at Higher level, 2010-2016

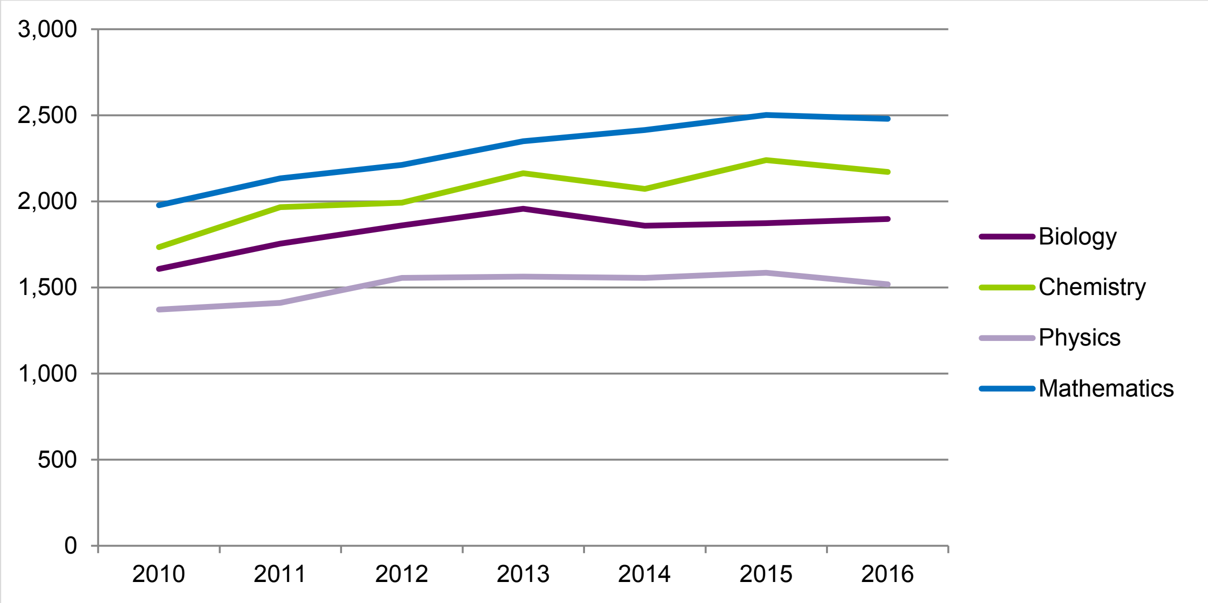


Source: SQA, 2017

Contributors to change – SCQF Level 7 (Advanced Higher level)

6.35 In contrast to National and Higher levels, the number of STEM passes and the overall pass rate at Advanced Higher level has increased from 2010 to 2016. As shown in Figure 6.7, there have been increases in passes for all science subjects at Advanced Higher level over the period 2010 to 2016, accounting for 117% of the overall STEM pass uplift as there was a decline in the number of passes in technology subjects. This has been most significant and consistent for *Mathematics* where the number of passes has grown by over 500 between 2010 and 2016. However, between 2015 and 2016, there were slight reductions in passes in *Chemistry*, *Mathematics*, and *Physics*.

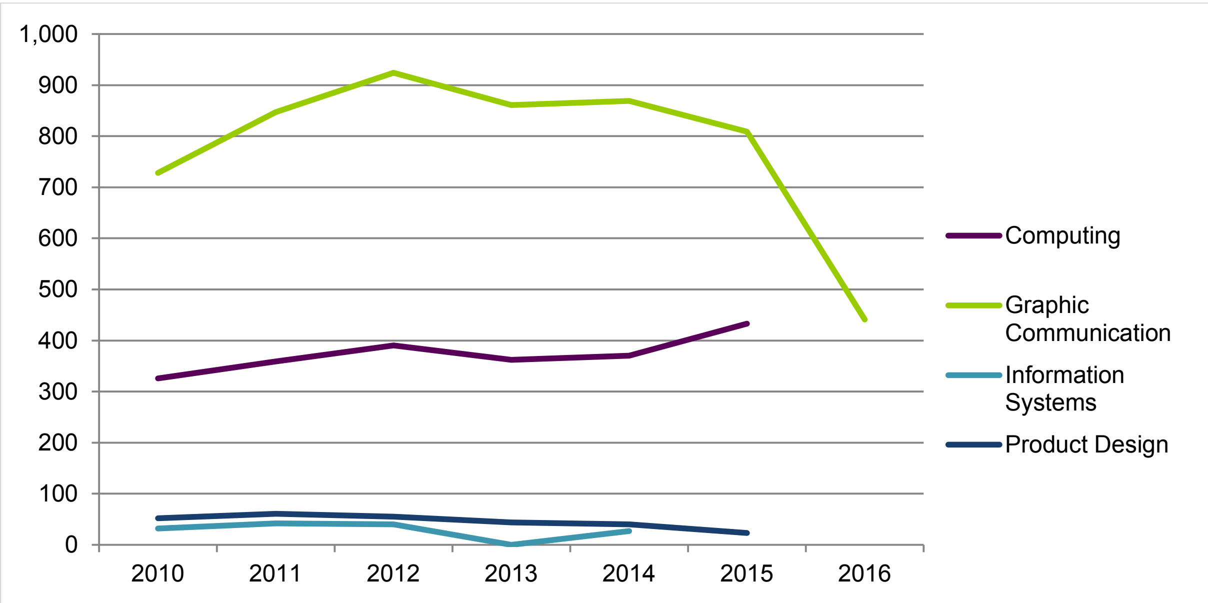
Figure 6.7: STEM passes for Science and Mathematics subjects at Advanced Higher level, 2010-2016



Source: SQA, 2017

6.36 As shown in Figure 6.8, there have historically been fewer passes in Technology subjects than Science subjects at Advanced Higher. Trends by subject have also been less uniform. There has been a significant (nearly 40%) decline in passes in *Graphic Communication*, partly due to a 16% reduction in entries, and *Computing Science* (which does not show on the line chart as it was only established at Advanced Higher level in 2016) failed to match the growth trend in *Computing* Advanced Higher passes as the number of passes was 70 less than that of *Computing* in 2015.

Figure 6.8: STEM passes for Technology subjects at Advanced Higher level, 2010-2016



Source: SQA, 2017

Profile of learners

6.37 Table 6.2 shows that females continue to be underrepresented in STEM-related subjects at school. In 2016, 44.3% of STEM entrants were female at National level, 45.5% were female at Higher level, and 42.1% were female at Advanced Higher level. This is lower in comparison to the female entry share for all school subjects of 48.7% at National level (+4.4 pp), 55.3% at Higher level (+9.8 pp) and 54.7% at Advanced Higher level (+12.6 pp).

6.38 Where female engage in STEM-related subjects, data suggests that they secure a higher success rate than males. Females make up a higher percentage of STEM passes than STEM entrants. This reflects their higher pass rate across all levels, with the difference in pass rate increasing with the level of qualification. In 2016, the female pass rate in STEM-related subjects at Advanced Higher level was 6.6 percentage points higher than that for males, it was 3.8 percentage points Higher at Higher level and 0.1 percentage points higher at National level. For comparison, the female pass rate for all subjects at Advanced Higher level was 6.5 percentage points higher than that for males, it was 5.5 percentage points higher at Higher level and 1.9 percentage points higher at National level. This shows that whilst females do perform better than males in STEM-related subjects, the difference is less pronounced than it is for other subjects. This is, in part, due to relatively similar pass rates for males and females for *Biology*, *Human Biology* and *Chemistry* at Higher level, and *Chemistry* at Advanced Higher.

Table 6.2: STEM school entries and passes, by gender, 2016

Level	STEM entries		All subjects entries		STEM passes		All subjects passes	
	Female share	Male share	Female share	Male share	Female share	Male share	Female share	Male share
SCQF 3-5	44.3%	55.7%	48.7%	51.3%	44.4%	55.6%	49.2%	50.8%
SCQF 6	45.5%	55.5%	55.3%	57.0%	46.8%	53.2%	57.0%	43.0%
SCQF 7	42.1%	57.9%	54.7%	56.7%	44.2%	55.8%	56.7%	43.3%

Source: SQA, 2017

6.39 The differences in gender representation between subjects are also notable. For example, females made up 98% of passes in *Fashion and Textile Technology* at National Level in 2016. This compares with just 7% of passes in *Engineering Science*. In terms of Science subjects, females make up a majority of passes in *Biology* at National level while there is a fairly even gender split in *Chemistry* and *Mathematics*. However, males make up nearly three quarters of *Physics* passes at National level. This pattern largely persists through Higher and Advanced Higher entries and passes, for example males account for over 80% of *Computing Science* entries and passes at Higher and Advanced Higher. The exception is *Mathematics*. Whilst the gender split in *Mathematics* is fairly equal at Higher and National levels, males make up over 60% of both entries and passes at Advanced Higher.

STEM qualified school leavers by local authority

6.40 Data on sub-national school STEM attainment is available for school leavers only, rather than all current school pupils. Table 6.3 shows the attainment of secondary school leavers by their highest level achieved in a STEM-related subject, by local authority. However, it should be noted that local authorities are not like-for-like comparisons because the offer across authorities differ as a result of the flexibility of CfE. Over one third (35%) of school leavers in

Scotland has a STEM pass at SCQF 6 and above while fewer than one in 10 (9%) has a pass at SCQF 7 and above.

6.41 At the sub-national level, Midlothian and East Dunbartonshire have the highest leaver attainment levels for SCQF 3-5 and above; and East Renfrewshire and East Dunbartonshire for both SCQF 6 and above and SCQF 7 and above. It is notable that some of the local authorities reporting the highest levels of STEM attainment are suburban areas such as East Renfrewshire and East Dunbartonshire. Shetland Islands and Na h-Eileanan Siar, rural Highland areas, are also amongst those with the highest STEM attainment at Higher level. For cities, whilst Aberdeen City has high attainment at Advanced Higher level, Dundee City and Glasgow City, both of whom face significant challenges in terms of deprivation, have relatively low attainment at Higher level, and Glasgow City at Advanced Higher level.

Table 6.3: School leaver STEM attainment by level and local authority, 2016

Local authority	**% of all leavers with a STEM subject pass at SCQF level or better**		
	SCQF 3-5 and above	SCQF 6 and above	SCQF 7 and above
Aberdeen City	93.2	37.1	11.3
Aberdeenshire	95.7	36.1	8.9
Angus	96.2	36.8	6.8
Argyll & Bute	92.1	34.7	7.4
Clackmannanshire	94.3	24.5	4.7
Dumfries & Galloway	95.9	37.4	7.6
Dundee City	93.7	27.7	6.3
East Ayrshire	94.1	33.3	7.0
East Dunbartonshire	98.5	51.2	16.4
East Lothian	96.2	34.7	8.6
East Renfrewshire	98.1	61.0	19.3
Edinburgh, City of	95.9	36.3	10.7
Falkirk	96.2	35.7	8.1
Fife	93.7	33.2	8.0
Glasgow City	94.4	25.5	5.5
Highland	93.6	36.1	9.3
Inverclyde	96.5	31.1	6.1
Midlothian	98.6	34.1	7.3
Moray	93.3	32.4	8.4
Na h-Eileanan Siar	95.7	42.3	7.1
North Ayrshire	95.7	32.0	5.6
North Lanarkshire	95.1	31.0	5.2
Orkney Islands	95.8	33.2	7.0
Perth & Kinross	95.3	40.1	12.6
Renfrewshire	95.6	37.2	7.8
Scottish Borders	94.3	37.2	8.2
Shetland Islands	98.2	43.6	9.2
South Ayrshire	97.4	39.9	10.7
South Lanarkshire	95.7	34.3	7.2
Stirling	97.1	39.8	11.3
West Dunbartonshire	96.0	35.6	7.4
West Lothian	98.3	36.4	8.0
Scotland	**95.4**	**35.4**	**8.5**

Source: SQA, 2017

6.42 In terms of the number of leavers, reflecting concentrations of population, Glasgow City (3,137) and North Lanarkshire (2,545) have the greatest number of school leavers with a SCQF 3-5 and above STEM pass. At SCQF 6 and above, STEM leavers are greatest in North Lanarkshire (1,023) and South Lanarkshire (946), while the SCQF 7 and above level, STEM leavers are highest in City of Edinburgh (351) and Fife (299).

6.43 A greater proportion of school leavers are leaving secondary schools in Scotland with an SCQF pass in maths subjects (87%) than in science (74%) and technology (49%) subjects. In contrast, greater proportions of leavers are gaining passes in science subjects at the SCQF 6 and above and SCQF 7 and above levels.

Table 6.4: School leaver STEM attainment by subject, 2016

Level	STEM	Maths	Science	Technology
SCQF 3-5 and above	95.4	87.4	73.6	49.0
SCQF 6 and above	35.4	22.2	23.5	15.3
SCQF 7 and above	8.5	3.9	6.2	1.5

Source: SQA, 2017

6.44 There are significant variations at the local authority level, though it should be noted that the offer across schools and local authority areas is not uniform as a result of different policies on subject choices operating in different authorities, and therefore influencing local curriculum design. Comparisons are therefore not like-for-like. At the SCQF level 6 and above, school leaver passes in maths and science subjects are particularly high in East Renfrewshire (48% and 49% respectively) and East Dunbartonshire (38% and 40% respectively). School leaver attainment in technology subjects at SCQF 6 and above is highest in East Dunbartonshire (22%) and Perth and Kinross (21%). In contrast, school leaver STEM attainment is low in areas of high deprivation – Clackmannanshire, Glasgow City and Dundee City – across all SCQF levels, and particularly in maths and science-related subjects. For example, across Scotland 22.2% of school leavers achieved a pass in Higher mathematics. This compares to 15.1% in Clackmannanshire, 16.4% in Glasgow City and 17% in Dundee City. For science subjects, 23.5% of school leavers in Scotland achieved a Higher pass. This compares to 11.2% in Clackmannanshire, 15.4% in Glasgow City and 15.8% in Dundee City.

6.45 Across all STEM-related subjects, female school leavers have a greater attainment than males at SCQF 6 and above, while a higher proportion of male school leavers have STEM passes at SCQF 7 and above. There is little gender variation in total STEM attainment at SCQF 3-5 and above. Table 6.5 gives a gender breakdown of school leaver STEM attainment in Scotland.

6.46 Analysis by subject shows that technology subject pass rates, at all SCQF levels, amongst males are almost double those of female school leavers. School leaver attainment for maths and science-related subjects are much more gender-balanced, although male leavers report higher maths pass rates at SCQF 7 and above, while SCQF 6 and above passes for science subjects are more prevalent for female leavers.

Table 6.5: School leaver STEM attainment by subject and gender, 2016

Level	STEM		Maths		Science		Technology	
	Female	Male	Female	Male	Female	Male	Female	Male
SCQF 3-5 and above	95.1	95.7	87.5	87.3	74.4	72.8	33.4	64.2
SCQF 6 and above	36.3	34.4	22.4	22.1	24.9	22.1	11.5	19.0
SCQF 7 and above	7.9	9.0	3.1	4.8	6.0	6.3	1.0	2.1

Source: SQA, 2017

School leavers by SIMD Quintile

6.47 Data on pupil attainment according to SIMD[118] quintile is only available for school leavers and by subject area. It is not possible to calculate an overall figure for STEM attainment as pupils may have attained passes in more than one STEM-related subject and it should be noted that some subjects are grouped within the data (see Appendix 6).[119]

6.48 As shown in Appendix 6, there are significant differences in STEM attainment for pupils from different SIMD quintiles, with rates typically higher for those residents in the least deprived parts of the country. At National Level differences are somewhat less pronounced, partly due to the fact that the table has not been split between SCQF levels 3, 4 and 5. Key points to note are:

- Differences are most noticeable in science subjects. For Physics more than double the percentage of school leavers from the least deprived quintile achieved a National pass or better compared with those from the most deprived quintile.
- In 2016 nearly 40% of school leavers from the least deprived quintile held a Higher or better pass in Mathematics. This compared with less than 10% of those from the most deprived quintile.
- There is no STEM-related subject for which more than 9.8% of school leavers from the most deprived quintile had achieved a Higher or better pass. In contrast, for Mathematics, Biology, Chemistry and Physics at least 18% of school leavers from the least deprived quintile achieved a Higher pass or better.
- Looking at Advanced Higher level, there is no STEM-related subject for which more than 1.4% of school leavers from the most deprived quintile achieved an Advanced Higher pass. Whereas for Mathematics, Biology, Chemistry and Physics more than 5% of school leavers from the least deprived quintile achieved an Advanced Higher.
- There are differences between subjects traditionally perceived to be more “academic” relative to those that are “practical”. Whilst attainment for pupils from the most deprived quintile tended to be lower in physical and mathematics, 14.3% of school leavers from the most deprived quintile achieved a National level pass or better in Practical Craft Skills, compared with 7.3% from the least deprived quintile.

6.49 This data emphasises the prevalence of the attainment gap within STEM-related subjects. As a point of comparison, 25% of school leavers from the most deprived quintile achieved a Higher pass or better in English. Less than 10% did so for Mathematics. Though this trend is

[118] Scottish Index of Multiple Deprivation, 2012 classification, which ranks all of the datazones in Scotland in terms of different deprivation domains. 1 is the most deprived quintile, and 5 is the least deprived quintile.

[119] For example, the Construction and Engineering grouping includes Architectural Technology, Construction, Engineering Science, Engineering Skills, Mechatronics and Practical Experiences: Construction and Engineering. Health and Food Technology does not appear in the table because it is grouped with other non-STEM subjects.

also apparent for the least deprived quintile as 65% of leavers achieved a Higher pass or better in English compared to just under 40% for Mathematics. However the attainment gap for Maths at Higher level or better between those from the most and least deprived SIMD quintile is still higher than recorded in England. In order to boost STEM skills to meet economic demand and to help promote inclusive growth it will be important to tackle the STEM attainment gap. It should be noted, however, that levels of deprivation will not be the only influencing factor in differences in levels of attainment between SIMD quintiles. Other factors, such as the quality of teaching between schools, will also be a factor.

Schools summary

- Between 2010 and 2016 there has been a fall in STEM entries (9% - partly due to a reduction in *Mathematics*) and passes (19%) at SCQF level 3-5 (National level). This can in part be explained by changes in the number of qualifications being taken; however, the flexible senior phase is opening new learning pathways. From 2015 to 2016 the drop in entries and passes was far smaller at 1% each and STEM National passes fell at a slower rate than all National passes.
- At Higher level there has been a 3% increase in entries, whilst the number of passes has remained stable. However this masks a fall in the last year of 5% and 6% in entries and passes respectively, and an overall growth in passes for all Highers.
- There has been marked growth in STEM Advanced Higher entries and passes from 2010 to 2016, growing by 13% and 17% respectively. However, as with Higher this masks decline from 2015 to 2016 as entries and passes fell by 5% and 4% respectively.
- Overall, STEM pass rates have fallen at the National and Higher levels but have been increasing at the Advanced Higher level.
- At school, males make up the majority of passes and entries for STEM-related subjects across all levels. However, the female pass rate is higher than the male pass rate at all levels and this is particularly marked at Advanced Higher level at + 6.5 percentage points. For comparison, the female entry share for all subjects is 4.4 percentage points higher than the female STEM entry share at National level, 9.8 percentage points higher at Higher level and 12.6 percentage points higher at Advanced Higher level. Whilst the female pass rate for STEM-related subjects is higher than that for males, the difference is not as pronounced as it is for all subjects.
- The gender split is more notable in certain subjects than others. Whilst *Chemistry* and *Mathematics* are fairly even at National and Higher level, males make up nearly three quarter of passes in *Physics* at National level and females make up the majority of *Biology* National passes. For Technology subjects as a whole, the percentage of male school leavers achieving a National level qualification is nearly double that of females.
- Looking at local authorities, in 2016 Midlothian had the highest percentage of school leavers with a STEM National level qualification at 98.6%, followed by East Dunbartonshire at 98.5%.
- At Higher level and Advanced Higher, East Renfrewshire recorded the highest proportions of qualified leavers at 61% and 19.3% respectively, followed by East Dunbartonshire where 51.2% of leavers had a Higher STEM qualification and 16.4% an Advanced Higher.
- Argyll & Bute had the lowest percentage of leavers with a National STEM qualification at 92.1%. For Higher level, Clackmannanshire had the lowest percentage at 24.5% and for

Advanced Higher it was North Lanarkshire at 5.2%.

- In total 95.4% of school leavers in Scotland in 2016 had a National STEM qualification, 35.4% a Higher and 8.5% an Advanced Higher.
- There is a significant attainment gap between the most and least deprived parts of the country. In 2016 nearly 40% of school leavers from the least deprived SIMD quintile achieve a Higher pass or better in *Mathematics*, compared to less than 10% from the most deprived SIMD quintile.

College provision

6.50 Colleges in Scotland deliver a wide range of education provision relevant to STEM employers and occupations. This section provides an analysis of the College provision in Scotland according to the FE College definition detailed in Chapter 2.[120]

Overall college provision in STEM

6.51 Table 6.6 below shows the total number of enrolments on STEM-related qualifications as a proportion of total provision in Scottish colleges in 2015/16. It also presents the number of credits, which measure the volume of learning activity[121], and provide an indication of the level of activity being delivered.

Table 6.6: College enrolments and credits in STEM-related subjects 2015/16

Subject	Enrolments		Credits		Full Time Equivalents (FTEs)	
	No.	%	No.	%	No.	%
STEM overall	85,063	30%	552,229	32%	41,907	32%

Source: SFC, 2017

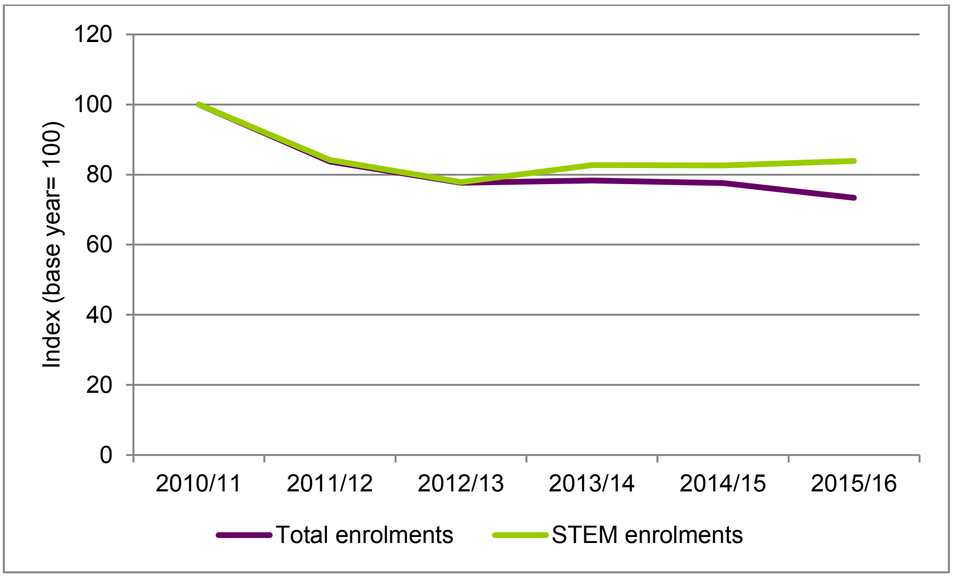
6.52 STEM-related subjects contribute a significant proportion of college enrolments in Scotland, accounting for 30% of the total in 2015/16, with over 85,000 enrolments. As shown at Figure 6.9, this fell from over 100,000 enrolments in 2010/11 to approximately 85,000 in 2011/12 and has remained relatively stable since. This is in contrast to the picture of overall college provision across Scotland, where enrolments have followed a trend of overall decline since 2010/11, though enrolments were relatively stable from 2012/13 to 2014/15.

6.53 It is possible that this overall decline could be in part due to a policy focus on full-time provision, and the regionalisation of colleges in Scotland. FTE data backs up the former – there has been a small increase in STEM FTEs over the period, in contrast to the decrease in enrolments. This recent increase in STEM-related subject enrolments likely reflects the increased recognition of the importance of STEM skills in recent years and initiatives to encourage engagement with these subjects, with the proportion of college enrolments accounted for by STEM increasing from 26% in 2010/11.

[120] This includes SFC, SDS, private and ESF funded college provision

[121] 1 credit is equivalent to 40 hours of learning

Figure 6.9: College enrolments in STEM-related subjects, 2010/11 to 2015/16



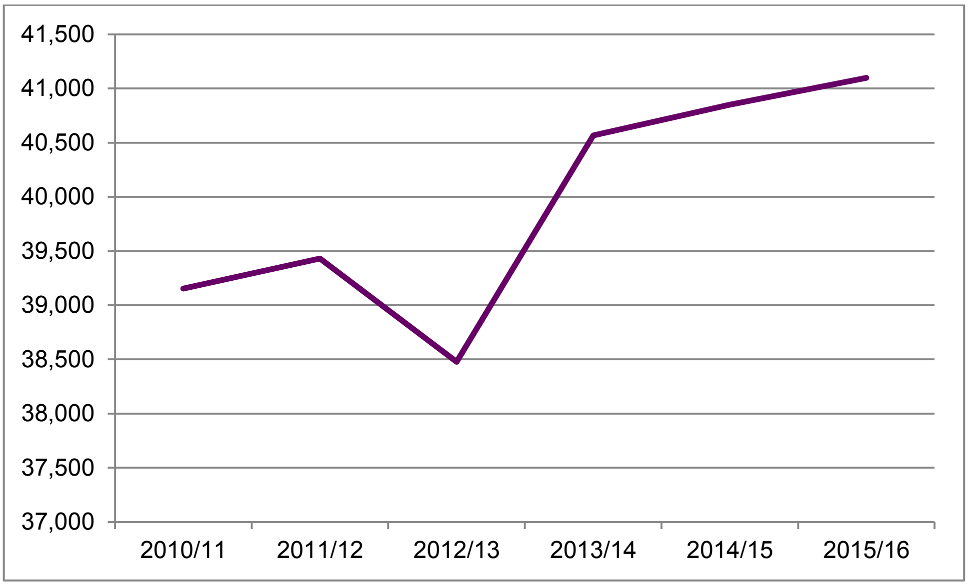
Source: SFC, 2017

6.54 Learning delivered in STEM-related subjects was worth a total of 522,299 credits, accounting for 32% of total credits across college provision in all subject areas. This is two percentage points more than the proportion of enrolments which these subjects account for, suggesting that some STEM provision is more intensive in terms of the number of learning hours than other subjects. The proportion of credits across all subject areas which STEM-related credits account for has risen sharply since 2010/11 (plus six percentage points).[122]

6.55 There were a total of 41,097 Full-time Equivalent (FTE) students on STEM courses in colleges across Scotland in 2015/16. As with enrolments, the share of STEM FTEs has grown since 2010/11, from 29% in 2010/11 to 32% in 2015/16. As shown in Figure 6.10, the number of STEM FTEs has also grown in absolute terms, from 39,152 to 41,097, despite the overall number of FTEs haven fallen within the same period. Looking in more detail at the period from 2010/11 to 2015/16, there was a small fall in the number of STEM FTEs from 2010/11 to 2012/13 before a spike in growth from 2012/13 to 2013/14, followed by more modest growth thereafter. This again reflects increasing recognition of the importance of STEM-related subjects.

[122] Pre 2014/15 credits were measured as SUMS and therefore data presented for 2010/13 to 2013/14 are estimated credit values.

Figure 6.10: College FTEs in STEM-related subjects, 2010/11 to 2015/16



Source: SFC, 2017

Provision by region

6.56 Across Scotland, 25 colleges are delivering STEM-related subjects. This includes all of Scotland's regional colleges and the SRUC specialist rural college.

6.57 Whilst STEM-related courses are delivered in all 13 college regions (plus by Scotland's Rural College (SRUC)), it is geographically concentrated (Table 6.7). In 2015/16, provision was greatest in the Glasgow region (East Dunbartonshire, East Renfrewshire and Glasgow City local authorities), with over 13,000 enrolments (15% of the total) worth a total of over 100,000 credits (18% of the total). This was followed by provision in the West, Aberdeen and Aberdeenshire and Fife regions, each having approximately 10,000 enrolments on STEM-related courses. These geographical concentrations of STEM provision remain consistent with trends since 2010, when Glasgow had the highest STEM enrolments, followed by Aberdeen and Aberdeenshire, Fife and then the West region. This is in part driven by variations in subject choices by college. Some colleges in Scotland have more limited STEM offerings than others, and this should be borne in mind.

6.58 In comparison with overall enrolments, the high number of STEM enrolments in Glasgow region reflects the region's large number of overall enrolments – 64,632, over twice the number of any other region. However, the prevalence of STEM enrolments in West, Aberdeen and Aberdeenshire, and Fife to a greater degree reflects the higher share of STEM enrolments at these institutions. The top four institutions[123] for number of overall enrolments are: Glasgow (64,632), Highlands and Islands (31,646), West (25,926) and Lanarkshire (21,992). Enrolments in Glasgow are particularly high in *Electrical* and *Mechanical Engineering* and *Construction*, while West has a concentration of enrolments in *Health Care* and *General Science and Technology*, Aberdeen and Aberdeenshire in *Health Care* and *Mechanical Engineering*, and Fife in *Engineering/Technology*.

6.59 As shown in Table 6.7, areas that have amongst the largest number of STEM enrolments are not necessarily amongst the areas with the largest number of FTEs. For example,

[123] It should be noted that Lanarkshire, Glasgow and Highlands are multi-college regions

Lanarkshire, which is ranked sixth on the basis of STEM enrolments, has the second highest number of STEM FTEs and Fife, which is ranked fourth on the basis of STEM enrolments, is sixth-placed for STEM FTEs. This underlines the increased prevalence of full-time students within certain college regions. Differences in STEM share of all FTEs are also notable. For example, Glasgow, which has the highest absolute number of STEM FTEs and enrolments, has amongst the lowest share of STEM FTEs at 27%. Aberdeen and Aberdeenshire has the highest at 42%, perhaps reflecting the importance of the Oil & Gas industry in this area.

6.60 In a number of regions, most notably West Lothian, Lanarkshire, Edinburgh and Ayrshire, the ratio of credits to enrolments is significantly higher than in other areas, indicating a higher proportion of full-time courses in these areas. These areas (plus Forth Valley) also had high credit to enrolment ratios in 2010/11. Overall credit to enrolment ratios have increased since 2010/11, rising from 5.31 to 6.49 across Scotland, indicating an increase in the intensity of STEM-related courses.

Table 6.7: College enrolments and credits STEM-related subjects by college region, 2015/16

College Region	Enrolments	Credits	Enrolment-Credit Ratio	No of FTEs	STEM % of all FTEs
Glasgow	13,061	100,604	7.70	7,964	27%
West	10,450	56,177	5.38	4,170	35%
Aberdeen and Aberdeenshire	10,057	59,335	5.90	4,338	42%
Fife	9,905	43,659	4.41	3,053	33%
Highlands & Islands	8,092	40,223	4.97	2,971	34%
Lanarkshire	7,436	68,116	9.16	4,817	36%
Edinburgh	6,057	53,986	8.91	4,075	31%
Forth Valley	5,933	30,844	5.20	2,480	38%
Tayside	4,794	33,940	7.08	2,464	32%
Ayrshire	4,506	35,448	7.87	2,529	28%
Dumfries & Galloway	1,772	9,606	5.42	702	33%
West Lothian	1,310	12,421	9.48	916	26%
Landbased (SRUC)	1,122	2,093	1.87	145	11%
Borders	568	5,846	10.29	474	23%
Total	**85,063**	**552,299**	**6.49**	**41,097**	**32%**

Source: SFC, 2017

Please note, this data includes HE provision in colleges

6.61 Across the country, the three largest college providers (in terms of the number of enrolments) for STEM-related subjects are West College Scotland, North East Scotland College and Fife College, which together account for over one third (36%) of total STEM enrolments, and 28% of total STEM FTEs (Table 6.8). The largest seven providers account for 63% of all STEM provision across Scotland in terms of enrolment (60% of FTEs). Some college providers have a more limited STEM offering than others, which will partly explain different levels of STEM uptake across institutions, i.e. it is driven by supply rather than necessarily being demand-driven).

Table 6.8: College enrolments on STEM qualifications – largest providers, 2015/16

College	No. of enrolments	% STEM total	No. of FTEs	% STEM total
West College Scotland	10,450	12%	4,170	10%
North East Scotland College	10,057	12%	4,338	11%
Fife College	9,905	12%	3,053	7%
Edinburgh College	6,057	7%	4,075	10%
New College Lanarkshire	5,948	7%	3,790	9%
Forth Valley College	5,933	7%	2,480	6%
City of Glasgow College	5,613	7%	2,877	7%
Others	31,100	37%	16,314	40%
Total	**85,063**	**100%**	**41,097**	**100%**

Source: SFC, 2017

Full-time/part-time split

6.62 In 2015/16, approximately 27% of enrolments in STEM-related subjects were full-time, accounting for 23,171 full-time enrolments, whilst the remainder of enrolments were to study STEM-related subjects part-time. The prevalence of part-time study at college is not surprising, with many students choosing to study a number of different subjects. However, as would be expected, when looking at credits data, full-time provision accounts for a much higher proportion of the total in STEM-related subjects (67% compared to 33% from part-time enrolments). This suggests, that there may be a considerable number of short courses being delivered.

6.63 Since 2010/11, there has been an increase in the proportion of enrolments in STEM-related subjects which are full-time, rising six percentage points to 21%. There has been a similar increase in the proportion of credits these enrolments account for (+8 percentage points).

Enrolments by subject

6.64 College programme data shows provision according to its Superclass II code (general subject groups), which captures the subject being delivered. There are a wide range of superclasses included in our definition of STEM-related subjects (see Chapter 2 for details) and Table 6.9 presents the 10 with the highest numbers of enrolments.

Table 6.9: College enrolments on qualifications in top 10 STEM Superclass – 2015/16

Superclass	Enrolments		Credits		Credits per enrolment	FTEs	
	No.	% of total	No.	% of total			
Health Care Management/Health Studies	13,511	16%	63,067	11%	4.67	4,748	12%
Engineering / Technology	10,487	12%	39,586	7%	3.77	2,954	7%
Construction	7,152	8%	54,070	10%	7.56	4,015	10%
Mechanical Engineering	5,290	6%	40,160	7%	7.59	2,974	7%
Electrical Engineering	5,255	6%	46,904	8%	8.93	3,293	8%
Science and Technology	3,858	5%	27,752	5%	7.19	2,109	5%
IT: Computer Science / Programming / Systems	3,757	4%	39,590	7%	10.54	3,043	7%
Building/Construction Operations	3,543	4%	29,198	5%	8.24	2,178	5%
Computer Technology	3,315	4%	33,809	6%	10.20	2,473	6%
Vehicle Maintenance / Repair	3,311	4%	32,470	6%	9.81	2,268	6%
Total	**85,063**	**100%**	**552,299**	**100%**	**6.49**	**41,097**	**100%**

Source: SFC, 2017

6.65 *Healthcare management/health studies* and *Engineering/technology* have the highest enrolments of all the STEM superclasses, together accounting for 28% of enrolments (c.24,000) in 2015/16, but just 19% of FTEs. These subjects are followed by *Construction*, with around 7,150 enrolments (8%), *Mechanical engineering* with 5,300 enrolments (6%) and *Electrical engineering* with 5,250 enrolments (6%) in 2015/16.

6.66 Comparing the 2015/16 enrolments to 2010/11, the courses with the highest levels of enrolments were largely the same, with eight of the top ten superclasses in 2015/16 also in the top ten in 2010/11, albeit in a slightly different order. *Science and technology* and *IT: Computer science/programming/systems* now account for an increased share of enrolments compared to 2010 – taking them into the top ten superclasses.

6.67 When considering subjects by credit and FTE data, the same ten most commonly studied subjects are identified. *Healthcare management/health studies* again accounts for the highest share of credits (11%) and FTEs (12%), with construction following closely behind (10% of credits and FTEs). The proportion of the total credit and FTEs base which the superclasses account for varies relative to enrolments, reflecting the variations in hours studied by course. The most notable examples of this are in *Engineering/technology* which accounts for 12% of enrolments but just 7% of credits and *Healthcare management/health studies* which accounts for 16% of enrolments and 11% of credits.

6.68 Enrolment and credit data by subject area shows a considerable variation in terms of the average number of hours studied. For example, the *Food sciences/technology* superclass has the lowest 'credits per enrolment' average of 0.23 credits per enrolment (indicating the average enrolment is for the equivalent of approximately 9.2 hours of study). The equivalent figure for *Ophthalmic services* is 22.0 credits per enrolment, indicating around 880 hours of study. This is borne out by FTE data.

FE/HE Split

6.69 Table 6.10 shows that the majority of college enrolments are at Further Education level, accounting for 81% of student enrolments in STEM-related subjects compared to 19% for

Higher Education. However, reflecting the way in which Higher Education is delivered (with a tendency to focus on just one subject), it accounts for a higher share of credits than enrolments (28%).

Table 6.10: College enrolments on STEM qualifications – FE/HE split 2015/16

Level	Enrolments		Credits	
	No.	% of total	No.	% of total
Further Education	69,254	81%	400,066	72%
Higher Education	15,809	19%	152,232	28%
Total	**85,063**	**100%**	**552,299**	**100%**

Source: SFC, 2017

6.70 Since 2010/11, the trend of Further Education dominating STEM college provision has continued, although the proportion of Higher Education provision within colleges has increased from 15% of enrolments and 24% of credits in 2010/11 to 19% and 28% respectively in 2015/16.

Enrolments by level

6.71 The 35 qualification aims recorded in the SFC data can be coded to the SCQF levels shown in Table 6.11 below. The share of enrolments leading to SCQF Level 7-12 qualifications has risen over the last five years to approximately 19% (16,300 enrolments) in 2015/16. The share of enrolments leading to SCQF Levels 6 and 5 has also increased slightly over the period, accounting for approximately a quarter of enrolments in 2015/16 compared to a fifth in 2010/11. There is a falling share of enrolments at SCQF levels 1-4 and the proportion of enrolments which will not lead to a qualification has almost halved since 2010/11.

Table 6.11: College enrolments on STEM qualifications by level 2015/16

Level	2015/16		2010/11		Change
	Count	%	Count	%	%
SCQF 7 to 12	16,316	19%	15,048	15%	+4pp
SCQF 6	13,713	16%	12,667	12%	+4pp
SCQF 5	7,385	9%	8,313	8%	+1pp
SCQF 1 to 4	1,541	2%	5,146	5%	-3pp
Other Qualifications	22,045	26%	27,849	27%	-1pp
No Qualifications	15,566	18%	32,344	32%	-14pp
Total	**85,063**	**100%**	**101,415**	**100%**	**-16%**

Source: SFC, 2017

Profile of learners

6.72 The age profile of the STEM student cohort is varied and has remained relatively stable over the last five years, with approximately half of the cohort aged 19 or under, compared to 39% for all college enrolments. In 2015/16, 14% of enrolments on STEM-related qualifications were aged under 16 (-5 percentage points since 2010/11) and 34% were aged 16-19 years old (+4 percentage points since 2010/11). Older learners (aged 20+) continue to account for a significant proportion of enrolments, with 19% of enrolments in STEM-related subjects by learners aged 20-24 and 32% aged 25 and over in 2015/16 (with the latter proportion falling since 2010/2011).

Table 6.12: College enrolments on STEM qualifications – enrolments by age 2015/16

Age group	No. of enrolments	% of STEM total	% of total enrolments	Change 2010/11 – 2015/16
Under 16	11,660	14%	9%	-5pp
16-19	29,869	35%	30%	+4pp
20-24	15,898	19%	17%	+4pp
25 and over	27,636	32%	43%	-3pp
Total	**85,063**	**100%**	**100%**	**-16%**

Source: SFC, 2017

6.73 Table 6.13 shows that males accounted for two thirds of college enrolments on STEM qualifications (66%) in 2015/16, whilst females accounted for one third. The gender gap has widened slightly over the last five years, with female participation in STEM-related subjects decreasing from 37% in 2010/11 to 34% in 2015/16 (a fall of 8,762 enrolments). Males account for an even higher proportion of STEM credits (73%), suggesting that males, on average, enrol on more intensive STEM courses than females.

Table 6.13: College enrolments on STEM qualifications – male/female split 2015/16

Gender	Enrolments		Credits	
	No.	% of total	No.	% of total
Male	55,948	66%	402,572	73%
Female	29,074	34%	149,478	27%
Total	**85,022**	**100%**	**552,049**	**100%**

Source: SFC, 2017; excludes 'unknown'

Colleges summary

- STEM-related subjects accounted for 30% of enrolments (85,063) and 32% of credits (552,229) in Scottish colleges in 2015/16.
- As with the general trend for college enrolments, STEM enrolments have declined since 2010/11 but at a lower rate than overall enrolments. However, STEM FTEs have increased. The STEM share of overall enrolments has increased from 26% in 2010/11 to 30% in 2015/16.
- STEM college enrolments and credits are concentrated in the Glasgow college region, accounting for 15% of the total (over 13,000 enrolments) and in West, Aberdeen and Aberdeenshire and Fife which each accounted for around 10,000 enrolments (over a third of STEM enrolments across the three).
- There are high numbers of *Engineering*-related enrolments in Glasgow, Aberdeen and Aberdeenshire and Fife; high numbers of *Health care* enrolments in West and Aberdeen and Aberdeenshire; and high numbers of *Construction* enrolments in Glasgow.
- *Health care management/Health studies* accounted for the highest shares of STEM college enrolments in 2015/16 at 16%, followed by *Engineering/Technology* at 12%.
- In comparison with 2010/11, college enrolments on STEM qualifications in 2015/16 were at a higher level – 19% of enrolments in 2015/16 were on qualifications at SCQF levels 7 to 12, compared with 15% in 2010/11.
- At college level, males accounted for two thirds of STEM enrolments and 73% of credits in 2015/16. This suggests that not only are males more likely to study STEM courses, on

average, they choose more intensive STEM courses.

- Approximately half of STEM college enrolments were by people aged 19 or younger in 2015/16, significantly higher than 39% across all college enrolments.

Apprenticeship family provision

Foundation Apprenticeships

Total starts

6.74 Foundation Apprenticeships (FAs) are two year programmes developed during an early pathfinder design and development stage from 2014-17. The early pathfinders for the period 2014-16 and 2015-17 engaged a range of lead partners in the design and development of Foundation Apprenticeship frameworks and pathfinder delivery models to capture insight and learning to inform future design, development and delivery. The period 2016-18 is the first time that Foundation Apprenticeship starts and cohorts will participate in the fully designed and certified Foundation Apprenticeship Frameworks[124].

6.75 Table 6.14 shows STEM FA starts under the pathfinders and the 2016-18 full programme cohort. There has been a ramp-up of starts to 251 in the 2016-18 cohort. The attrition rate for early leavers is currently around 20%. Mirroring the trend in STEM college enrolments, there is a clear gender imbalance, with males accounting for around 63% of all Foundation Apprenticeship starts.

Table 6.14: STEM Foundation Apprenticeship starts 2014-16

Academic Year	Starts			Currently in Training	Early Leavers	Completers
	Total	Female	Male			
2014/16[125]	72	8	55	-	30	42
2015/17[126]	249	52	197	46	145	58
2016/18	251	94	157	201	50	-

Source: SDS, 2017

Starts by framework

6.76 As Table 6.15 shows, *Social Services and Healthcare* (33%) and *Engineering* (28%) frameworks account for the greatest proportion of STEM starts. Gender imbalance is apparent across the five frameworks with four skewed towards male starts of between 83% (*Civil Engineering*) and 97% (*Information Technology Software Development*) while the imbalance is reversed for *Social Services and Healthcare*, where females account for 93% of starts. This reflects traditional gender patterns evident in the economy. *Social Services and Healthcare* also records a higher than average proportion of starts by learners aged 12-15 – 17% compared to 13% across all frameworks.

[124] Frameworks falling under the STEM definition are outlined in Chapter 2. It should be noted that *Creative and Digital Media* and *Scientific Technologies* frameworks are due to commence in the Academic Year 2017/18.

[125] The data for the initial 14/16 early pathfinders is based on participant information from 63 of the 72 starts

[126] 9 learners from the 2015/17 programme due to complete their Pathfinder Foundation Apprenticeship

Table 6.15: STEM Foundation Apprenticeship starts by framework, 2016-18 cohort

Framework	Starts					Currently in Training	Early Leavers
	Total	Female	Male	12-15	16-19		
Social Services and Healthcare	84	78	6	14	70	64	20
Engineering	71	5	66	8	63	64	7
Civil Engineering	53	9	44	4	49	35	18
Information Technology Software Development	30	1	29	3	27	29	1
Information Technology Hardware Systems Support	13	1	12	4	9	9	4
Total	**251**	**94**	**157**	**33**	**218**	**201**	**50**

Source: SDS, 2017

Starts by geography

6.77 Table 6.16 shows that for the current 2016-18 cohort, FAs are being delivered in 23 of Scotland's 32 local authorities, with concentrations in Highland (14% of starts), Glasgow (11%) and Inverclyde (9%). In Highland, the majority of starts are in *Information Technology Hardware Systems Support* and *Social Services and Healthcare*. In Glasgow, *Engineering* accounts for over half of starts, while in Inverclyde Foundation Apprenticeship starts are in *Social Services and Healthcare* and *Civil Engineering*. Provision is typically focused in a limited number of subject areas with only four local authorities recording starts in three or more frameworks.

Table 6.16: STEM Foundation Apprenticeship Starts by Local Authority Area, 2016-18

	Civil Engineering	Engineering	IT Hardware Systems Support	IT Software Development	Social Services and Healthcare	Total
Highland	6	-	13	4	12	35
Glasgow	3	14	-	3	7	27
Inverclyde	8	-	-	-	14	22
Fife	11	-	-	5	-	16
Renfrewshire	5	-	-	-	10	15
West Lothian	7	-	-	8	-	15
Aberdeenshire	-	10	-	-	4	14
Falkirk	-	9	-	-	5	14
North Lanarkshire	7	2	-	4	-	13
Shetland	-	7	-	-	5	12
Western Isles	-	-	-	-	10	10
East Dunbartonshire	3	3	-	1	2	9
Perth and Kinross	-	9	-	-	-	9
East Renfrewshire	3	-	-	3	-	6
South Ayrshire	-	6	-	-	-	6
Aberdeen City	-	1	-	-	3	4
Angus	-	-	-	-	4	4
Argyll and Bute	-	4	-	-	-	4
North Ayrshire	-	4	-	-	-	4
Stirling	-	-	-	-	4	4
Clackmannanshire	-	2	-	-	1	3
Dundee City	-	-	-	-	3	3
West Dunbartonshire	-	-	-	2	-	2
Total	**53**	**71**	**13**	**30**	**84**	**251**

Source: SDS, 2017

Leaver destinations

6.78 The majority of early leavers remain in education (Table 6.17) with 2016-18 cohort data showing half remained in school and 28% progressed to either Further Education or a Modern Apprenticeship. A further 6% entered employment.

Table 6.17: Foundation Apprenticeship early leaver destinations[127]

Destination	2014-16	2015-17	2016-18
Employment FT / PT	3	14	3
Further Education	5	35	7
Higher Education	2	5	0
Modern Apprenticeship	6	13	7
Other Training	-	4	1
Remain at School	3	66	25
Unemployed	2	3	2
Unknown	-	5	5
Total	**21**	**145**	**50**

Source: SDS, 2017

[127] Early leaver destinations are still to be confirmed

6.79 FA completer data indicates that the majority also remain in education. As with early leavers, Further Education and Modern Apprenticeship are the most frequent destinations (Table 6.18).

Table 6.18: Foundation Apprenticeship completer destinations, 2014-17

Destination	2014-16	2015-17
Employment	1	2
Further Education	13	1
Higher Education	4	-
Modern Apprenticeship	11	2
Potential Further Education	-	8
Potential Higher Education	-	2
Potential Modern Apprenticeship	-	20
Remain At School	13	-
Unknown	-	23
Total	**42**	**58**

Source: SDS, 2017

6.80 There is concern over whether the new FA frameworks will provide an additional stream of STEM entrants, or whether this will divert entrants that would otherwise pursue STEM-related subjects at Higher/Advanced Higher level. The early stage of FA delivery means it is too early to test the concern.

6.81 Additionally, some anecdotal evidence gathered during consultations indicated that there is a potential perception issue with FAs amongst parents. The terminology used around FAs may present an image of low-level qualifications, resulting in negative connotations, and a reluctance for young people to pursue them.

Modern Apprenticeships

6.82 During 2016/17, there were 9,651 registrations on SDS-funded Modern Apprenticeships in STEM-related subjects in Scotland[128]. Of these starts, there were 6,893 achievements, equating to a success rate of 71%.

6.83 The vast majority of STEM starts were by males, accounting for 93% of the total. Over half (53%) of starts were by learners aged 16-19, with a further 17% aged 20-24 and 30% aged 25 or over.

Modern Apprenticeships by framework

6.84 STEM-related Modern Apprenticeships (MAs) are provided in 44 different framework areas in Scotland (see Chapter 2 for the definition applied). As presented in Table 6.19 below, *Construction: Building* was the most commonly started MA in 2016/17, with over 1,500 starts. This is followed by *Automotive* (1,100 starts), *Construction: Civil Engineering* (1,000 starts), *Construction: Technical* and *IT and Telecommunications* (900 starts each).

6.85 In line with the overall profile of STEM apprenticeship provision, the majority of framework areas are dominated by males, which is in line with the overall STEM workforce, and contrasting with university enrolments – in part due to the lack of availability of Apprenticeships in Medicine, and conversely degree-level Construction courses. However, there are a small

[128] Please note that some Modern Apprentices will necessarily also be included in the FE College provision given earlier in the chapter and this figure excludes privately funded training.

number of frameworks (not shown in the table below due to relatively low numbers), in which females make up the majority of starts, including *Dental Nursing* (98% female starts) and *Equine* (81% female starts).

Table 6.19: Provision of MAs in STEM-related subjects – 2016/17[129] - Top 10 frameworks with highest number of starts

Framework	No.	% F	% M	Achievements
Construction: Building	1,527	2%	98%	194
Automotive	1,099	2%	98%	819
Construction: Civil Engineering	997	0%	100%	632
Construction: Technical	905	4%	96%	616
IT and Telecommunications	900	16%	84%	651
Engineering	864	5%	95%	1,151
Electrical Installation	743	1%	99%	198
Construction: Technical Apprenticeship	597	2%	98%	468
Plumbing	398	1%	99%	234
Construction: Specialist	257	0%	100%	144
All other STEM frameworks	1,364	24%	76%	1,786
Total	**9,651**	**7%**	**93%**	**6,893 (71%)**

Source: SDS, 2017

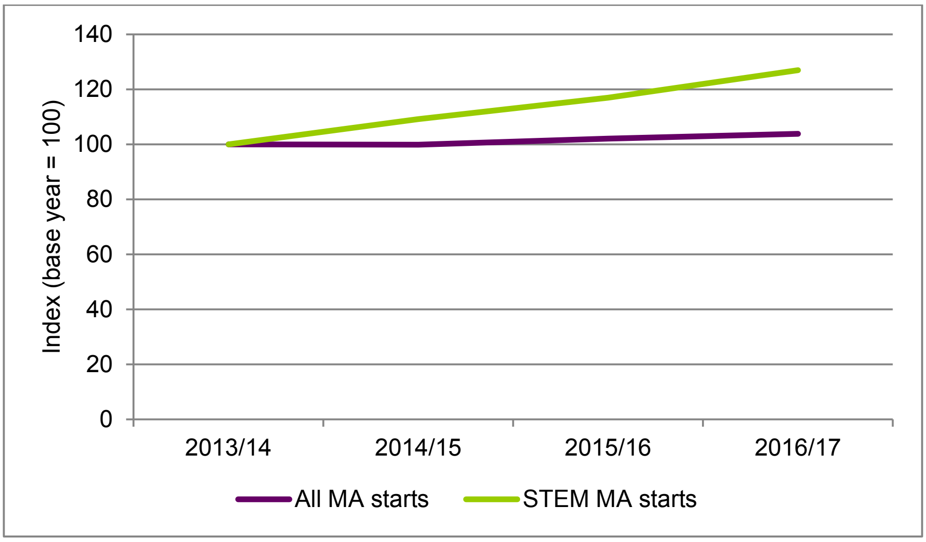
6.86 STEM MA provision has grown strongly in recent years, as more STEM-related frameworks have come on stream. Starts have grown by 27% in the past four years, from 7,600 (across 36 frameworks) in 2013/14 to 9,651 (across 44 frameworks) in 2016/17. As shown at Figure 6.11, this is a faster rate of growth than overall apprenticeship provision, which grew by 4% over the period to 26,262 starts in 2016/17. By 2016/17, STEM starts therefore accounted for 37% of the total, up from 30% in 2013/14.

6.87 STEM MA achievement rates[130] have also grown substantially year-on-year, from 52% in 2013/14 to 71% in 2016/17, narrowing the gap between all apprenticeship provision which had a 78% achievement rate in 2016/17. However, the STEM MA starts have remained male-dominated, at 93%-94% over the period, compared to 59%-60% across all subject areas.

6.88 The largest proportional increases in MA starts over this period have been seen in the *Water Industry* (483%), *Creative and Digital Media* (300%), and *Electronic Security Systems* (193%) frameworks. In real terms, the largest increases were in *Construction: Technical* (+679), *Construction: Civil Engineering* (+480), and *IT and Telecommunications* (+475).

[129] Note: only presents MA provision which is SDS funded and does not include any privately funded apprenticeship training and is therefore likely to underrepresent the number of apprenticeships being delivered across Scotland.
[130] Note: achievers can occasionally relate to prior years' leavers.

Figure 6.11: All and STEM MA starts, 2013/14-2016/17



Source: SDS, 2017

Apprenticeships by level

6.89 In general, MA starts in STEM-related frameworks were at a higher SCQF level than all subject starts in 2016/17. As shown at Table 6.20, nearly three quarters of STEM MAs are at Level 6-7, compared to 61% for all MAs, and STEM has double the proportion of Level 8-9 MAs starts compared to the average (8% v 4%).

6.90 Over time, STEM MA starts have increased proportionately at Level 8-9. At the same time, however, the proportion of STEM starts at the lowest level (SCQF Level 5) has grown from 15% in 2013/14 to 18% in 2016/17, at a time when the proportion has fallen nationally across all frameworks.

Table 6.20: All and STEM MA starts by level

Levels	2016/17		2013/14	
	% of STEM MAs	% of all MAs	% of STEM MAs	% of all MAs
SCQF Level 5	18%	34%	15%	38%
SCQF Level 6-7	73%	61%	81%	59%
SCQF Level 8-9	8%	4%	3%	3%
SCQF Level 11	1%	1%	1%	>1%
Total	**100%**	**100%**	**100%**	**100%**

Source: SDS, 2017

Apprenticeships by geography

6.91 MAs for learners in STEM-related subjects are provided across Scotland, although to varying extent. Lanarkshire has the highest proportion of STEM MA starts, accounting for almost one in five starts across Scotland. This is followed by significant levels of provision in Glasgow and the Highlands and Islands, which together account for a further 25% of provision.

Table 6.21: Provision of MAs in STEM-related subjects 2016/17 by Area

Region	No.	% of total
Lanarkshire	1,728	18%
Glasgow	1,307	14%
Highlands & Islands	1,088	11%
Ayrshire	821	9%
Edinburgh and Lothians	814	8%
West	808	8%
Tayside	643	7%
Fife	622	6%
Aberdeen City & Shire	611	6%
Forth Valley	611	6%
West Lothian	348	4%
Dumfries & Galloway	315	3%
Borders	194	2%
Total	**9,651**	**100%**

Source: SDS, 2017; numbers do not sum due to overlap between regions.

Graduate Level Apprenticeships

6.92 During the 2015-2016 pathfinder Graduate Level Apprenticeships (GLAs), a total of 14 learners began on the Civil Engineering (SCQF level 8) framework delivered by UHI and Inverness College. All learners were male.

6.93 This year, the numbers will be scaling up rapidly. From September 2017, up to 379 GLA places will be available as part of Phase One of the GLA programme. A total of 19 GLA courses will be delivered by nine Higher Education Institutions[131] across the following STEM frameworks:

- IT: Software Development (SCQF level 10 – Honours degree level)
- IT: Management for Business (SCQF level 10)
- Engineering: Design and Manufacture (SCQF level 10)
- Civil Engineering (SCQF level 8 – DipHE level)

6.94 From September 2018, Phase Two of the GLA programme will see an additional 520 GLA places made available. The following new frameworks will be introduced at that time:

- Engineering: Instrumentation, Measurement and Control (SCQF level 10)
- Business Management: Financial Services (SCQF level 10)
- Civil Engineering (SCQF level 10)
- Construction: Built Environment (SCQF level 10)
- IT: Cyber Security (SCQF level 10)

[131] These are University of the Highlands and Islands (with Inverness College), Glasgow Caledonian University, Robert Gordon University, Glasgow Kelvin College, Heriot-Watt University, Edinburgh Napier University, University of the West of Scotland, University of Dundee, and University of Strathclyde.

- IT: Cyber Security (SCQF level 11)
- Business Management (SCQF level 10)

Apprenticeships summary

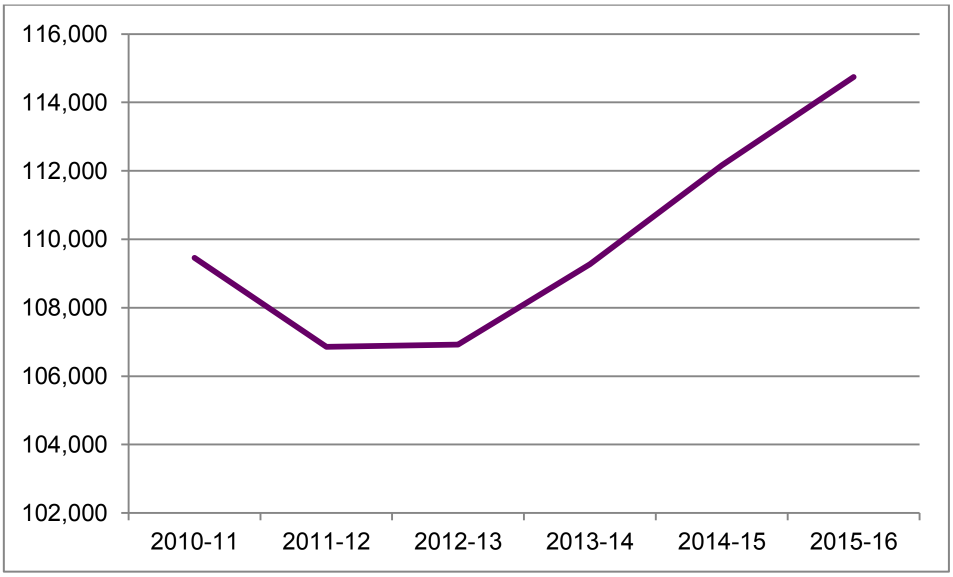
- Foundation Apprenticeships are two year programmes that have been developed from 2014-2017 with the first cohort for the fully designed and certified frameworks starting in 2016. There were 251 starts in 2016, a significant increase from 72 for the first pathfinder cohort in 2014.
- Foundation Apprenticeships are focussed around STEM-related subjects and the frameworks with the highest number of starts for the 2016-18 cohort were *Social Services and Healthcare* (84) and *Engineering* (71).
- Foundation Apprenticeships are being delivered in 23 local authorities with Highland (14%), Glasgow (11%) and Inverclyde (9%) accounting for the highest numbers of starts.
- The attrition rate for early leavers for the 2016-18 cohort of Foundation Apprenticeships is 20%. Of those who have left early, half have remained at school and over 20% have gone on to Further Education or Modern Apprenticeships.
- Over one third of those completing a Foundation Apprenticeship have gone on to a potential Modern Apprenticeship.
- In 2016/17 nearly 10,000 people registered for STEM Modern Apprenticeships in Scotland. STEM starts have grown significantly faster than the all apprenticeship average over the last four years. The success rate stands at 71%.
- *Construction: Building* records the highest number of starts for STEM Modern Apprenticeships at 1,527, followed by *Automotive* at 1,099.
- The Lanarkshire region records the highest provision of STEM Modern Apprenticeships at 1,728 (18%) in 2016/17.
- Males accounted for 93% of starts in STEM Modern Apprenticeships, reflecting male dominance across the majority of frameworks and the workforce (100% on two construction frameworks). A small number of frameworks were dominated by female starts, for example accounting for 98% in *Dental Nursing* and 81% in *Equine*.
- Graduate Level Apprenticeships (GLAs) began with a pathfinder of 14 learners in 2015/16. From September 2017 there will be 379 GLAs available across four frameworks, all representing STEM-related subjects. In September 2018, the number of GLAs will increase again by 520 through the introduction of seven new frameworks, all representing STEM-related subjects.

University Provision[132]

Overall University provision in STEM

6.95 During the 2015/16 academic year there were a total of 114,740 enrolments across full-time and part-time undergraduate and postgraduate courses in STEM-related subjects (see Chapter 2 for the definition) at Scottish universities, accounting for 49% of total enrolments. Between 2010/11 and 2015/16 total enrolments in STEM-related subjects at Scottish universities increased by 5% (+5,285 enrolments), as shown at Figure 6.12. This was accompanied by an increased STEM share of total enrolments from 46% in 2010/11 to 49% in 2015/16, shown at Figure 6.13. The strong and growing level of STEM enrolments reflects the recognised importance of STEM-related subjects and the prevalence of initiatives encouraging the study of STEM-related subjects. It is worth noting that this is within the wider context of a decrease in enrolments at Scottish universities (2% since 2010/11), at least in part driven by a reduction in sub-degree level courses.[133]

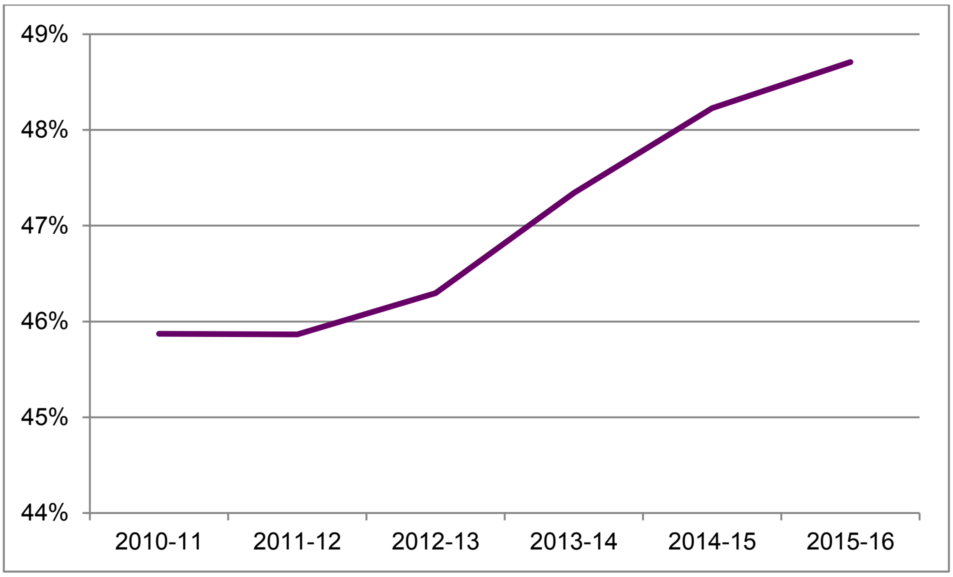
Figure 6.12: University enrolments in STEM-related subjects 2010/11-2015/16



Source: HESA/SFC, 2017

[132] Please see https://www.hesa.ac.uk/data-and-analysis for the data used in this section.
[133] http://www.sfc.ac.uk/communications/Statisticalpublications/2017/SFCST062017.aspx

Figure 6.13: University enrolments in STEM-related subjects as a share of total enrolments 2010/11-2015/16



Source: HESA/SFC, 2017

Provision by subject

6.96 As shown in Table 6.22, *Subjects allied to Medicine* accounted for the highest number (29,130) and share (25%) of STEM enrolments at Scottish universities in 2015/16. This is followed by *Biological Sciences* with a total of 21,850 enrolments and 19% share and *Engineering & Technology*, which had 20,250 enrolments and an 18% share of total STEM enrolments. In comparison with 2010/11, the popularity of STEM-related subjects has stayed fairly stable with the order of preference remaining the same.

Table 6.22: University enrolments by STEM-related subject, 2010/11 and 2015/16

Subject	2010/11		2015/16		Change in Enrolments	
	Count	Share %	Count	Share %	Count	%
Subjects allied to medicine	30,875	28%	29,130	25%	-1,745	-6%
Biological sciences	19,335	18%	21,850	19%	2,515	13%
Engineering & technology	18,245	17%	20,250	18%	2,005	11%
Physical sciences	10,695	10%	11,665	10%	970	9%
Computer science	9,655	9%	10,690	9%	1,035	11%
Medicine & dentistry	7,225	7%	7,655	7%	430	6%
Architecture, building & planning	6,655	6%	5,600	5%	-1,055	-16%
Mathematical sciences	3,765	3%	4,405	4%	640	17%
Agriculture & related subjects	1,575	1%	1,975	2%	400	25%
Veterinary science	1,430	1%	1,520	1%	90	6%
Total	**109, 455**	**100%**	**114, 740**	**100%**	**5285**	**5%**

Source: HESA/SFC, 2017

6.97 Points to note include:

- The biggest decline in enrolments has been in *Subjects allied to medicine* which saw a decrease of 1,745 enrolments (6%). This also represented a contraction in share of total STEM enrolments from 28% in 2010/11 to 25% in 2015/16.
- The biggest decline as a percentage of 2010/11 enrolments was in *Architecture, Building and Town Planning* at 16%. However, numerically the decrease was not so substantial – 1,055 – as enrolment numbers were fairly low to begin with.
- The biggest absolute increase in enrolments was recorded against *Biological Sciences*, which saw a total increase of 2,515 (13%) and a growth in share from 18% to 19%.
- The largest proportional increase in enrolments between 2010/11 and 2015/16 took place in *Agriculture & Related Subjects* at 25%. However, this was starting from a small base and only represented an absolute increase of 400 enrolments.

Full-time/part-time split

6.98 In 2015/16, 79% of enrolments in STEM-related subjects at Scottish universities were for full-time programmes, 20% were part-time and 1% was for sandwich programmes. The STEM full-time enrolment rate was slightly higher than that across all subjects which stood at 76%. From 2010/2011 there was an increase in the proportion of full-time enrolments from 75% to 79%. Reflecting the length of the course and its vocational nature, the full-time enrolment rate was highest in *Veterinary Science* at 98%. Part-time enrolments were most common for *Subjects allied to Medicine* where the share of part-time enrolments was 35%.

Provision by level

6.99 In 2015/16, 77% of enrolments in STEM-related subjects at Scottish universities were for undergraduate programmes and 23% were for postgraduate programmes. The share of postgraduate enrolments for STEM-related subjects was slightly lower than that across all subjects where postgraduate enrolments accounted for 24% of total enrolments. The share of postgraduate enrolments for STEM-related subjects stayed fairly stable from 2010/11 to 2015/16 (22% to 23%). *Veterinary Science* had the lowest rate of postgraduate enrolments at just 9%. Again, this likely reflects the length and vocational nature of the course. The share of postgraduate enrolments was highest for *Agriculture & Related Subjects* at 35% and *Architecture, Building and Planning* at 32%.

Provision by institution

6.100 As shown in Table 6.23, in 2015/16 STEM enrolment was highest at the University of Edinburgh with 14,115 enrolments. This was followed by the University of Glasgow with 12,705. This is to be expected as these are the two largest HEIs in Scotland and also have the highest number of overall enrolments.

6.101 The STEM share of total enrolments was highest at Scotland's Rural College where STEM-related subjects accounted for 75% of enrolments, reflecting the specialist nature of this institution. Glasgow Caledonian University and Heriot-Watt University both had the second highest share of STEM enrolments at 63%. Again this likely reflects the focus these institutions have on scientific and technical subjects.

6.102 From 2010/11 to 2015/16 the biggest absolute increase in STEM enrolments was seen at the University of Edinburgh (1,850), University of Strathclyde (1,830) and University of Glasgow (1,695). Again this reflects the size of these institutions and, at the University of Edinburgh, strong overall growth in enrolments (+4,655). The largest proportional increase was at

Scotland's Rural College (48%) – in line with the growth in Agriculture & Related Subjects identified above. However, this strong growth rate was from a small base, reflective of the small size of the institution. Proportional growth was also high at the University of Stirling (31%), the University of St Andrews (22%), and the University of Strathclyde (22%).

6.103 In terms of STEM share of total enrolments, growth was strongest at Heriot Watt University (11 percentage points), University of Stirling (10 percentage points), and University of Strathclyde (6 percentage points). For Heriot-Watt and Strathclyde this can be seen as a consolidation at universities where STEM-related subjects were already strong, whereas for the University of Stirling it represents a large increase at an institution where STEM-related subjects had previously held a fairly small share.

6.104 The smallest enrolments in STEM at Scottish universities in 2015/16 were at Scotland's Rural College (1,185) and Glasgow School of Art (525). This can be attributed to the small size of these institutions. In terms of STEM share of total enrolments, this was smallest at Glasgow School of Art (25%), which is to be expected due to the specialism of this institution. The University of the Highland Islands (UHI) and University of St Andrews also reported low STEM shares, at 36% and 38% respectively. For St Andrews it should be noted that this still reflects a 3 percentage point growth in STEM share from 2010/11.

6.105 Whilst overall there has been absolute and proportionate growth for STEM-related subjects from 2010/11 to2015/16, this has not been reflected across all institutions. Abertay University, which has specialisms in the area of Technology, saw a reduction in STEM enrolments over this time period of 1,230 (36%). This was in part reflective of an overall decline in enrolments of nearly 1,000 (19%), however, STEM enrolments did fall at a disproportionately high rate. There was also a significant reduction at Edinburgh Napier University where STEM enrolments decrease by 850 (11%). Again this was linked to an overall decline in enrolments of 1,385 (10%).

Table 6.23: University enrolment in STEM-related subjects by institution

Institution	2010/11		2015/16		Change in Enrolments		Change in STEM share of total enrolments
	STEM enrolment	STEM share	STEM enrolment	STEM share	Count	%	
University of Edinburgh (incl. Edinburgh College of Art)	12,835	50%	14,115	46%	1,850	15%	-3%
University of Glasgow	11,010	41%	12,705	47%	1,695	15%	5%
Glasgow Caledonian University	10,275	59%	10,470	63%	195	2%	4%
University of Strathclyde	8,485	42%	10,315	48%	1,830	22%	6%
University of Dundee	9,310	57%	8,770	59%	-540	-6%	2%
University of the West of Scotland	8,100	49%	7,725	50%	-375	-5%	1%
Edinburgh Napier University	7,850	56%	7,000	56%	-850	-11%	-1%
University of Aberdeen	6,870	42%	6,665	48%	-205	-3%	5%
Heriot-Watt University	5,850	52%	6,630	63%	780	13%	11%
Robert Gordon University	6,175	47%	6,165	48%	-10	0%	1%
University of Stirling	3,985	34%	5,210	44%	1,225	31%	10%
The Open University	4,370	No overall data	4,910	No overall data	540	12%	No overall data
University of St Andrews	3,295	35%	4,035	38%	740	22%	3%
Queen Margaret University Edinburgh	3,365	62%	3,145	60%	-220	-7%	-2%
University of the Highlands and Islands	2,930	41%	3,015	36%	85	3%	-5%
Abertay University	3,425	69%	2,195	55%	-1,230	-36%	-14%
Scotland's Rural College	800	78%	1,185	75%	385	48%	-3%
Glasgow School of Art	525	29%	505	25%	-20	-5%	-5%
Total	**109,455**	**46%**	**114,740**	**49%**	**5285**	**5%**	**3%**

Source: HESA/SFC, 2017

Profile of learners

6.106 In 2015/16, 52% of students enrolled in STEM-related subjects at Scottish HEIs were female. This is significantly lower than the 58% across all subjects; however it is high relative to trends in other provision considered earlier in this chapter (for example Apprenticeships; though it should be noted that considers enrolment data only, and does not take into account applications to study). The gender split remained unchanged from 2010/11 to 2015/16.

6.107 There were, however, significant differences in the gender gap between different subjects, which impacts on the overall gender balance of enrolments. For example, in 2015/16, 78% of enrolments in *Veterinary Science* and 81% in *Subjects Allied with Medicines* were female. This compared with just 18% in *Engineering and Technology* and 20% in *Computer Science*. This subject split appears to reflect traditional gender norms with women more represented in subjects associated with caring and less so in areas seen to be more technical. The limited number of females studying engineering and computing is particularly significant as they are projected to experience significant growth. For the most part, the gender split within subjects remained broadly stable from 2010/11 to 2015/16. The only significant changes were:

- In *Agriculture & related subjects* where the share of female enrolments increased from 53% to 63%; and
- In *Architecture, Building and Planning* where the share of female enrolments grew from 34% to 42%.

Table 6.24: University enrolment in STEM-related subjects by gender

Subject	**2010/11**		**2015/16**	
	Female % enrolments	**Male % enrolments**	**Female % enrolments**	**Male % enrolments**
Medicine & dentistry	60%	40%	59%	41%
Subjects allied to medicine	80%	20%	81%	19%
Biological sciences	65%	35%	65%	35%
Veterinary science	74%	26%	78%	22%
Agriculture & related subjects	53%	47%	63%	37%
Physical sciences	43%	57%	43%	57%
Mathematical sciences	44%	56%	43%	57%
Computer science	19%	81%	20%	80%
Engineering & technology	15%	85%	18%	81%
Architecture, building & planning	34%	66%	42%	58%
Total	**52%**	**48%**	**52%**	**48%**

Source: HESA/SFC, 2017

6.108 The age profile of STEM students at Scottish universities remains dominated by under 25 year olds. In 2015/16 25% of the cohort were 16-19, 41% 20-24, 13% 25-29, and 20% were 30 years old or over. This is in line with the profile for all university students in Scotland. The age profile of STEM learners has remained fairly stable since 2010/11. Notable points are:

- The share of 20-24 year olds increased from 38% to 41% whilst 30 and overs fell from 23% to 20%.
- *Mathematical Sciences* and *Physical Sciences* had the highest shares of 16-19 year old enrolments at 35% and 34% respectively.
- *Subjects Allied to Medicine* had the highest share of enrolments from students aged 30 and over at 39%.

6.109 In 2015/16, 66% of students enrolled on STEM courses at Scottish universities were Scottish domiciled, 14% were domiciled in the rest of the UK, 8% in the EU, and 11% were domiciled overseas in non-EU countries (Table 6.25). Points to note are:

- From 2010/11 to 2015/16 there was a slight reduction in the share of Scottish domiciled enrolments from 68% to 66%.

- In 2015/16 *Veterinary Science* had the lowest share of Scottish domiciled students at 31%. This was followed by *Medicine & Dentistry* and *Mathematical Science*, which both had a share of 53%.
- *Subjects allied to Medicine* had the highest share of Scottish domiciled enrolments at 75%. This was followed by *Biological Science (68%)*, *Agriculture & related subjects* and *Computer Science*, which both had a share of 67%.
- For Rest of UK students the highest shares were found in *Medicine & Dentistry* and *Veterinary Science* at 28% and 25% respectively.
- The highest shares of EU domiciled enrolments were in *Computer Science* (15%) and *Physical Sciences* (12%).
- For overseas non-EU domiciled students the highest shares were in *Veterinary Science* (41%) and *Mathematical Sciences* (19%).
- From 2010/11 to 2015/16, the overseas non-EU domiciled share of *Veterinary Science* increased from 34% to 41%.
- There were sizable falls in the share of Scottish domiciled enrolments for *Medicine and Dentistry* (59% to 53%), and *Mathematical Sciences* (62% to 53%).

Table 6.25: STEM enrolment at Scottish universities by domicile

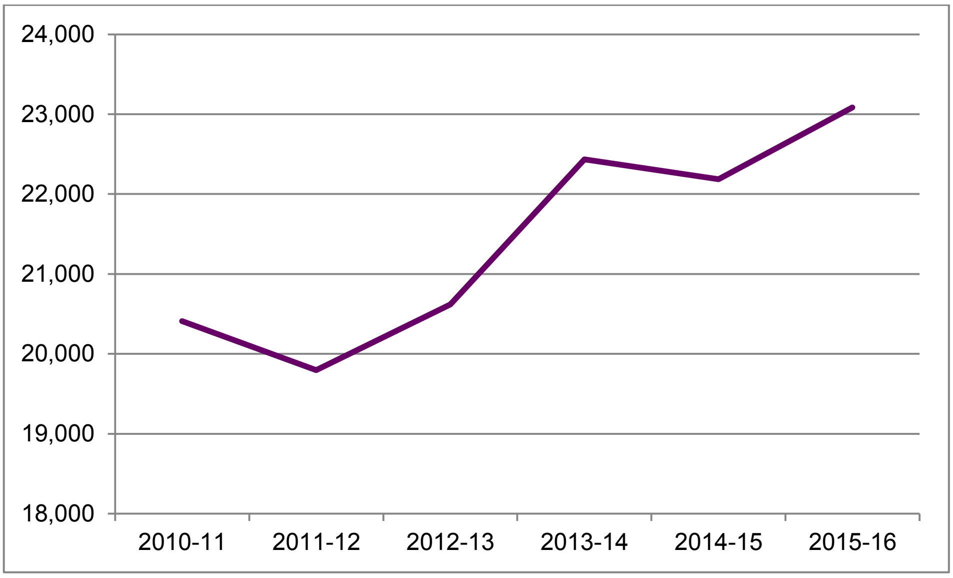
Subject	2010/11 enrolments				2015/16 enrolments			
	Scot %	RUK %	EU %	Non EU %	Scot %	RUK %	EU %	Non EU %
Medicine & dentistry	59%	25%	4%	12%	53%	28%	4%	16%
Subjects allied to medicine	77%	13%	5%	5%	75%	14%	5%	6%
Biological sciences	71%	14%	9%	6%	68%	12%	11%	8%
Veterinary science	33%	29%	4%	34%	31%	25%	4%	41%
Agriculture & related subjects	60%	18%	9%	13%	67%	16%	7%	9%
Physical sciences	64%	20%	9%	8%	61%	18%	12%	10%
Mathematical sciences	62%	20%	6%	12%	53%	19%	10%	19%
Computer science	70%	6%	11%	13%	67%	7%	15%	10%
Engineering & technology	64%	8%	9%	18%	65%	8%	10%	17%
Architecture, building & planning	62%	15%	9%	14%	61%	11%	10%	18%
Total	**68%**	**14%**	**8%**	**10%**	**66%**	**14%**	**8%**	**11%**

Source: HESA/SFC, 2017

Graduates profile

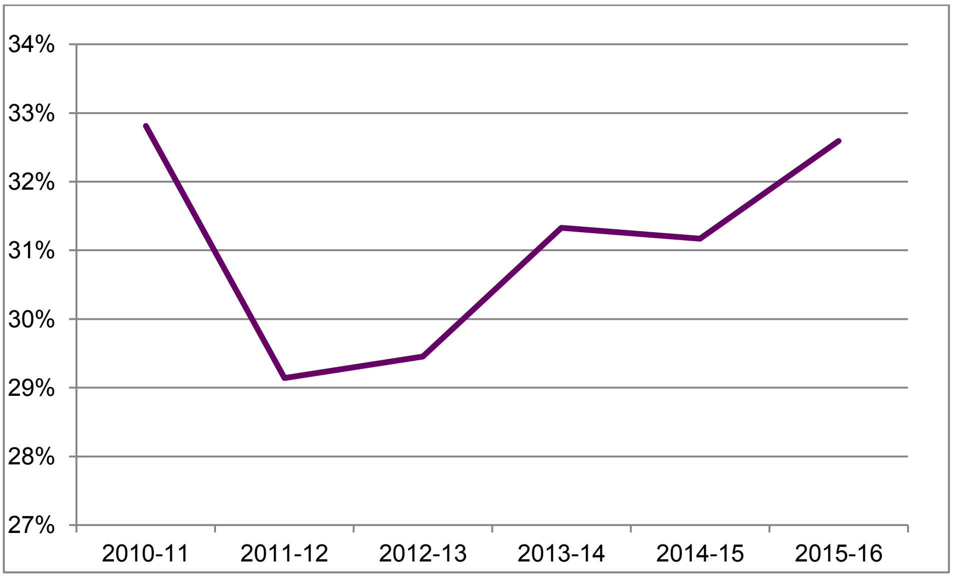
6.110 In total, 23,085 students qualified from Scottish universities in STEM-related subjects in 2015/16 – 33% of the total – following strong growth in recent years (+3,290, or 17% since 2011/12). The share of STEM qualifiers has risen back to the 2010/11 level after dropping as low as 29% in 2011/12 and 2012/13, as shown at Figure 6.14.

Figure 6.14: Scottish university qualifications in STEM-related subjects 2010/11-2015/16



Source: HESA/SFC, 2017

Figure 6.15: Scottish university qualifications in STEM-related subjects as a share of total qualifications 2010/11-2015/16



Source: HESA/SFC, 2017

6.111 In terms of subject coverage of qualifiers, as shown in Table 6.26:

- *Subjects Allied to Medicine* had the highest number of qualifiers from Scottish universities in 2015/16 at 5,250, or 23% of total STEM qualifiers reflecting strong enrolments in this subject area. This was followed by *Biological Sciences* with 4,745 qualifiers, or 21% of total STEM qualifiers.
- The biggest absolute growth in qualifiers between 2010/11 and 2015/16 was in *Biological Sciences* at 1,120, whilst the biggest proportional growth was in *Medicine & Dentistry* at 41%.
- The only decrease in number of qualifiers was in *Architecture, Building & Planning* subjects where there was a proportional decline of 25%, or 455 in absolute terms. *Architecture,*

Building & Planning also saw the biggest decline in share of total STEM qualifiers from 2010/11 to 2015/11, contracting by 3 percentage points.

- *Biological Sciences* saw the biggest growth in share, from 18% to 21%.

Table 6.26: Scottish University Qualifiers by STEM-related subject, 2010/11 and 2015/16

Subject	2010/11		2015/16		Change	
	Count	Share %	Count	Share %	Count	Share %
Subjects allied to medicine	5,200	25%	5,250	23%	50	1%
Biological sciences	3,625	18%	4,745	21%	1,120	31%
Engineering & technology	3,510	17%	3,905	17%	395	11%
Computer science	2,000	10%	2,565	11%	565	28%
Physical sciences	1,820	9%	2,015	9%	195	11%
Medicine & dentistry	1,200	6%	1,695	7%	495	41%
Architecture, building & planning	1,830	9%	1,375	6%	-455	-25%
Mathematical sciences	645	3%	800	3%	155	24%
Agriculture & related subjects	345	2%	445	2%	100	29%
Veterinary science	230	1%	290	1%	60	26%
Total	**20,410**	**100%**	**23,085**	**100%**	**2675**	**13%**

Source: HESA/SFC, 2017

6.112 In 2015/16, 51% of STEM qualifiers from Scottish universities were female and 49% were male. Table 6.27 gives a breakdown of qualifiers by gender and subject. The percentage of STEM female qualifiers is significantly lower than that across all subjects where it is 57%. The gender split has been fairly stable since 2010/11, having been 50:50 at the start of this period and rising to 52% female in 2013/14. As with enrolments, there are significant differences in the gender balance across subjects with points of note including:

- *Subjects Allied to Medicine* and *Veterinary Science* had the highest percentage of female qualifiers in 2015/16 at 81% and 76% respectively.
- *Engineering & Technology* and *Computer Science* had the lowest percentage of female qualifiers at 16% and 20% respectively.
- The biggest increases in the female share of qualifiers were in *Agriculture & related subjects* and *Architecture, Building & Planning* at 18 percentage points and 9 percentage points respectively.

Table 6.27: STEM qualifiers at Scottish universities by gender

Subject	2010/11		2015/16	
	Female % qualifiers	Male % qualifiers	Female % qualifiers	Male % qualifiers
Medicine & dentistry	59%	41%	58%	42%
Subjects allied to medicine	81%	19%	81%	19%
Biological sciences	66%	34%	65%	35%
Veterinary science	76%	24%	76%	24%
Agriculture & related subjects	46%	54%	64%	35%
Physical sciences	45%	55%	46%	54%
Mathematical sciences	50%	50%	46%	55%
Computer science	18%	82%	20%	80%
Engineering & technology	14%	86%	16%	84%
Architecture, building & planning	32%	68%	41%	59%
Total	**50%**	**50%**	**51%**	**49%**

Source: SFC, 2017

6.113 As shown in Table 6.28, in 2015/16, 67% of qualifiers from Scottish universities in STEM-related subjects were aged 20-24, 16% were aged 30 years or over, 12% were 25-29 and the remaining 5% were aged 16-19. The age of qualifiers stayed fairly stable from 2010/11 to 2015/16 with the only notable change being the growth in the share of the 20-24 age group from 63% to 67%. There were some differences between subjects, as examples:

- *Agriculture & related subjects* had by far the largest share of qualifiers aged 16-19.
- *Subjects Allied to Medicine* had by far the highest share of qualifiers aged 30 or over at 35%.

6.114 In 2015/16, 68% of qualifiers in STEM-related subjects from Scottish universities were Scottish domiciled, 11% were domiciled elsewhere in the UK, 9% were domiciled in the EU, and 12% were domiciled non-EU overseas domiciled. From 2010/11 to 2015/16 domicile shares were fairly stable with only minimal changes. The highest shares of Scottish domiciled qualifiers (arguably the group most likely to remain in Scotland after qualifying) were in *Subjects Allied to Medicine* (77%), *Biological Sciences* (69%), and *Engineering & Technology* (68%), whilst the lowest were in *Veterinary Science* (26%) and *Medicine & Dentistry* (47%). The high share of Scottish domiciled qualifiers in *Engineering & Technology* is positive due to the recognised skills shortage in this area.

6.115 The highest shares for Rest of UK domiciled qualifiers were *Medicine & Dentistry* and *Veterinary Science* at 28% and 29% respectively. For EU qualifiers the highest shares were in *Computer Science* (13%) and *Biological Sciences* (12%). Finally, highest shares for overseas non-EU qualifiers were in *Veterinary Science* at 41% and *Mathematical Sciences* at 24%. These shares also reflected high growth from 2010/11, with the overseas non-EU domiciled shares of *Veterinary Science* and *Mathematical Sciences* growing by 11 and 15 percentage points respectively. The biggest declines in share were 13 percentage points for Scottish domiciled students in both *Medicine & Dentistry* and *Veterinary Science.*

Table 6.28: STEM qualifiers at Scottish universities by domicile

Subject	2010/11 Enrolments				2015/16 Enrolments			
	Scot %	RUK %	EU %	Non EU %	Scot %	RUK %	EU %	Non EU %
Medicine & dentistry	60%	26%	3%	12%	47%	28%	4%	21%
Subjects allied to medicine	76%	12%	6%	7%	77%	11%	6%	7%
Biological sciences	72%	15%	9%	4%	69%	12%	12%	7%
Veterinary science	39%	26%	2%	30%	26%	29%	3%	41%
Agriculture & related subjects	68%	10%	10%	13%	76%	9%	7%	8%
Physical sciences	63%	23%	9%	5%	66%	15%	12%	8%
Mathematical sciences	62%	22%	5%	9%	49%	17%	11%	24%
Computer science	70%	5%	13%	12%	73%	5%	13%	9%
Engineering & technology	61%	5%	13%	22%	68%	5%	9%	18%
Architecture, building & planning	61%	14%	11%	13%	65%	11%	9%	16%
Total	**67%**	**13%**	**9%**	**11%**	**68%**	**11%**	**9%**	**12%**

Source: SFC, 2017

Graduate destinations

6.116 In 2015/16, two thirds of full-time STEM first degree leavers from Scottish universities were in UK employment six months after leaving, 19% were in further study, and 4% were unemployed. This compared with 61% in UK employment, 19% in further study, and 5% unemployed for subjects outside of STEM.

6.117 As shown in Table 6.29, destinations varied somewhat between subjects. At 45% and 46% respectively, *Physical Sciences* and *Mathematical Sciences* had the lowest rates of UK employment. These two subject areas also had the highest rates of further study at 37% and 34% respectively. Unsurprisingly, due to their vocational nature, *Veterinary Science* and *Medicine & Dentistry* had the highest rates of UK employment at 89% and 86% respectively.

Table 6.29: Destinations of full-time first degree leavers in STEM-related subjects from Scottish universities, 2015/16

Subject	UK work	Overseas work	Combination of work and further study	Further study	Unemployed	Other
Veterinary science	89%	6%	2%	0%	3%	0%
Medicine & dentistry	86%	0%	1%	11%	1%	1%
Subjects allied to medicine	81%	1%	6%	8%	1%	2%
Computer science	70%	4%	3%	13%	7%	2%
Engineering & technology	65%	3%	3%	18%	6%	4%
Architecture, building & planning	64%	2%	5%	22%	4%	2%
Agriculture & related subjects	63%	5%	6%	20%	3%	4%
Biological sciences	53%	3%	7%	28%	5%	5%
Mathematical sciences	46%	2%	6%	34%	5%	6%
Physical sciences	45%	3%	5%	37%	6%	4%
Total	**66%**	**2%**	**5%**	**19%**	**4%**	**3%**

Source: HESA/SFC, 2017

6.118 Reflecting the demand for STEM skills and growth of STEM industries, 80% of STEM full-time first degree leavers from Scottish universities who had entered UK employment were in professional jobs six months after leaving. This compared with 72% across all subjects. This figure ranged from 99% for *Medicine & Dentistry* and *Veterinary Science* down to just 31% of graduates from *Agriculture and related subjects*. Of those STEM full-time first degree leavers from Scottish universities in UK employment, 66% were working in STEM industries. The most common sector outside of STEM was *Wholesale and retail trade; repair of motor vehicles and motorcycles* where 11% were working.

6.119 STEM industries are often identified as offering higher than economy wide average wages. In 2015/16, UK domiciled first degree leavers from STEM-related subjects at Scottish universities who had entered employment in the UK had a mean and median wage of £23,500 and £22,000 respectively. This compared with a £22,500 mean and £22,000 median across all degree subjects.

6.120 As shown in Table 6.30, there were significant differences between male and female leavers and by degree subject. The mean and median wages for female STEM degree holders were £23,000 and £22,000 respectively. This compared to a mean of £24,500 and median of £24,000 for male STEM degree holders. There are however exceptions to this trend when looking at individual subjects. For example, female mean wages were higher than those for males in *Engineering and Technology* and *Veterinary Science*. Considering figures for both genders, *Medicine & Dentistry* graduates had the highest mean and median wages at £30,000 and £29,500 respectively, whilst *Agriculture and related subjects* had the lowest at £20,000 for both.

Table 6.30: Median & mean wages for UK domiciled full-time first degree leavers in STEM-related subjects from Scottish universities in UK employment by subject and gender, 2015/16

Subject	Female mean wage	Female median wage	Male mean wage	Male median wage	All sexes mean wage	All sexes median wage
Medicine & dentistry	£30,000	£30,000	£30,500	£30,500	£30,000	£30,000
Veterinary science	£27,500	£27,000	£27,000	£25,000	£27,000	£27,000
Engineering & technology	£26,500	£26,000	£25,000	£25,000	£25,500	£25,500
Computer science	£23,500	£23,000	£24,500	£24,000	£24,500	£24,000
Mathematical sciences	£23,500	£22,500	£25,000	£25,000	£24,500	£24,000
Architecture, building & planning	£22,500	£22,000	£22,500	£23,000	£22,500	£22,000
Subjects allied to medicine	£22,000	£22,000	£22,000	£22,000	£22,000	£22,000
Physical sciences	£21,000	£21,500	£21,500	£21,500	£21,500	£21,500
Biological sciences	£19,000	£18,500	£19,500	£19,000	£19,000	£18,500
Agriculture & related subjects	£18,000	£18,000	£19,500	£20,000	£18,500	£18,500
Total	**£23,000**	**£22,000**	**£24,500**	**£24,000**	**£23,500**	**£22,000**

Source: HESA/SFC, 2017

University applicants

6.121 Additional consideration can be given to the scale of applicants to STEM courses at Scottish universities, to further detail the picture of HE level education. As shown in Table 6.31, Universities and Colleges Admissions Service (UCAS) [134] applications[135] for STEM-related subjects from Scottish domiciled applicants have increased from 73,870 in 2012 to 79,610 in 2016 (8% proportionally). In absolute terms, the subjects that have seen the biggest growth are Biological Sciences (1,670) and Computing Sciences (1,630). Proportionally the biggest increases have been in Veterinary Sciences, Agriculture and related (60%) and Technologies (37%). Declines have taken place in Physical Sciences (590), Medicine and Dentistry (480) and Mathematical Sciences (320).

Table 6.31: STEM applications from Scottish domiciled applicants to UK universities by subject, 2012 & 2016[136]

Subject	2012 Applications	2016 Applications	Change in Applications	
			Count	%
Subjects allied to Medicine	20,660	22,100	1,440	7%
Biological Sciences	15,410	17,080	1,670	11%
Engineering	12,730	13,860	1,130	9%
Computing Sciences	5,860	7,490	1,630	28%
Physical Sciences	7,100	6,510	-590	-8%
Medicine & dentistry	5,230	4,750	-480	-9%
Architecture, building and planning	2,740	2,970	230	8%
Veterinary Science, Agriculture & related	1,360	2,170	810	60%
Mathematical Sciences	2,180	1,860	-320	-15%
Technologies	600	820	220	37%
Total	**73,870**	**79,610**	**5,740**	**8%**

Source: UCAS, 2017

6.122 Whilst there has been an increase, growth in STEM applications from Scottish domiciled students has been less than that for all UK domiciled students as all UK applications have increased by 123,414 in absolute terms or 14% proportionally. Table 6.32 shows that there are a number of differences between trends for Scottish domiciled and all UK domiciled STEM applications. For example, *Mathematical Sciences* applications from Scottish students fell by 15% from 2012 to 2016 whereas for all UK domiciled students they increased by 10%. Growth in *Engineering* and *Computer Sciences*, two areas of skill shortage, has also not been as pronounced for Scottish domiciled applications as it has been for all UK applications. For Scottish domiciled applicants *Engineering* and *Computer Sciences* applications grew by 9% and 28% respectively; for all UK applicants *Engineering* applications increased by 30% and *Computer Sciences* applications increased by 41%. However, there has been a more

[134] UCAS mainly covers full-time first degree entrants to university

[135] It should be noted that each applicant can make up to five applications. Applicants can make applications to both STEM and non-STEM courses.

[136] This is UCAS cycle data – this does not directly correspond to academic years, e.g. most (but not all) 2016 applicants will enter in 2016-17.

pronounced increase in *Veterinary Sciences, Agriculture and related* for Scottish domiciled applicants, 60% compared with 11%; and whilst for Scottish domiciled applicants *Technologies* applications increased by 37%, for all UK domiciled applicants they declined by 16%.

Table 6.32: STEM applications from all UK domiciled applicants to UK HEIs by subject, 2012 & 2016

Subject	2012 Applications	2016 Applications	Change in Applications	
			Count	%
Subjects allied to Medicine	306,020	329,630	23,610	8%
Biological Sciences	179,830	226,040	46,210	26%
Engineering	85,660	110,990	25,330	30%
Computing Sciences	67,180	94,420	27,240	41%
Physical Sciences	83,590	88,830	5,240	6%
Medicine & dentistry	74,160	65,250	-8,910	-12%
Architecture, building and planning	26,900	28,270	1,370	5%
Veterinary Science, Agriculture & related	21,880	24,340	2,460	11%
Mathematical Sciences	33,750	37,050	3,300	10%
Technologies	6,860	5,790	-1,070	-16%
Total	**860,942**	**984,356**	**123,414**	**14%**

Universities summary

- In 2015/16 there were 114,740 enrolments in STEM-related subjects at Scottish universities. This accounted for 49% of total enrolments and the number has increased by 5,285 (5%) since 2010/11.

- Subjects allied to medicine had the highest number of STEM enrolments at 29,130 and a 25% share of total STEM enrolments.

- Reflecting their overall status as the two largest universities in Scotland, the University of Edinburgh and University of Glasgow had the highest number of STEM enrolments in 2015/16 at 14,115 and 12,705 respectively.

- STEM share of total enrolments was highest at Scotland's Rural College at 75%, reflecting its specialist nature.

- The biggest absolute increases in STEM enrolments from 2010/11 to 2015/16 were recorded at University of Edinburgh (1,850), the University of Strathclyde (1,830) and University of Glasgow (1,695).

- At Heriot Watt and University of Stirling STEM growth outstripped overall growth in enrolments.

- Across all STEM-related subjects 52% of enrolments were female. This is much lower than the

58% across all enrolments but it counters the trends in Apprenticeship enrolments considered earlier in this chapter.

- Reflecting gender norms, women were more represented in subjects associated with care. They made up 81% of enrolments in Subjects allied to medicine and 78% in Veterinary science but just 18% in Engineering & technology and 20% in Computer science.

- Overall in 2015/16, 68% of qualifiers were Scottish domiciled, but this was much lower for Veterinary Science and Medicine & Dentistry at 26% and 47% respectively.

- In 2015/16, 66% of qualifiers from full-time first degrees in STEM-related subjects from Scottish universities went on to UK employment – a rate 5 percentage points higher than for subjects outside of STEM. Veterinary science had the highest STEM rate of UK work at 89% and Physical sciences the lowest at 45%.

- For those full-time first degree leavers who had entered UK employment, 66% were working in STEM industries.

- The mean wages for UK domiciled full-time first degree leavers in STEM-related subjects from Scottish universities was £23,500 – a £1,000 premium relative to the all degree subject average.

7 Issues arising in the STEM skills pipeline

Introduction

7.1 The previous chapter explored the supply-side picture for STEM education, training and skills. Though some of the issues around the data analysis have been explored in that chapter, further consideration of some of the wider issues is required. This chapter explores these issues in more detail.

Curriculum for Excellence and subject availability

7.2 One of the key issues highlighted through the consultations regarding STEM education was the effectiveness of the implementation of Curriculum for Excellence (CfE). It is recognised that CfE should have a positive effect on STEM education, and the consensus is that this is happening at primary level. However, there is a suggestion from stakeholders that this is not necessarily the case at secondary level. We gained an impression from consultation findings that CfE is still bedding in, and many see practitioners as focusing on the development of the curriculum to ensure a smooth transition for learners, and that as a consequence, CfE is yet to reach its full potential. This is perceived to be having an impact on the approach and quality of secondary school teaching within the CfE framework.

7.3 Also identified through consultation is a need to make learning more applicable to the real world, by focusing on problem solving, and identifying solutions to societal challenges, and this can be achieved through careful planning at the local level. Many schools now design the curriculum to enable students to build a range of qualifications and skills-based awards over the three years of the Senior Phase. Findings from the stakeholder and employer consultations indicate that the application and quality of the 'life' and 'work' elements of CfE need to be boosted. Connecting schools with wider extra-curricular activity and employability tools such as My World Of Work Live can help this. Education Scotland's Careers Education Standard explicitly makes clear the expectation that education practitioners and others will more closely relate the learning and teaching to skills and employability.[137] The Work Placements Standard[138] and guidance for School/Employer Partnerships[139] also contribute to the development of employability skills and awareness of career options.

7.4 The Organisation for Economic Co-operation and Development (OECD) have recently completed an independent review of CfE for the Scottish Government.[140] It is recognised that a number of the issues highlighted above and identified through stakeholder consultations were also highlighted through this review, and steps have already been put in place to address these.

7.5 Evidence from consultees indicates that targeting resources at the secondary level is key to increasing the supply of STEM skills, and encourage a greater uptake of STEM subjects in tertiary education. It is important to capture the enthusiasm of students at this stage in order to keep them engaged with STEM subjects. During one of the focus groups, there was discussion around whether constant classrooms at S1 and S2 level would help to achieve

[137] https://www.education.gov.scot/Documents/dyw2-career-education-standard-0915.pdf

[138] Education Scotland (2015) *Developing the Young Workforce: Work Placements Standard*

[139] Education Scotland (2015) *Developing the Young Workforce: School/Employer Partnerships*

[140] http://www.oecd.org/edu/school/improving-schools-in-scotland.htm

greater collaboration, encourage inter-disciplinary learning, and better engage and enthuse learners. Whilst there was some support for this, it was recognised that it may not be practical.

7.6 Timetabling is also a problem identified by consultees. There can be conflict within subject timetabling, and this may be a result of the choices that schools themselves make in the scheduling of STEM-related subjects. This has the effect of preventing pupils from making the choices they want or need to gain the qualifications required to pursue STEM education at further or higher level, or indeed to pursue a STEM career. This can be compounded by a lack of STEM-related subject practitioners, as highlighted by recent Learned Societies' Group research in support of their response to the Scottish Parliament's Education and Skills Committee.[141] Teacher Census data from the Scottish Government indicates that there has been a decrease in the number of STEM practitioners of around 7% from 2010-2016. This is in line with the 7% decrease in the number of Secondary school teachers across all subjects. STEM subjects that have seen a more marked decrease include Mathematics (-12%) and Computer Studies (-15%).[142] For STEM subjects a decline in the number of practitioners is potentially to an extent offset by the number of practitioners able to teach STEM-related subjects that are not their main subject areas. In some cases, there appears to be a lack of choice in certain subjects in some parts of Scotland, though it is recognised that some schools and colleges pool provision in an attempt to overcome this challenge. For example, CDN is delivering ICT courses across the Highlands and Islands to overcome a lack of Computing Science practitioners, a subject area experiencing a severe shortfall nationally.[143]

Influencing the influencers – practitioners, careers advisers

7.7 There is an identified need to support practitioners in improving the currency of their STEM skills and understanding. Our understanding is that all education practitioners are required to maintain their professional skills in order to maintain their accreditation and are contracted to have 35 hours of CLPL a year. Further, the Scottish Government's Curriculum Unit invests around £1.5 million per year in professional development in STEM for practitioners, including through the Scottish Schools Education Research Centre (SSERC) and the National Numeracy and Maths Hub. Nevertheless, there is a perception that practitioners do not have sufficient current industry experience. This is something that is being exacerbated by the pace of technological and industry change, as discussed in Chapter 5.

7.8 There are a number of initiatives that help to address this, some of which were identified through consultation. For example, in Ayrshire some placement work is currently being co-ordinated to link practitioners with key employers to improve their industry understanding, and in turn their understanding of the learning and career opportunities in STEM. The Energy Skills Partnership (ESP) is also collaborating with Education Scotland to help upskill college lecturers and expose them to modern trends and techniques.

7.9 There is also a need to provide better industry information and labour market intelligence (LMI) to careers advisors. Some stakeholders considered that, in a similar way to practitioners, careers advice can be disconnected from industry, and as a result career advice being given is not necessarily accurate or a true reflection of STEM careers or industries. There are efforts to address this evident across the national network of Developing the Young Workforce (DYW) groups. One example is through the DYW Dundee and Angus group, where employers are

[141] Learned Societies' Group (2017) *Teacher Workforce Planning for Scotland's Schools: A Response from the Learned Societies' Group on STEM Education to the Scottish Parliament's Education and Skills Committee*

[142] http://www.gov.scot/Topics/Statistics/Browse/School-Education/teachcenssuppdata/teachcensus2015/teachercensus2016

[143] Computing at School Scotland (2016) *Computing Science Teachers in Scotland 2016*

engaging with schools to give real work experience and understanding, and improve careers guidance. This is engaging a lot of SMEs, which is having the added benefit of helping smaller companies with their recruitment and workforce planning. Additionally, it is driving the demand for MAs. Also, SDS's *Marketplace* is an online tool connecting schools and colleges with business. Registered businesses are able to raise awareness and understanding of their sector through workshops, talks, workplace visits or placements. *Marketplace* was created to explicitly improve engagement between employers and education through DYW.[144]

7.10 In a similar vein, Dundee & Angus College have reorganised their whole careers advice and approach to students. Careers rather than courses are promoted as a means to attract students, but also to better align provision with industry need. This approach uses the career as a starting point, promoting what's involved in a particular industry or role, and then identifying courses that can lead to these.

7.11 Addressing the quality and currency of careers advice provided through advisers also represents a significant opportunity to help address equality issues, and challenge stereotypical assumptions (e.g. gendered views of occupations and industries). Previously identified initiatives such as #ThisAyrshireGirlCan represent a good example of this – focusing on the abilities of individuals and the needs of industry through LMI, but also on factors such as job satisfaction, which can arguably be critical in informing the career aspirations and decisions of young people.

7.12 The Inverness Campus development, which opened in May 2015 as a Life Science Enterprise Area, has developed a number of initiatives to help engage young people in STEM. These include a STEM hub where children and young people can take part in activities and events around STEM-related subjects. The STEM hub has been well used by schools in the community. There are also plans to develop a Science Skills Academy on the campus as part of several STEMD Centres in the Highlands & Islands. These STEM centres are based on Newton Rooms, a Norwegian model where industry provides facilities for children to take part in multidisciplinary science activities.[145] Industry bodies such as the Royal Society of Biology are also able to provide STEM careers advice through the centres. Similarly, North East Scotland College's Fraserburgh Campus opened a STEM Centre in 2017 after an £8.2 million refurbishment programme. The 2,300m^2 extension, opened by Sir Ian Wood GBE, increases accommodation for existing engineering, automotive and construction, and also offers more flexible teaching space that has allowed the College to introduce additional study options, including science subjects.[146]

Qualifications, multi-disciplinary learning and work-readiness

7.13 There is some criticism of SQA qualifications from stakeholders, in that there is a perception – from strategic stakeholders and from industry – that they are not matching what industry needs. There is some suggestion that the emphasis needs to be more on the skills that industry needs, and is also responsive to industry changes. This is in contrast to what some stakeholders saw as academic, theory-heavy teaching.

7.14 STEM activities are more in demand, and in different combinations. In line with this, consultees felt that learning needs to be more cross-discipline: e.g. combining data analysis with Life Sciences. Data development, and big data, is seen as a key accelerator by many,

[144] https://www.skillsdevelopmentscotland.co.uk/what-we-do/our-products/marketplace/
[145] ekosgen (2017) *Inverness Campus: Interim Evaluation*
[146] http://www.nescol.ac.uk/why-nescol/our-campuses-and-centres/fraserburgh-campus

and multi-disciplinary learning will be important in realising its application across a number STEM and other industry areas.

7.15 Though it is recognised that interdisciplinary learning is already a core component of CfE, a greater modular or multi-disciplinary approach may be needed. This is advocated by some stakeholders in order to teach core STEM skills across subjects, and ensure depth of understanding and transferability of skills. Given the rapid pace of change in STEM industries and roles, and the uncertainty around the particular requirements of future jobs, this is important. For example, the University of Glasgow deliver a common suite of modules across the first year of study in Biology, Chemistry and Life Sciences. Such an approach of common foundation learning could be extended to other subjects – such as maths and engineering.

7.16 STEM silos are also reinforced through physical design of buildings – i.e. where school, college, and university building designs keep departments apart, and don't encourage interdisciplinary approaches or collaborative working. A very good example of the importance of physical design is on Inverness Campus. Prior to moving to the new Campus, Inverness College UHI had limited collaboration between departments. The relocation of Inverness College to the Campus has brought a number of departments much closer together, working side by side and in shared spaces. This has been done very deliberately to foster more collaboration within the College and although the new College building has less space than previously, the accommodation is being used much more efficiently and enables more modern learning activities. As a result, a number of internal department collaborations have emerged, e.g. between STEM-related departments and others, including Creative Studies. This is driving enhancements in teaching and the students' learning experience.

7.17 Further, work-readiness and softer transferable skills are in high demand from STEM employers. This is something that is already embedded in college training, and is a focus of DYW in schools through Change Theme 1. There is a view amongst stakeholders that instilling work-readiness and employability is something that needs to be extended to the senior phase of school, in line with providing education that is more work-focused and aligned with industry skills requirements.

7.18 An additional barrier to ensuring the appropriateness of skills and work-readiness is the nature of the funding system. At present, education funding is focused on qualification progression – that is, students will only continue to be funded if they progress to the next level of study after gaining a qualification. From a career development point of view, there may be merit in completing qualifications in aligned subjects at a similar level, e.g. HND in both graphic design and gaming technology. However, pursuing this would currently preclude funding in one of these subjects. Alternative funding models for further and higher education could be explored to allow such blended learning opportunities, where there is a clear skills and employability benefit for the learner and industry need.

Developing the Young Workforce

7.19 The Commission for Developing Scotland's Young Workforce (the Wood Commission), was established in January 2013, during a time of high youth unemployment levels. It considered how to achieve better connectivity and co-operation between education and the world of work, alongside the development of the intermediate vocational education and training system. The aim was to ensure young people at all levels of education understand the expectations of employers, and that employers are properly engaged. The report, published in June 2014 produced 39 recommendations.

7.20 Following this, the Scottish Government's Youth Employment Strategy, Developing the Young Workforce, was published in December 2014, which accepted all 39 recommendations in the Commission's report and set out how these would be implemented. [147] Developing the Young Workforce (DYW), aims to create an excellent, work relevant education offer to young people in Scotland, giving them the skills for the current and anticipated jobs market. This includes creating new vocational learning options; enabling young people to learn in a range of settings in their senior phase of school; embedding employer engagement in education; offering careers advice at an earlier point in school; and introducing new standards for careers guidance and work experience. The strategy is targeted to improve Scotland's young workforce, on issues such as better preparing school leavers for the world of work and encouraging more employers to engage with education and recruit more young people.

7.21 There is a sense that whilst DYW is beginning to have some impact, its focus needs to be sharpened, in the sense that there should be greater education-industry collaboration on pathways for the learner journey. Ultimately, at each decision point in the pathway, young people *and* their influencers should have correct information, and should be able to act upon it. Some stakeholders see scope for there being a greater number of DYW co-ordinators in schools, spending dedicated time linking schools with employers, and developing understanding of industry and economy requirements, for example drawing on Skills Investment Plans (SIPs) and Regional Skills Assessments (RSAs) to inform guidance, and helping to deliver against the Action Plans set out in the SIPs, or drawing on industry expertise available through SDS's *Marketplace*.

7.22 As part of this, there is a specific need for STEM companies to engage with schools and colleges, as well as continuing to develop their engagement with universities. This may be through more open days, or more social engagement, but there is a role for companies or trade bodies to sell STEM industries and careers better. This can help young people and learners make more informed choices. Practitioners need to be more fully involved in such processes – this will help develop their understanding further, as noted above.

Continuous professional development and workforce development

7.23 In contrast to the objectives for DYW, there is an identified need to expand work-based learning. Industry and strategic stakeholders recognise that there are a number of people in existing workforce who might want a career change, or just to upskill, but they can't, as there are no opportunities for older learners. For example, they may wish to enrol on an MA framework.

7.24 Anecdotal evidence suggests that there are people in the workforce already struggling with the new and increasing emphasis on technology, but without the means to acquire the necessary skills and understanding. This will become more acute with the advent of the Fourth Industrial Revolution, as identified in Chapter 5. This is an issue, as there is a need to retain sectoral knowledge. Access to apprenticeships for older learners and those in the existing workforce can help to upskill people in the necessary technology-focused STEM skills required to adapt to technological change. Continuous professional development for education practitioners through SSERC and other channels is also critical in this regard.

[147] Scottish Government (2014) *Developing the Young Workforce - Scotland's Youth Employment Strategy*

Community learning and development

7.25 Though there is much focus on the formal skills and education pipeline that feeds STEM employment, consideration should be given to learning that occurs outside of formal education, in communities, and how this can contribute to the skills pipeline. We recognise that, as previously discussed in relation to availability of detailed data, qualifications such as PDAs and National Certificates are not considered in this report. This is something that may be addressed in future research.

7.26 Nevertheless, many of these qualifications will be obtained through CLD. Consequently, CLD's role in widening knowledge of qualifications such as foundation degrees, different career pathways and alternative routes to employment can ultimately lead to change for individuals and communities, as well as creating an additional pipeline of skills for STEM occupations. It also allows for a different route into the formal education and training pipeline for STEM skills. Further, CLD can help to support STEM ambassadors to effectively engage with communities to create development pathways to STEM employment.

Summary

- Curriculum for Excellence (CfE) is intended to have a positive impact on STEM education and it is generally agreed that this is the case at primary schools. However, some stakeholders feel CfE has not yet reached its full potential at secondary level.
- Issues with timetabling may restrict STEM-related subject choices at some schools. But there is an issue regarding practitioner shortage. This may be impacting on the availability of STEM-related subjects to young people.
- There is a perception that practitioners may lack current knowledge of STEM technology and industry. Consultees acknowledge that there are a range of initiatives in place to offer support and help upskill practitioners and college lecturers, but this should be expanded. Careers advisors also require better and more up-to-date information.
- Qualifications offered need to better match the skills and capabilities required by STEM industries and employers.
- Though a core component of CfE, it is felt that there is a need to further develop the interdisciplinary approach to learning, to build depth of understanding and transferability of STEM skills. This may be addressed through the delivery of common modules across a number of subjects, or by co-locating different departments and teaching spaces to encourage teaching and learning collaboration.
- Softer employability skills are also seen to be important, and these are already being taught as part of college training, but need to be further developed at school and university level.
- The activities undertaken as part of DYW should be sharpened to encourage greater education-industry collaboration on pathways for the learner journey. There is a specific need for STEM companies to engage with schools and colleges.
- There is also a need for professional and workforce development for those who are already in the workplace. This may be important for older workers who may need to upskill in technology skills to meet the challenges of technological change.
- CLD should be recognised as a valid and alternative route into STEM employment, as well as more formal STEM education and training.

8 Building on the evidence base

Introduction

Summary of findings

8.1 Scotland's STEM industry workforce has grown to just over 884,000 people in 2015, an increase of 4% from 2009, and accounting for 35% of total employment in Scotland. This has outstripped employment growth in Scotland as a whole, and the STEM workforce is projected to grow by a further 4% over the next 10 years. Growth to date, and expected future growth, is in Scotland's urban areas. The more modest forecast growth in employment is accompanied by a 23% increase in GVA over the same period of time.

8.2 This disproportionately high growth rate is expected to compound the skills shortages in STEM sectors that currently exist, and particularly in higher-level STEM occupations. As well as sector-specific worker shortages, STEM skills are increasingly in demand, and in short supply. Further, the demand for university graduates is potentially creating a gap in more operational STEM skills. It is unclear whether this issue is common across the wider labour market, or indeed how this impacts on SMEs and larger companies.

8.3 The pace of technological change, and increasingly technological nature of the economy also has implications for skills requirements and demand for new entrants, and for the existing workforce too. The speed at which jobs are changing as a result of technological change is significantly altering the skills demand and requirement of the labour market, and creating a mismatch between current and required skills of the workforce. As a result, there is significant and increasing need for skilling, re-skilling and upskilling, to ensure that STEM is able to underpin future economic growth in Scotland.

8.4 There are a number of workforce challenges compounding the STEM skills challenge. Gender is undoubtedly playing a significant role in the skills shortage. Under-representation of females in the STEM workforce (females make up an estimated 20% of the STEM workforce in Scotland), and in key positions, is affecting individual opportunities, and also the availability of skills. This is made worse by the 'leaky pipeline' effect – the high attrition rate of trained, qualified women from employment in STEM, as identified in Chapter 5. It should be noted that there is a data gap in capturing the exact scale of female attrition in STEM learning and employment, which is something that can be explored in future research.

8.5 The continued under-representation of females in the STEM workforce also continues to affect social attitudes towards STEM roles, and the suitability of females and males to undertake specific roles. Though there are a number of initiatives aimed at redressing the imbalance, gender segregation in STEM remains a significant challenge.

8.6 The ageing profile of the STEM workforce is impacting on skills in a number of ways. There is a rise in retirement age in some sectors, potentially crowding out young entrants particularly in the sciences. However, the ageing workforce is also posing an increasingly large replacement demand challenge, which brings with it issues of knowledge transfer and potentially lost skills.

8.7 The profile of STEM is also problematic. There remains work to be done to reposition STEM industries and roles, and improve their image and perception. Stakeholders have much to do to counter media portrayals of STEM, but also addressing misconceptions held by society more generally. However, employers also have a role to play in creating positive perceptions of STEM jobs and careers.

8.8 Much of this could be achieved by influencing the influencers. Targeting parents and practitioners in particular could address not only the perception of STEM, but also the persistent preference for academic routes for learning versus vocational, technical, or professional learning, all of which could benefit the supply of STEM skills.

8.9 There is currently a multitude of policies, strategies and plans aimed at developing, supporting and addressing the skills challenges faced by individual STEM sectors. Skills planning activities appear to be carried out to a certain extent in a silo fashion. Adopting a matrix approach to skills planning would perhaps provide for greater alignment of skills needs. There are also a wide range of initiatives, programmes, activities and partnerships. Evidence suggests that these could be better joined up and simplified.

8.10 The skills supply pipeline in Scotland presents a mixed picture. The overall trend is that fewer pupils are studying and passing STEM-related subjects at school, but those who do take it (and pass) at a higher level. That said, fewer than 10% of leavers at Advanced Higher level hold a STEM qualification. At a school level, there were around 220,000 STEM passes at all levels in 2015/16. However, there has been a decline overall, driven by a fall in the number of National level passes as demonstrated in Chapter 6. This has been particularly so for Mathematics, Chemistry, and Technology subjects. There is relative stability at Higher level in terms of STEM passes. In contrast, the number of passes at Advanced Higher has grown over the period 2010-16. At school males make up the majority of passes and entries for STEM-related subjects across all levels. However, the female pass rate is higher than the male pass rate at all levels and this is particularly marked at Advanced Higher level. The gender split is more notable in certain subjects than others. Whilst Chemistry and Mathematics are fairly even at National and Higher level, males make up nearly three quarter of passes in Physics at National level and females make up the majority of Biology National passes.

8.11 There were 85,000 enrolments on STEM FE courses in 2015/16. Though there has been a decline in STEM enrolments in Scottish colleges from 2010 to 2016, this is lower than overall college enrolments over the same period. Further, this drop has been driven by a policy change to phase out non-qualification study, and since 2012/13 there has been an increase in STEM enrolments, and enrolments have also increased in higher level courses (SCQF6+). STEM-related subjects have also increased their share of enrolments in colleges to around 30% in 2016. Gender imbalance is still evident in college enrolments, and female participation in STEM-related subjects is decreasing. Females made up 34% of STEM enrolments and only 27% of credits in 2015/16. This suggests that not only are males more likely to study STEM courses, they are also more likely to choose more intensive STEM courses.

8.12 Foundation, Modern and Graduate Level Apprenticeships present an increasing number of opportunities for STEM skills supply, with almost 10,000 registrations across the three levels of apprenticeships. The development of Foundation Apprenticeships are creating an additional pathway for school leavers. However, there is a question as to the extent to which this is creating an additional flow of STEM skills, rather than displacement from Highers and Advanced Highers. Modern Apprenticeships have seen a steady growth in the number of available STEM frameworks and STEM MA registrations in recent years – and at generally higher levels than for MA provision overall. However, the gender split persists, and males account for 93% of all STEM MA registrations in 2015/16.

8.13 Graduate Level Apprenticeships (GLAs) began as a pathfinder in 2015-16. From September 2017 there will be rapid scaling up of delivery, providing degree- and masters-level equivalent training across 11 frameworks by September 2018.

8.14 University enrolments on STEM courses has steadily increased since 2011/12, and were at almost 115,000 in 2015/16, accounting for almost 49% of all enrolments at Scottish universities. Overall there is a degree of gender balance, but within specific subjects there are significant gender imbalances. Reflecting gender norms, women were more represented in subjects associated with care. They made up 81% of enrolments in subjects allied to medicine and 78% in Veterinary science but just 18% in Engineering & technology and 20% in Computer science. The STEM share of qualifiers of total graduates in 2015/16 was 33%. Overall in 2015/16, 68% of qualifiers were Scottish domiciled, but this was much lower for Veterinary Science and Medicine & Dentistry at 26% and 47% respectively.

8.15 CfE is intended to have a positive impact on STEM education and it is generally agreed that this is the case at primary schools. However, some stakeholders feel that the CfE approach to teaching is still not being fully implemented at secondary level so has not yet reached its full potential. There is a perception that practitioners may lack current knowledge of STEM technology and industry, and more needs to be done to facilitate updating and refreshing of practitioners' industry- and work-specific knowledge. Stakeholders also emphasised the need for a multi-disciplinary approach and to discourage subject silos. Soft-skills are also seen to be important and these are already being taught as part of college training, but need to be further developed at school and college level. Careers advisors also require better and more up-to-date information. Initiatives to help improve careers advice include Developing the Young Workforce (DYW) in Dundee and Angus helping employers to engage with schools. From a qualifications point of view, there is also a strong desire to see qualifications that match industry-specific skills requirements, and are less theory-focused.

8.16 There is a need for greater collaboration between education and industry to improve STEM employment opportunities for young people. Whilst DYW is beginning to have some impact, its focus needs to be sharpened, in the sense that there should be greater education-industry collaboration on pathways at each stage of the learner journey.

8.17 Therefore there are a number of **key priority areas** that the STEM Strategy should tackle in order to better align the demand and supply of STEM skills:

- Ensuring that the potential of CfE at secondary school is fulfilled, namely by supporting interdisciplinary, flexible learning to enhance the acquisition of adaptable STEM skills and qualifications; and helping the development of softer employability skills to aid work-readiness. Additionally, there should be greater alignment of qualifications to industry need.
- Ensuring that key influencers have sufficiently up-to-date industry and technical knowledge/experience. This will enhance teaching, but will also enable the provision of informed career advice and guidance, which is also able to challenge stereotypes of career choices.
- Developing an overarching communications or PR approach to counter out-dated views and misconceptions of STEM held in society, and also portrayed in the media.
- Issues of equality, and gender in particular, remain critical factors in addressing the shortage in STEM skills. Efforts to redress the imbalance present in all under-represented groups in STEM should continue in this regard, though it is recognised that the emerging STEM Strategy can only do this for education, training and lifelong learning provision.

- Taking steps to ensure that the skills of the incumbent STEM workforce, and new entrants to STEM occupations, are fit-for-purpose and future-proof. This will include wider access to CPD/CLPL and similar learning and qualification opportunities, but may also extend to changes to funding of education, to allow for different models of funded learning. This will help to meet the needs of STEM employers and industries, and indeed the career aspirations of potential and current STEM workers. This is currently out of scope for the STEM Strategy, but it is important that anticipated future workforce issues are addressed.
- Determine the overall pattern of progression through the STEM pipeline. This should capture the overall potential scale of entrants to STEM occupations, but also address data gaps to identify the scale and nature of leakage in the STEM education and training system.

Building on the evidence base

8.18 In addition to the priority areas for action outlined above we have identified a number of actions which would add value to this evidence base. These include the following.

Mapping of engagement and support

8.19 An exercise which maps all current STEM supporting and engagement activities (including those new initiatives proposed in the draft STEM Strategy Consultation document) is required. Because of the potential size of this task, at a minimum this could be a high-level review, to help introduce a greater degree of co-ordination amongst existing activities, on a local, regional, and national basis. This should be done with the aim of identifying areas of duplication, overlap, and gaps in provision or access. Identifying approaches and initiatives which have been proven to be effective would also be a critical part of this exercise. This would inform the implementation of the STEM strategy and its accompanying actions.

Addressing evidence gaps

8.20 In developing this STEM evidence base we have identified a number of evidence gaps and further research may be required to provide further depth of information for the sector. This includes:

- Research to define and articulate the entire STEM skills pipeline, i.e. calculating the total potential supply of STEM entrants to the workforce. This exercise will involve determining levels of leakage, attrition, and potential double counting, and could reasonably include the development of a framework or methodology to account for any differences in training delivery or qualification types;
- Allied to this, the undertaking of a detailed STEM employer survey across Scotland would help to identify key areas of skills shortage, qualification and skills demand, and perceptions of skills issues. Factors such as salary levels across the STEM workforce could also be explored, alongside Annual Survey of Hours and Earnings (ASHE) data;
- Understanding factors affecting choices made by young people and their parents regarding pathway into and through the Senior Phase;
- Understanding more about university applicants for STEM courses by interrogating UCAS and other HE data and gaining more information about school leavers' choices with respect to where to study STEM and the availability of STEM places across the university network;
- Another gap is information providing a picture of post-6 month destinations of STEM graduates. Some more longitudinal data on HE leaver destinations and outcomes is

becoming available from sources such as HEFCE and Department for Education, and this should be interrogated to examine the impact of STEM education on graduate career destinations[148];

- Bespoke interrogation of current education datasets is recommended to gain a better understanding of equality imbalances at all stages of the skills pipeline; and
- There is currently very limited data to draw on to assess the shortages of and vacancies for practitioners by subject. Aside for the implications for practitioner workforce planning, it is important for assessing if shortages are impacting on STEM-related subject and course provision.

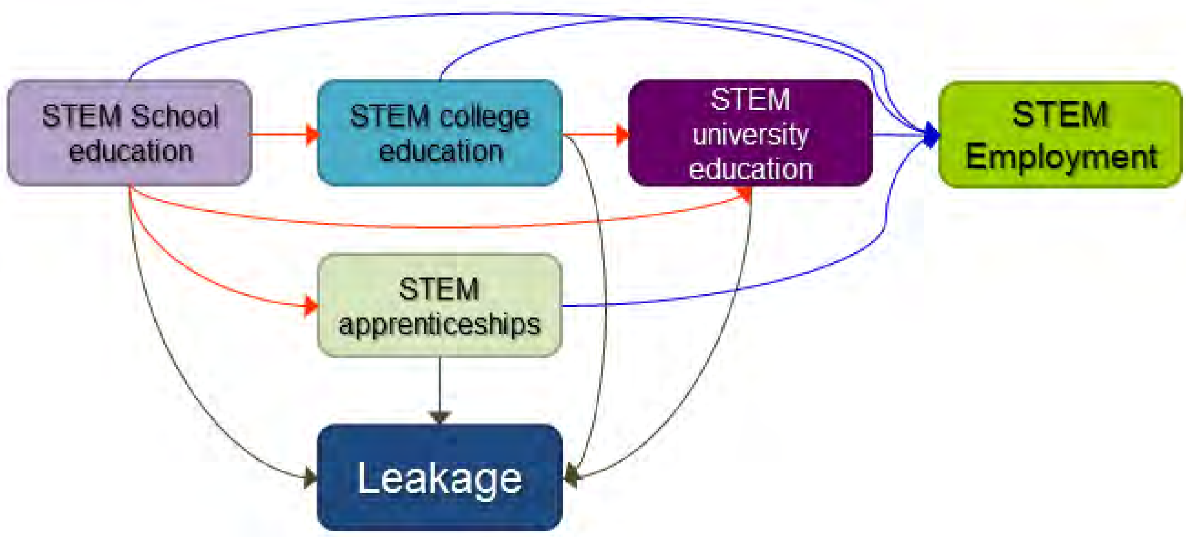
Key Performance Indicators (KPIs)

8.21 In order to track the success of the STEM Strategy there are a number of KPIs which should be developed to measure performance and impact in the following areas:

- **Skills shortages**: This would include indicators measuring shortages in the workforce in terms of types of occupations and number of job vacancies in STEM industries. This could reasonably include a matrix approach to identifying current and future shortages and recruitment challenges for specific occupational types and technical or experience levels;
- **Workforce skills gaps:** This would include indicators measuring employers' views on the level and type of skills gaps experienced; their STEM-related subject preferences and skills requirements; and their satisfaction with workforce skills levels. This could be extended to explore the business impact of skills shortages and gaps, as well as exploring anticipated future issues and challenges;
- **Provision:** These indicators track availability of STEM-related subjects and courses, levels of take-up, qualifications and progression at each stage of the STEM skills pipeline. Some of these, such as entries and passes at school level, are already collected and presented within this report. Others could include detailed data on destinations, which are only available for HE qualifiers at present. Data for school and college leaver destinations could be expanded to identify STEM qualifier destinations, or perhaps STEM-related destinations of leavers;
- **Equality:** Indicators monitoring trends in gender balance, and the numbers of individuals from a deprived background and BME entering the STEM skills pipeline and workforce; and
- **Leakage:** Monitoring at what stages of the progression pathway is there a drop in participation, how it has happened and to what extent. Figure 8.1 illustrates the potential flow through the STEM education system.

[148] Some experimental statistics for Scotland are available here: http://www.gov.scot/Publications/2017/06/2061

Figure 8.1: STEM progression and leakage



Next steps

8.22 This evidence base will be considered by the STEM Strategy Evidence Base Short Life Working Group, and the STEM Strategy Reference Group. It will form an integral part of the next stage of development of the STEM Strategy for Education and Training for Scotland.

Appendices

Appendix 1: Consultees

Consultee	Organisation
Data scoping consultees	
Jane Allan*	Skills Development Scotland
Aisling Spain	Scottish Government
Michael Hunter	Scottish Government
Alan Sloan	Scottish Government
Gayle Mackie	Scottish Government
Ian Menzies	Education Scotland
Cathy Mitchell	Scottish Funding Council
Strategic stakeholders	
Suzanne Marshall	Colleges Development Network
Ian Menzies	Education Scotland
Cath Hamilton	Education Scotland
Talat Yaqoob	Equate Scotland
David Reid	Highland & Islands Enterprise
Nicola Marchant*	Learned Society Reference Group
Jonathan Slow	Scottish Enterprise
Barbara Morton	Scottish Government
Employers	
Alison Clayton	Eurofins
Karen Bingham	Reprocell
Callum MacInnes	SLG Technology Ltd
Nicola Marchant*	Formerly (AstraZeneca)
Skills Development Scotland Sector Managers Focus Group	
Jane Allan	Skills Development Scotland
Alison Eaglesham	Skills Development Scotland
Ken Edwards	Skills Development Scotland
Claire Gillespie	Skills Development Scotland
Lynn Haughton	Skills Development Scotland
Derek Hawthorne	Skills Development Scotland
Ronnie Palin	Skills Development Scotland
William Scott	Skills Development Scotland
David Martin	Skills Development Scotland
Ian Hanson	Skills Development Scotland
Industry Leadership Groups and Employers Focus Group	
Willie Bell	Lloyds Banking
Gary Bisset	CGR PerEx (DYW Dundee & Angus)
Jim Brown	Energy Skills Partnership
Fiona Craig	Zero Waste Scotland

Consultee	Organisation
Gordon Doig	Institute of Physics
Svea Miesch	ScotlandIS
John Keenan	CITB
Wendy Pring	KCP Environmental Services
Paul Stuart	Royal Society of Edinburgh
STEM CLPL Workshop	
STEM Community Learning Workshop	
STEM Strategy Reference Group	
Professor Sheila Rowan	Chief Scientific Adviser for Scotland
Professor Iain Hunter	Strathclyde University
Fiona Brown	Forth Valley College
Allan Colquhoun	Leonardo
Marie Crawford	Blairmore ELCC, Inverclyde
Heather Earnshaw	Institute of Physics
Peter Finlayson	Highland Council
Jackie Howie	Learning Link Scotland
Robert Hynd	Community Learning and Development Managers
Sarah Johnston	Energy and Utility Skills (Scotland)
Linda Leuchers	Dundee Science Centre
David Maxwell	Dumfries and Galloway Council
Nicola Marchant	Royal Society of Biology in Scotland
Maggie Morrison	Public Sector Scotland, CGI
Professor Tim Newman	University of Dundee
Colm O'Riordan	National Parent Forum for Scotland
Zoe Thomson	Woodmill High School
Talat Yaqoob	Equate Scotland

Appendix 2: Initial STEM definitions set out in ITQ

Industry (SIC) definition

Based on a review of documentation, the ITQ considers that to be classified as a STEM sector (classified at the four-digit SIC level), "at least 15 per cent of the sector's workforce should be a STEM qualification holder and the sector as a whole should employ at least 0.06 per cent of the core STEM workforce (0.1 per cent for Med STEM sectors)".[149] In Scotland, industry sectors generally considered being STEM include chemical sciences, construction, engineering, energy, ICT/digital and life sciences. STEM industries are therefore likely to fall within SIC codes contained within the following broad industrial groupings:

- Mining and quarrying;
- Manufacturing;
- Electricity, gas, steam and air conditioning supply;
- Water supply, sewerage, waste management and remediation activities;
- Construction;
- Information and Communication;
- Professional, scientific and technical activities; and
- Human health and social work.

Occupation (SOC) definition

Similarly, a SOC definition is included in the ITQ. It recognises that an occupation at the 3-digit SOC level (minor group) may be considered to be a STEM occupation if at least 15 per cent of its workforce is a STEM qualification holder and the occupation as a whole employs at least 0.5 per cent of the STEM workforce. Occupations can also be considered 'core' or 'related' STEM occupations, dependent on whether the roles are STEM-specific, or simply within a STEM industry, e.g. senior manager, director role, but undertaken by a STEM graduate. Table A.2.1 details these occupations, which are drawn from SOC2000 codes.[150]

Table A.2.1: SOC STEM definitions

SOC Code	SOC Description
Core STEM occupations	
112	Production Managers
113	Functional Managers
116	Managers in Distribution, Storage and Retailing
118	Health and Social Services Managers
121	Managers in Farming, Horticulture, Forestry and Fishing
211	Science Professionals
212	Engineering Professionals
213	Information and Communication Technology Professionals
221	Health Professionals
232	Research Professionals

[149] Ibid., p.14

[150] Ibid., pp.14-15

SOC Code	SOC Description
242	Business and Statistical Professionals
243	Architects, Town Planners, Surveyors
244	Public Service Professionals
311	Science and Engineering Technicians
312	Draughtspersons and Building Inspectors
313	IT Service Delivery Occupations
321	Health Associate Professionals
322	Therapists
323	Social Welfare Associate Professionals
351	Transport Associate Professionals
355	Conservation Associate Professionals
356	Public Service and Other Associate Professionals
524	Electrical Trades
531	Construction Trades
532	Building Trades
821	Transport Drivers and Operatives
Related STEM occupations	
111	Corporate Managers and Senior Officers
115	Financial Institution and Office Managers
231	Teaching Professionals
341	Artistic and Literary Occupations
343	Media Associate Professionals
353	Business and Finance Associate Professionals

Client ITQ document, based on Standard Occupational Classification 2000 Volume 1

Education definition

A working definition for education, training and skills has been developed through a workshop held between Education Scotland, SDS, Scottish Funding Council, and the Scottish Government's Learning and Advanced Learning and Science Directorates. Though there was acceptance that any definition should focus on skills, participation in STEM courses, and attainment of STEM qualifications, represents the most easily measurable indicator.[151] The working definition is set out in Table A.2.2.

Table A.2.2: Education definitions

3 – 18 curriculum	College Superclasses	MA Frameworks
Mathematics	***C: Information Technology and Information***	Agriculture
Lifeskills Mathematics	Computer Technology	Aquaculture
Literacy and Numeracy	IT: Computer Science / Programming / Systems	Automotive
Mathematics	IT: Computer Use	Bus and Coach Engineering and Maintenance
Mathematics of Mechanics	Information Systems / Management	Construction: Building
Statistics	Text / Graphics / Multimedia Presentation Software	Construction: Civil Engineering
Sciences	Software for Specific Applications / Industries	Construction: Professional Apprenticeship
Science	Information Work / Information Use	Construction: Specialist
Biology	Information Systems / Management	Construction: Technical
Physics	Libraries / Librarianship	Construction: Technical Apprenticeship
Chemistry	***R: Science and Mathematics***	Creative and Digital Media

[151] Ibid. pp.16-17

3 – 18 curriculum	College Superclasses	MA Frameworks
Human Biology	Science and Technology (general)	Dental Nursing
Science in the Environment	Mathematics	Electrical Installation
Environmental Science	Physics	Electronic Security Systems
Technologies	Chemistry	Engineering
Computing Science	Astronomy	Engineering Construction
Engineering Science	Earth Sciences	Equine
Information and Communications Technology	Land and Sea Surveying / Cartography	Gas Heating & Energy Efficiency
Design and Manufacture	Life Sciences	Gas Industry
Design and Technology	***X: Engineering***	Heating, Ventilation, Air Conditioning and Refrigeration
Fashion and Textile Technology	Engineering / Technology	Horticulture
Graphic Communication	Metals working / Finishing	Information Security
Health and Food Technology	Welding / Joinery	Industrial Applications
Music Technology	Tools / Machining	IT and Telecommunications
Practical Electronics	Mechanical Engineering	Land-based Engineering
Practical Metalworking	Electrical Engineering	Life Sciences and Related Science Industries
Practical Woodworking	Power / Energy Engineering	Network Construction Operations (Gas)
	Electronic Engineering	Pharmacy Services
	Telecommunications	Plumbing
	Electrical / Electronic Servicing	Power Distribution
	Aerospace / Defence Engineering	Process Manufacturing
	Ship and Boat Building / Marine / Offshore Engineering	Rail Engineering
	Road Vehicle Engineering	Trees and Timber
	Vehicle Maintenance / Repair	Upstream Oil and Gas Production
	Rail Vehicle Engineering	Water Industry
		Water Treatment Management
		Wind Turbine Installation and Commissioning
		Wind Turbine Operations and Maintenance

Client ITQ document, based on SQA and SFC classifications, and SDS Frameworks

Appendix 3: STEM employment in Scotland: industry – BRES data

Introduction

As highlighted in Chapter 3, there are differences between the Annual Population Survey (APS) and Business Register Employment Survey (BRES). Firstly BRES does not report gender, whereas APS does, so APS is used to set out data on employment by industry and gender. However, there are a number of other differences that can account for the difference in data between the two sources. These factors may not account for all of the difference between BRES and APS figures, and other factors may be at play.

BRES reports employee and employment jobs, where APS reports people in employment. As people can either share jobs or hold multiple jobs, these are not like-for-like comparison. Further, BRES does not fully capture self-employed/non-VAT-registered businesses. Conversely, APS data captures self-employed workers, as well as HM Forces, Farm agriculture employees, and Government-sponsored trainees. This will necessarily have an impact on the employment figures across both datasets. Further, whilst BRES is workplace-based, APS data is residence-based and does not take account of where people work. Consequently BRES and APS are not directly comparable. Nevertheless, it is useful to consider both BRES and APS data.

Employment within STEM sectors

Using the SIC-based definition agreed with the Short Life Working Group, the analysis shows there were 884,000 people in employment in STEM sectors in Scotland in 2015. This represents an increase of 33,900 (4%) from 2009 levels, and is greater than the overall increase in employment in the Scottish economy (1%). STEM employment accounted for 35% of all Scottish employment in 2015, an increase of one percentage point from 2009.

STEM employment was concentrated around Scotland's largest urban areas. The Glasgow region accounts for the highest share of total STEM employment at 19%. This is followed by Edinburgh and Lothians and Aberdeen and Aberdeenshire, both at 15%. This is of course to be expected as urban areas represent concentrations of population and, as a result, employment.

Table A3.1: STEM sector employment by College Region, 2015

College Region	STEM Employment	Total Employment	STEM Share of Employment (%)	Location Quotient
Glasgow	166,100	453,100	37%	1.05
Edinburgh and Lothians	133,800	381,800	35%	1.01
Aberdeen and Aberdeenshire	132,900	288,000	46%	1.33
Lanarkshire	90,100	274,800	33%	0.94
Highlands & Islands	71,900	221,400	32%	0.93
Tayside	57,100	173,000	33%	0.95
West	54,800	166,600	33%	0.94
Fife	53,500	135,100	40%	1.14
Forth Valley	43,500	123,700	35%	1.01
Ayrshire	40,700	127,300	32%	0.92
West Lothian	24,400	77,500	31%	0.90
Dumfries and Galloway	16,000	59,100	27%	0.78
Borders	12,800	41,900	31%	0.88
Scotland	**884,000**	**2,540,600**	**35%**	**1.00**

Source: BRES, 2017

STEM sectors' share of total employment in Scotland

The STEM sector accounted for 35% of total employment in 2015 in Scotland. This had remained fairly stable since 2009, in the preceding 6 years the STEM share of employment had ranged between 33%-35%. However, there are significant variations in the share of employment between college regions. Employment share was highest in Aberdeen and Aberdeenshire at 46%. This is likely related to the importance of the oil industry in the area, even though the industry has seen a downturn in recent years. STEM share of employment is lowest in the more rural areas of Dumfries and Galloway at 27% and the Borders at 31%. However, the STEM sector also only accounted for 31% of employment in the more urban area of West Lothian.

The Glasgow region had the highest number of people in STEM employment, and accounted for almost 19% of STEM employment in Scotland. STEM employment as a proportion of overall employment in Glasgow rose from 33% in 2009 to 37% in 2015. Fife has seen the largest growth in the share of STEM employment, from 33% in 2009 to 40% in 2015. The Borders region has also seen an increase in STEM's share of overall employment over this period from 28% to 31%. There were also small increases in STEM share of employment in Aberdeen and Aberdeenshire, Ayrshire, and Lanarkshire. There was no overall change in West and Highlands & Islands. Elsewhere in Scotland, there was been a decrease in STEM's share of overall employment of just over 1% on average. For example, in Edinburgh and Lothians, the region with the second highest number of STEM employments, there was a modest decline in the share of STEM employment from 36% to 35%.

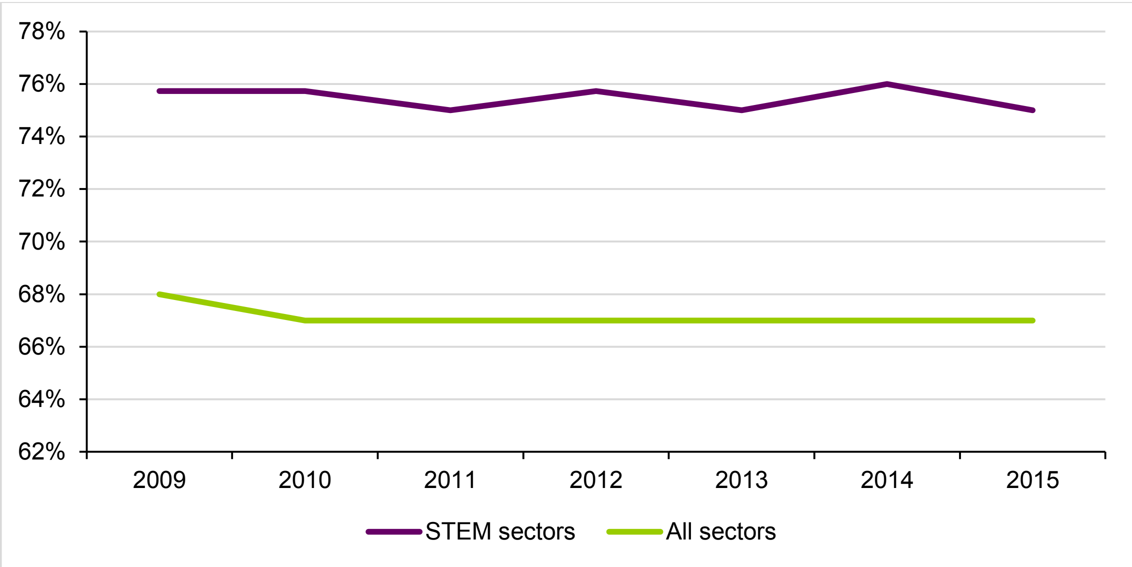
Geographical distribution of employment in STEM sectors

Location Quotients are a measure of the concentration or degree of specialism of a particular industry, occupation, or in this case industrial sector, in a local area or region in comparison to a larger geography – usually national, and in this case, Scotland. A Location Quotient of greater than 1 indicates a greater degree of specialism in the STEM sector in a particular area compared to the national workforce. The higher the score, the greater the specialism. As demonstrated in Table 3.1, Aberdeen and Aberdeenshire had a particularly high concentration of the STEM workforce, and this is likely related to the Oil & Gas industry. Fife and Glasgow also had a relatively high concentration of STEM employment.

Sector employees by status for STEM

In 2015, 75% (654,200) of employees working in STEM worked full-time and 25% (217,400) part-time. This has remained fairly stable from 2009 when 76% (631,200) worked full-time and 24% (202,200) part-time. At 75%, the rate of full-time working in STEM was far higher than the national rate of 67%. This prevalence of full-time working may be a factor in the lower number of women working in STEM industries as women continue to carry the burden of caring duties.

Figure A3.1: Full-time employment in STEM sectors, 2009-15



Source: BRES, 2017

Appendix 4: School entries and passes by gender

Table A4.1: STEM entries and qualifications for Scottish school pupils by gender, 2010-2016[152]

	2010		2011		2012		2013		2014		2015		2016		% or p.p.[153] change 2010-2016	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
SCQF 3-5																
Entries	103,262	120,161	101,044	120,264	101,442	121,159	98,240	117,987	93,643	114,715	91,262	114,521	89,938	112,859	**-13%**	**-6%**
Passes	92,035	107,117	90,882	107,841	90,430	107,963	88,182	105,583	74,546	91,225	72,353	91,821	71,897	90,129	**-22%**	**-16%**
Pass rate	89.1%	89.1%	89.9%	89.7%	89.1%	89.1%	89.8%	89.5%	79.6%	79.5%	79.3%	80.2%	79.9%	79.9%	**-9.2 p.p.**	**-9.2 p.p.**
SCQF 6[154]																
Entries	29,846	35,806	30,404	36,178	30,545	36,125	31,026	36,089	31,587	38,496	32,330	38,697	30,664	36,699	**3%**	**2%**
Passes	22,093	26,461	22,818	26,794	23,110	27,045	23,382	26,670	23,317	27,828	23,910	27,849	22,830	25,911	**3%**	**-2%**
Pass rate	74.0%	73.9%	75.0%	74.1%	75.7%	74.9%	75.4%	73.9%	73.8%	72.3%	74.0%	72.0%	74.5%	70.6%	**-0.5 p.p.**	**-3.3 p.p.**
SCQF 7[155]																
Entries	4,383	6,027	4,616	6,527	4,836	6,850	5,009	6,872	5,217	6,882	5,044	7,344	4,971	6,834	**13%**	**13%**
Passes	3,385	4,444	3,713	4,861	3,826	5,203	4,072	5,281	4,080	5,126	4,024	5,486	4,040	5,105	**19%**	**15%**
Pass rate	77.2%	73.7%	80.4%	74.5%	79.1%	76.0%	81.3%	76.8%	78.2%	74.5%	79.8%	74.7%	81.3%	74.7%	**4.1 p.p.**	**1.0 p.p.**

Source: SQA, 2017

[152] The exclusion of standard level qualifications accounts for the disparity between 2013 and 2014 data

[153] Percentage point

[154] SCQF level 6 data contains both Highers and previous Highers in 2015. Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015. Human biology only available at SCQF level 6.

[155] Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015

Appendix 5: School entries and passes by subject

Table A5.1: STEM entries for Scottish school pupils by subject, 2010-2016[156]

	2010	2011	2012	2013	2014	2015	2016	% change 2010-2016
SCQF 3-5								
Biology	36,125	36,378	37,469	37,212	35,254	33,656	31,858	-12%
Biotechnology	110	100	87	88	56	0	0	-100%
Chemistry	27,904	28,192	28,334	28,247	26,709	25,124	23,873	-14%
Computing	3,079	3,157	3,074	3,061	2,092	232	0	-100%
Computing Science	0	0	0	0	10,252	11,608	11,334	n/a
Computing Studies	15,312	14,378	14,350	12,924	744	133	0	-100%
Craft & Design	11,721	11,189	10,862	10,283	0	0	0	-100%
Design and Manufacture	0	0	0	0	6,580	7,157	6,662	n/a
Engineering Science	0	0	0	0	1,693	2,283	2,306	n/a
Environmental Science	0	0	0	0	318	511	642	n/a
Fashion and Textile Technology	0	0	0	0	715	720	775	n/a
Geology	96	80	124	75	47	0	0	-100%
Graphic Communication	11,419	11,583	11,275	11,139	9,374	8,251	8,079	-29%
Health and Food Technology	0	0	0	0	3,158	3,146	2,779	n/a
Information Systems	1,547	1,366	1,184	1,281	479	77	0	-100%
Lifeskills Mathematics	0	0	0	0	6,907	13,036	14,108	n/a
Mathematics	90,325	89,077	90,076	86,033	74,524	69,066	70,083	-22%
Music Technology	0	0	0	0	374	659	952	n/a
Physics	22,183	22,446	22,571	22,669	22,285	21,563	20,775	-6%
Practical Electronics	0	0	0	0	161	255	231	n/a
Practical Metalworking	0	0	0	0	499	1,132	1,389	n/a
Practical Woodworking	0	0	0	0	4,562	6,228	6,223	n/a
Product Design	995	993	1,109	1,090	885	96	0	-100%
Science	2,607	2,369	2,086	2,125	690	815	728	-72%

	2010	2011	2012	2013	2014	2015	2016	% change 2010-2016
SCQF 6[157]								
Biology	9,308	9,771	9,554	9,971	10,197	9,699	7,492	-20%
Biology (Revised)	0	0	33	163	131	204	0	n/a
Biotechnology	27	27	*	21	24	*	0	-100%
Chemistry	10,179	10,293	10,364	10,004	10,717	10,412	10,077	-1%
Chemistry (Revised)	0	0	266	652	702	481	0	n/a
Computing	4,356	4,128	4,028	3,989	4,468	3,008	0	-100%

[156] The exclusion of standard level qualifications accounts for the disparity between 2013 and 2014 data

[157] SCQF level 6 data contains both Highers and previous Highers in 2015. Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015. Human biology only available at SCQF level 6.

Computing Science	0	0	0	0	0	1,182	4,454	n/a
Design and Manufacture	0	0	0	0	0	2,224	3,079	n/a
Engineering Science	0	0	0	0	0	881	1,029	n/a
Environmental Science	0	0	0	0	0	83	392	n/a
Fashion and Textile Technology	0	0	0	0	0	*	305	n/a
Geology	63	64	*	64	49	34	0	-100%
Graphic Communication	4,071	4,179	4,122	4,066	4,150	4,682	4,611	13%
Health and Food Technology	0	0	0	0	0	943	1,448	n/a
Human Biology	4,078	4,269	4,356	4,126	3,944	4,550	5,990	47%
Human Biology (Revised)	0	0	54	149	213	176	0	n/a
Information Systems	1,433	1,407	1,208	1,224	1,059	487	0	-100%
Mathematics	20,657	20,552	20,566	20,665	21,851	21,075	18,871	-9%
Music Technology	0	0	0	0	0	280	486	n/a
Physics	9,018	9,447	9,171	8,793	9,098	9,063	9,129	1%
Physics (Revised)	0	0	457	841	1,111	717	0	n/a
Product Design	2,462	2,445	2,456	2,387	2,369	616	0	-100%

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**% change 2010-2016**
SCQF 7[158]								
Biology	2,177	2,288	2,417	2,458	2,518	2,425	2,362	8%
Biology (Revised)	0	0	0	0	15	0	0	n/a
Chemistry	2,226	2,472	2,496	2,545	2,393	2,448	2,614	17%
Chemistry (Revised)	0	0	0	111	278	335	0	n/a
Computing	414	461	460	435	440	509	0	-100%
Computing Science	0	0	0	0	0	0	485	n/a
Design and Manufacture	0	0	0	0	0	0	70	n/a
Engineering Science	0	0	0	0	0	0	0	n/a
Graphic Communication	798	903	1,011	950	956	909	671	-16%
Health and Food Technology	0	0	0	0	0	0	0	n/a
Information Systems	51	53	47	0	32	0	0	-100%
Mathematics	2,936	3,098	3,239	3,314	3,444	3,641	3,358	14%
Mathematics of Mechanics	0	0	0	0	0	0	222	n/a
Physics	1,736	1,757	1,917	1,867	1,815	1,845	1,923	11%
Physics (Revised)	0	0	0	62	133	177	0	n/a
Product Design	72	111	99	78	75	47	0	-100%

Source: SQA, 2017

[158] Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015

Table A5.2: STEM passes for Scottish school pupils by subject, 2010-2016[159]

	2010	2011	2012	2013	2014	2015	2016	% change 2010-2016
SCQF 3-5								
Biology	32,022	32,396	33,205	32,912	26,416	26,493	25,612	-20%
Biotechnology	69	69	57	77	44	0	0	-100%
Chemistry	26,002	26,301	26,329	26,451	21,239	20,059	19,453	-25%
Computing	2,445	2,475	2,391	2,449	1,493	150	0	-100%
Computing Science	0	0	0	0	8,980	10,090	9,729	n/a
Computing Studies	14,730	13,868	13,851	12,619	681	122	0	-100%
Craft & Design	11,413	10,870	10,659	10,065	0	0	0	-100%
Design and Manufacture	0	0	0	0	5,897	6,215	5,627	n/a
Engineering Science	0	0	0	0	1,389	1,990	1,913	n/a
Environmental Science	0	0	0	0	254	402	491	n/a
Fashion and Textile Technology	0	0	0	0	666	678	706	n/a
Geology	80	65	114	66	38	0	0	-100%
Graphic Communication	10,599	10,972	10,459	10,428	7,833	7,135	6,391	-40%
Health and Food Technology	0	0	0	0	2,508	2,641	2,384	n/a
Information Systems	1,222	1,081	950	1,008	331	49	0	-100%
Lifeskills Mathematics	0	0	0	0	6,273	10,299	11,321	n/a
Mathematics	77,230	77,533	77,050	74,043	58,357	52,098	53,092	-31%
Music Technology	0	0	0	0	337	615	852	n/a
Physics	20,093	20,029	20,414	20,622	17,138	17,331	16,641	-17%
Practical Electronics	0	0	0	0	106	221	180	n/a
Practical Metalworking	0	0	0	0	430	1,034	1,263	n/a
Practical Woodworking	0	0	0	0	4,050	5,668	5,681	n/a
Product Design	790	810	925	943	680	81	0	-100%
Science	2,457	2,254	1,989	2,082	631	772	690	-72%

	2010	2011	2012	2013	2014	2015	2016	% change 2010-2016
SCQF 6[160]								
Biology	6,496	7,066	6,955	7,076	7,064	6,963	5,167	-20%
Biology (Revised)	0	0	18	132	104	165	0	n/a
Biotechnology	19	20	*	18	21	*	0	-100%
Chemistry	7,834	7,979	8,263	7,811	8,184	7,746	7,710	-2%
Chemistry (Revised)	0	0	219	568	568	376	0	n/a
Computing	3,117	2,964	2,889	2,853	3,150	2,034	0	-100%
Computing Science	0	0	0	0	0	813	3,153	n/a
Design and Manufacture	0	0	0	0	0	1,531	1,925	n/a
Engineering Science	0	0	0	0	0	655	770	n/a

[159] The exclusion of standard level qualifications accounts for the disparity between 2013 and 2014 data

[160] SCQF level 6 data contains both Highers and previous Highers in 2015. Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015. Human biology only available at SCQF level 6.

Environmental Science	0	0	0	0	0	55	238	n/a
Fashion and Textile Technology	0	0	0	0	0	*	270	n/a
Geology	52	46	*	58	37	31	0	-100%
Graphic Communication	3,290	3,338	3,341	3,345	3,291	3,731	3,240	-2%
Health and Food Technology	0	0	0	0	0	685	1,020	n/a
Human Biology	2,805	2,976	3,018	2,950	2,845	3,156	4,122	47%
Human Biology (Revised)	0	0	32	83	121	129	0	n/a
Information Systems	1,090	1,068	966	920	769	364	0	-100%
Mathematics	14,955	14,890	15,140	15,058	15,779	15,200	13,906	-7%
Music Technology	0	0	0	0	0	245	432	n/a
Physics	7,059	7,384	7,109	6,764	6,779	6,687	6,788	-4%
Physics (Revised)	0	0	371	649	855	563	0	n/a
Product Design	1,837	1,881	1,802	1,767	1,578	417	0	-100%

	2010	2011	2012	2013	2014	2015	2016	% change 2010-2016
SCQF 7[161]								
Biology	1,607	1,755	1,861	1,957	1,845	1,873	1,898	18%
Biology (Revised)	0	0	0	0	13	0	0	n/a
Chemistry	1,735	1,966	1,992	2,066	1,833	1,963	2,171	25%
Chemistry (Revised)	0	0	0	97	239	277	0	n/a
Computing	326	359	390	362	370	433	0	-100%
Computing Science	0	0	0	0	0	0	363	n/a
Design and Manufacture	0	0	0	0	0	0	34	n/a
Engineering Science	0	0	0	0	0	0	0	n/a
Graphic Communication	728	847	924	861	869	809	441	-39%
Health and Food Technology	0	0	0	0	0	0	0	n/a
Information Systems	32	42	40	0	27	0	0	-100%
Mathematics	1,978	2,134	2,212	2,350	2,414	2,502	2,479	25%
Mathematics of Mechanics	0	0	0	0	0	0	164	n/a
Physics	1,371	1,410	1,555	1,513	1,465	1,443	1,519	11%
Physics (Revised)	0	0	0	50	91	142	0	n/a
Product Design	52	61	55	44	40	23	0	-100%

Source: SQA, 2017

[161] Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015

Appendix 6: STEM attainment by deprivation

Table A6.1: School leaver attainment by STEM-related subject and SIMD quintile, 2016

Subject	SIMD Quintile	% of all leavers with a STEM subject pass at SCQF level or better		
		SCQF 3 and above	SCQF 6 and above	SCQF 7 and above
English (included as a comparator)	1	84	25	1
	2	87	35	2
	3	88	44	3
	4	89	52	4
	5	92	65	5
Mathematics	1	84	10	1
	2	86	15	2
	3	88	21	4
	4	89	27	5
	5	90	39	8
Biology	1	35	4	1
	2	40	7	2
	3	42	10	2
	4	45	13	4
	5	47	18	6
Chemistry	1	26	5	1
	2	29	8	2
	3	33	11	3
	4	37	15	4
	5	46	23	7
Physics	1	19	4	1
	2	23	7	1
	3	28	10	2
	4	31	13	3
	5	38	20	6
Computing	1	16	3	>1
	2	18	4	1
	3	17	5	1
	4	16	5	1
	5	20	8	1
Graphic Communication	1	-	3	-
	2	-	5	-
	3	15	7	1
	4	16	8	1
	5	17	9	1
Practical Craft Skills	1	14	-	-
	2	14	-	-
	3	12	-	-
	4	11	-	-
	5	7	-	-
Design and Technology	1	-	2	-
	2	-	3	-
	3	12	3	>1
	4	12	4	>1
	5	-	4	-
Human Biology	1	3	3	-
	2	4	4	-
	3	6	6	-
	4	7	7	-
	5	8	8	-
Construction and Engineering	1	4	-	-
	2	-	1	-
	3	-	-	-
	4	6	1	>1

Subject	SIMD Quintile	% of all leavers with a STEM subject pass at SCQF level or better		
		SCQF 3 and above	SCQF 6 and above	SCQF 7 and above
	5	6	3	>1
Other Science	1	3	>1	-
	2	3	>1	-
	3	3	>1	-
	4	3	>1	-
	5	2	>1	-
Fashion and Textile Technology	1	2	>1	-
	2	2	>1	-
	3	-	>1	-
	4	-	1	-
	5	2	1	-
Practical Electronics	1	>1	-	-
	2	1	-	-
	3	>1	-	-
	4	>1	-	-
	5	>1	-	-
Product Design	1	-	>1	-
	2	-	>1	-
	3	-	>1	-
	4	-	>1	-
	5	-	>1	-

Source: Scottish Government, 2017