Science, Technology, Engineering and Mathematics (STEM) Evidence Base

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1. Introduction

The Science, Technology, Engineering and Mathematics (STEM) Strategy for Scotland has been launched by Scottish Government. To complement the Strategy an evidence base has also been developed.

STEM skills are of huge importance to the future success of Scotland. This is the first time that a comprehensive evidence base for STEM in Scotland has been put in place. Its preparation has involved desk research and consultation with stakeholders.

This evidence base is not fully developed and identifying gaps in the data was a key objective of this work. Building on this evidence base will very much be part of the implementation of the STEM Strategy. Nonetheless, the evidence gathered and presented in this report is a considerable step forward. It reveals the strength of STEM in Scotland, and also the extent of the challenges going forward in maximising the potential of STEM.

This study includes the following. It is based on a longer report which is also available:

1. The definition of STEM from employment, occupational and educational perspectives;
2. The demand for STEM skills by industry and by occupation;
3. Drivers of demand for STEM and related challenges;
4. The supply of STEM provision in education and training; and
5. Conclusions and recommendations.

2. Defining STEM

There is no single definition for STEM. STEM can be conceived as a set of inter-related disciplines and required skills and STEM related 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. The different components of STEM are defined as follows in the STEM strategy:

- **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, experimentation, exploration and discovery.

- **Engineering** is the method of applying scientific and mathematical knowledge to human activity and **Technology** is what is produced through the application of scientific knowledge to human activity. Together these cover a wide range of fields including business, **computing science**, chemicals, food, textiles, craft, design, engineering, graphics and applied technologies including those relating to construction, transport, the built environment, biomedical, microbiological and food technology.

- All of STEM is underpinned by **Mathematics**, which includes numeracy, and equips us with the skills and approaches we need to interpret and analyse information, simplify and solve problems, assess risk and make informed decisions. Mathematics and Numeracy develop essential skills and capabilities for life, participation in society and in all jobs, careers and occupations. As well as providing the foundations for STEM, the study and application of mathematics is a vast and critical discipline in itself with far-reaching implications and value.

- **Digital skills** also play a huge and growing role in society and the economy as well as enabling the other STEM disciplines. Like Mathematics, digital skills and digital literacy in particular are essential for participation in society and across the labour market. Digital skills embrace a spectrum of skills in the use and creation of digital material, from basic digital literacy, through data handling and quantitative reasoning, 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. Within digital skills, as noted above, computing science is a separate discipline and subject.

STEM is more difficult to define in data terms given the different data-sets covering employment, occupational and skills supply. STEM is not a sector in itself, rather 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, varies.

In analysing and quantifying STEM from a skills perspective, it is important to recognise the importance of skills and education, as well as industry and occupation. The approach adopted here is consistent with existing definitions of STEM (e.g. UKCES) that take a broad, rather than a narrow definition. 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 capability in early years, primary and secondary school learners from age 3-18, as well as in tertiary education, through the apprenticeship programmes and for adults and young people through community learning and development. The ambition is to develop STEM capability and skills in all learners.

In data terms, however, early learning and childcare and primary settings have not been included, as 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. For the purposes of this report, STEM is therefore defined according to the respective education, training, occupation and industry sector dataset:

- Standard Industrial Classifications (SIC) for jobs in STEM industrial sectors;
- Standard Occupational Classifications (SOC) for those employed in STEM occupations;
- Secondary school qualifications and Skills for Work qualifications;
- College Further Education Superclasses – and this is a wider definition of STEM than has traditionally been the case;
- Apprenticeship Frameworks: Foundation Apprenticeships, Modern Apprenticeships and Graduate Level Apprenticeships;
- Higher Education Degree subjects by Joint Academic Coding System (JACS) principal subject areas.

Appendix 1 presents the definition of STEM used in this report for each of the data-sets above (further details are in the longer report). There will be a requirement for subsequent refining of the definition during the implementation phase of the STEM Strategy. For the rest of this report, where it talks about STEM it means the definition set out in Appendix 1, based on the list above.

3. Demand for STEM

The demand for STEM can be classified under two headings:

- Jobs in STEM Industries – by Standard Industrial Classification (SIC); and

- Jobs in STEM Occupations – by Standard Occupational Classification (SOC).

Both the SIC and SOC based analysis draw from the Annual Population Survey (APS).

3.1 Jobs in STEM related Industries

There were 963,400 people working in STEM related sectors in Scotland in 2016 (APS, SIC defined). This represents an increase of 70,500 (8%) from 2010 levels, double the overall increase in employment in the Scottish economy (4%). It represents a 37% share of total employment, higher than the Great Britain average of 32% (the proportion for England was 31% in 2015, and 33% for Wales).

The number of jobs in STEM related sectors is highest in urban regions (Table 1). The Location Quotient (LQ) denotes where STEM related jobs are proportionately more concentrated than the Scotland average (where LQ is greater than 1).

The LQ is highest in Aberdeen City and Shire (an LQ of 1.24), largely as a result of the oil and gas sector, Edinburgh and Lothians (LQ 1.07), which includes financial technologies (FinTech) and the West region (LQ 1.02), partly reflecting its historic manufacturing and engineering base. There is a high proportion of STEM related employment in the former industrial areas of Forth Valley, Ayrshire and West Lothian. The Glasgow and Lanarkshire regions account for the highest absolute numbers of STEM related employment in Scotland. The STEM related share of total employment is lowest in the more rural areas of Dumfries and Galloway at 28% and the Borders at 34%.

Between 2010 and 2016, Aberdeen City and Shire experienced the largest growth in the share of STEM related employment, from 40% in 2010 to 46% in 2016, related to (until recently) strong growth in the oil and gas sector. There were also notable increases in the share of STEM related employment in both Edinburgh and Lothian, (from 35% to 40%), and West Lothian, from (33% to 37%). Elsewhere, the STEM related share of total jobs shows no change, or modest increases. In Fife and Tayside, there were modest decreases, from 36% to 35%.

In 2016, 80% of STEM related jobs in Scotland were full-time, compared with 75% across all industries. The gap has narrowed slightly since 2010. The higher prevalence of full-time working in STEM related industries may be a factor in the lower number of women working in STEM related industries compared to other sectors, as women are less likely to be in full time employment.

Table 1. STEM sector employment by College Region, 2016

College Region	STEM Employment	Total Employment	STEM Share 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 City and Shire	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: UK Business Counts

Employment in STEM related sub-sector industries is highest in *Hospital activities* and *Administration of the State and the economic and social policy of the community*, with around 115,000 people employed in each (Table 2). This is followed by over 71,000 people employed in *Provision of services to the community as a whole* and almost 60,000 in both *Construction of residential and non-residential buildings* and in *Higher education*. Collectively, the top five sub-sectors account for under half (44%) of employment in STEM related industries.

Table 2. STEM sub-sector employment 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

There is a strong gender bias in several sub-sectors:

- There are 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 (82%);
    - 861: Hospital activities (80%); and
    - 869: Other human health activities (79%).

It is projected that there will be a 4% growth in STEM related employment in Scotland from 2015 to 2027 (Oxford Economics)[1]. This increase amounts to approximately 42,600 jobs. Much of this growth is forecast to be concentrated between 2021 and 2024.

Employment and GVA growth related to STEM is expected to be concentrated in urban areas. Forecast employment growth is highest in Edinburgh (14%) and Glasgow (9%) and lowest in Borders (-2%) and Dumfries and Galloway (-2%). The

[1] Note, these are based on a 2 digit SIC-based approximate definition of STEM

exception is Aberdeen and Aberdeenshire, where there is expected to be a 4% fall in STEM related employment to 2024, as a result of the current challenges in the oil and gas sector.

3.2 Jobs in STEM Occupations

There were 838,000 people employed in core STEM related occupations in Scotland in 2016. Core STEM related occupations account for around one third (32%) of all occupations in Scotland. STEM *Professionals* is the largest occupational grouping, at over half (58%) of the total core STEM related workforce in Scotland (see Table 3). This group includes occupations such as teaching and education, health, and information technology and telecommunications professionals. When taking into consideration potential related STEM roles, this figure increases to over 900,000 people in employment.

Table 3: Employment by STEM occupation in Scotland, 2016

Occupation	Number employed	% of all STEM occupation employment
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

Table 4 shows employment in STEM related occupations by region.

Table 4: Employment in STEM occupations by College Region, 2016

College Region	All core STEM occupations	Location quotient[2]
Edinburgh and Lothians	140,357	1.27
Glasgow	129,945	1.06
Lanarkshire	115,050	0.96
Aberdeen City and Shire	94,681	1.16
Highlands & Islands	65,873	0.85
West	63,826	0.95
Fife	56,622	1.01
Tayside	55,620	0.88
Forth Valley	45,302	0.97
Ayrshire	44,283	0.88
West Lothian	27,155	0.96
Borders	18,060	1.06
Dumfries and Galloway	16,557	0.74
Scotland	**833,362**	**1.00**

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

Key points to note are:

- Edinburgh and Lothians, as well as having the largest *number* of core STEM related occupations, has the greatest *concentration* of these occupations at 127% of the national average, driven by the City of Edinburgh local authority area;
- Aberdeen City and Shire has a slightly higher concentration of STEM related *occupations* than the Scotland average, although lower than its concentration of STEM *industries*;
- In Highlands and Islands, despite a STEM related *industry* concentration in line with the national average, STEM related *occupations* are 85% of Scotland's average. This under-representation is the case in all local authorities within the region.
- As with employment in STEM related *industries*, Dumfries and Galloway has the lowest concentration of STEM related *occupations* in Scotland, at 74% of the national average

Within core STEM related occupations, *Professionals* are the most gender balanced, with 52% of the jobs held by females. However, there is a strong tendency for males to hold roles in *Skilled Trades* (97%) occupations, and also in *Director and Manager* (63%) and *Technician* (61%) roles.

In related STEM occupations, 86% are held by males, again driven by male 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 5.

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

Table 5: Employment by STEM occupation in Scotland by gender, 2016

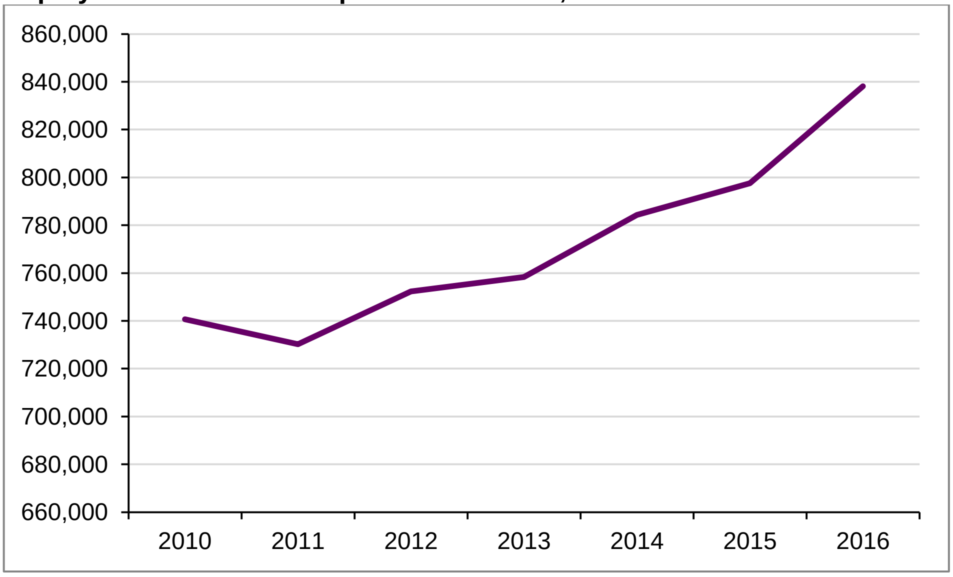
Occupation	Number employed	Males	Females
Total core STEM occupations	**838,100**	**58%**	**42%**
STEM Directors and Managers	119,800	63%	37%
STEM Professionals	483,900	48%	52%
STEM Technicians	130,200	61%	39%
STEM Skilled Trades	104,200	97%	3%
Total potential related STEM occupations	**61,600**	**86%**	**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. Figures may not sum due to rounding

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 dominated by women (both 92%).

Employment in core STEM occupations grew strongly by 13%, or 97,500 jobs, between 2010 and 2016 (Figure 2).

Figure 2: Employment in STEM occupations over time, 2010-2016



Source: Annual Population Survey, ONS, 2016

There has been substantial increases in jobs in STEM related professional occupations over the period from 2010 to 2016 (71%), while there have been substantial declines in *Directors and Managers (*-38%) and *Technicians* (-22%) (Table 6).

Table 6: Employment in STEM occupation groupings over time, 2010-2016

Occupation	2010	2016	Males	Females
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

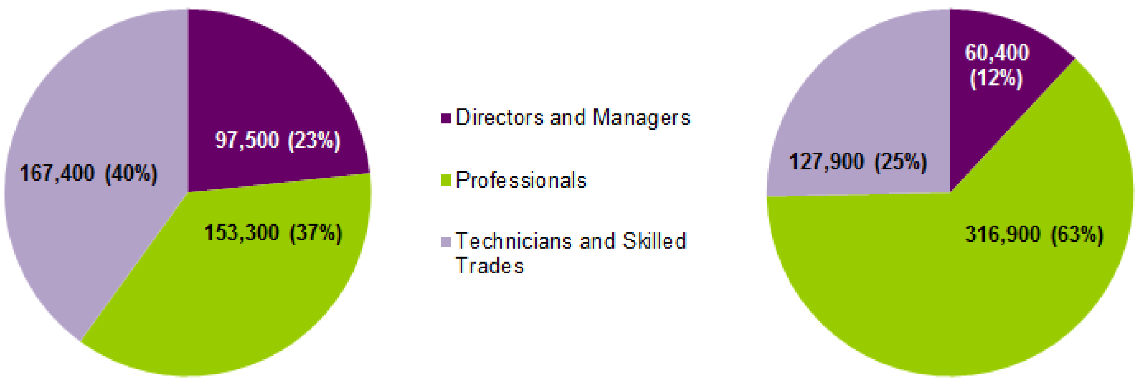
The greatest increase has been in *213: Information Technology and Telecommunications Professional* (an increase of 41,600 jobs, a 153% growth), *242: Business, Research and Administrative Professionals* (20,000 jobs, 65%), and *353: Business, Finance and Related Associate Professionals* (17,200 jobs, 46%)

The overall gender split by occupations has narrowed over time. In 2010, 39% of core STEM occupations were held by females, by 2016 this was 42%. There are higher proportions of women employed as core STEM *Professionals* and *Directors and Managers,* but the proportion STEM *Technicians* has fallen, from 56% of this group in 2010 to 39% to 2016.

In 2016, 505,000 of those employed in core STEM occupations worked within STEM industries (60% of all core STEM). Therefore, 40% of core STEM occupations were employed in non-STEM industries in 2016, equivalent to around 332,000 people. This proportion employed in core STEM occupation in STEM industries has increased from 56% in 2010.

There have also been changes in the different occupational groupings, as shown at Figure 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 3: Core STEM occupations in STEM industries, 2010 (left) and 2016 (right)



Source: Annual Population Survey, ONS, 2016

4. Drivers of Change in STEM

The desk research and our consultations with stakeholders identified a number of drivers that have – and will – impact on the demand for STEM skills.

4.1 Sector Growth and Demand Forecasts

Future employment growth is forecast to be concentrated in higher level STEM related occupations that require more complex skills and knowledge. Employment in higher level occupations is projected to grow by 18% or approximately 500,000 jobs in the UK, three times the all sector average. Sectors where particularly strong growth is expected include Information and communications (25%) and professional services (20%) (UKCES, 2015). [3]

This strong growth in employment is expected against a backdrop where employers are already identifying recruitment difficulties and skills shortages. The UK has a shortfall of 400,000 STEM graduates every year[4], particularly engineering and IT professionals and 39% of employers seeking STEM skills have reported difficulties with recruitment. UKCES's Employer Skills Survey 2013 found a skill shortage to vacancy ratio of 43% amongst Science, Research, Engineering and Technology professionals.[5] The 2015 Employer Skills Survey reports skill shortages are highest in Electricity, Gas & Water and Construction.[6] Further, the Royal Academy of Engineering suggests there is an 'engineering skills crisis' in the UK, in part caused by the supply of STEM skills failing to keep pace with demand.[7]

STEM skills were cited by employers as being amongst those skills that are difficult to obtain from applicants (UKCES, 2015). Overall, 30% stated it was difficult to find candidates with adequate computer literacy, 27% to find candidates with advanced or specialist IT skills, 24% complex numeracy/statistic skills and 20% basic numeracy skills[8].

Some STEM industries may find the challenges to meet demand greater than others, e.g. IT, where there is potentially a global job market for the individual with the right skill set. Employers also face uncertainty in relation to Brexit i.e. the potential for out-migration of skilled workers returning to the EU. There is also an indication from employers that senior managers and Masters/PhD level entrants and workers are in

[3] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*
[4] IDOX (2017) *Building STEM Skills in the UK*
[5] UKCES (2013) *Employer Skills Survey*
[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/525444/UKCESS_2015_Report_for_web__May_.pdf
[7] Royal Academy of Engineering (2016) *The UK STEM Education Landscape*
[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/525449/UKC004_Summary_Report__May_.pdf

particularly 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 may be worth considering for future research.

Despite recent policy initiatives to promote more vocational and technical routes into STEM employment, and employment more widely, employer preference for university graduates persists. There is a perception that university education generates operational managers, whilst college education (HNC, HND and MAs) generates operational 'doers'. Historic trends in young people pursuing university education has contributed to the skills gap at the operational technician level in STEM.

Employers also say that softer skills, while often overlooked, are in high demand. They want core skills and work ready young people, but these are difficult to obtain. Work based learning can therefore be beneficial to both potential employee and employer.

L STEM technicians and professionals often progress their careers and move into management roles. This can have an impact on the retention and deployment of STEM skills in the workplace e.g. good engineers become managers. There needs to be more recognition (financial and other) of the contribution that experienced technicians make to a business.

4.2 Pace of Technological Change and Innovation: Industry 4.0

There are eight technologies in which the UK has the potential to be a global leader, based on existing research strengths and industrial capability. These are the Eight Great technologies[9]: 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. Commercialisation of these technologies has to date led to substantial growth opportunities for the UK economy, and will continue to do so.

The pace of technological change is not expected to slow down. A survey of more than 3,100 IT and business executives showed 86% anticipate that the pace of technology change will increase rapidly or at an unprecedented rate in their industry over the next three years.[10] 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,

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

greater levels of technical assistance, and decentralised decision-making – greater automation and decision-making by cyber-physical systems.[11]

The speed at which jobs are changing as a result of technological change is altering the skills demand and requirement of the labour market. This is creating a 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.

4.3 STEM as an Enabler of Growth

STEM's role in driving high levels of productivity and innovation gives it a critical role in economic development.[12] For high wage economies, the development of knowledge-intensive industries and expertise are particularly important for maintaining competitiveness within an increasingly global market.[13]

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 whole economy. A study by the Centre for Economics and Business Research and O2 Business highlights 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[14]. Further, the same study states productivity will rise by 22% in the next seven years as new high technology products are developed, allowing businesses to work smarter.

STEM skills are also a key driver of innovation development and growth across a range of industries. Recent research shows that 45% of graduate employees in innovative manufacturing firms have STEM degrees compared to 30% in non-innovative firms.[15] The numeracy and reasoning skills of STEM graduates are closely linked to innovation.

Experimental statistics published by the Scottish Government indicate that those graduating in STEM subjects groupings in general earn more than those in non-STEM subject groupings five years after graduation.[16]

Generally people with STEM qualifications will earn more though this is more pronounced with technology, engineering and mathematics than science. Those

[11] Hermann, M. et al. (2016) *Design Principles for Industrie 4.0 Scenarios, 2016 49th Hawaii International Conference on System Sciences (HICSS)*
[12] UKCES (2011) *Briefing Paper: The Supply of and Demand for High Level STEM Skills*
[13] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*
[14] Centre for Economics and Business Research/O2 Business (2013) O2 Individual productivity Index
[15] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*
[16] Scottish Government (2017) *Graduate outcomes by University and subject (LEO data) – Scotland (Experimental Statistics: data being developed)*

working in the science, technology and engineering sectors earn nearly 20% more than those working outside of these sectors.[17]

4.4 Workforce Demographics

While current workforce issues are outwith the scope of the STEM strategy, they are an important element in understanding the STEM workforce overall and for informing the development of future provision and the pipeline

Gender: Women are under-represented in a range of STEM-related sectors. 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. 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.

Research by TERU[18] found that women were under-represented across a range of STEM sectors, such as Energy, Life and Chemical Sciences, Engineering, and ICT/Digital. Compared to other sectors, there is a longer qualification lead-in time for STEM, and 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. Research by Equate Scotland on the construction industry highlighted issues of gender segregation related to 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.

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[19], this is often compounded by a lack of female role models.

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. In some STEM sectors, developments can move so fast that spending any time out of the workforce can

[17] UKCES (2015) *Reviewing the Requirements for High Level STEM Skills*
[18] TERU (2015) *Equalities in Scotland’s Growth Economic Sectors: Final Report, report for SE*
[19] The Royal Society of Edinburgh (2012) *Tapping all our talents: Women in science, technology, engineering and mathematics: a strategy for Scotland*

mean that skills and knowledge quickly become outdated. Such rapid changes can make re-entry difficult after even a short career break.

These factors all contribute to what is known as the 'leaky pipeline' effect – the attrition of trained, qualified women from employment in STEM. There is limited data evidence on this but the *Tapping all our Talents* report from 2012 said, at that time, that 73% of women graduates were lost from STEM industry, compared with 48% male graduates. Further investigation and data analysis is required here.

There are a number of initiatives aimed at addressing such gender issues. These include Close the Gap's 'Be What You Want'[20] programme that works in schools, and local initiatives such as Ayrshire College's #whatiactuallydo #ThisAyrshireGirlCan social media campaign.

Age: the demographic profile has important implications for planning and resourcing the pipeline for STEM skills, both in terms of replacement and expansion demand. 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

Ethnicity: There is widespread evidence (e.g. UK Association for Science and Discovery Centres)[21] that there is considerable under-representation of people from a variety of ethnic backgrounds working in STEM. STEM sectors have very low numbers of BME employees with BME men 28% less likely to work in STEM than white men[22]. The converse is true however for BME women although the reasons for this are unclear.

Those from deprived areas: People living in areas of multiple deprivation are less likely to participate in STEM from either an education, employment or occupational perspective.[23] There is a data gap here regarding how many children from deprived areas progress to STEM careers, or how many people living in deprived areas work in STEM careers.

There is also 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.

[20] http://www.bewhatyouwant.org.uk/
[21] http://sciencecentres.org.uk/events/2015_Education/Penny%20Fidler.pdf
[22] https://race.bitc.org.uk/issues_overview/ethnicity-and-stem
[23] http://sciencecentres.org.uk/events/2015_Education/Penny%20Fidler.pdf

4.5 Societal Challenges

Image and profile of STEM: There is feedback from stakeholders that there is further work to be done in terms of repositioning and rebranding STEM. There is a need to overcome outdated and misplaced perceptions which still exist about STEM careers and skills. Kings College London's ASPIRES research indicates that ethnicity, deprivation and gender all affect the level of 'science capital' (science-related qualifications, understanding, knowledge about science and 'how it works', interest and contacts) in the household growing up. Those from BME backgrounds, girls, care 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.[24]

The portrayal of STEM and Science in the mainstream and social media also contributes to the misconceptions of STEM, as does the language and terminology used to describe activities, achievements and careers. Employers also have a key role to play in creating positive perceptions of STEM jobs and careers and addressing gender segregation.

Influencing the influencers – parents, peers and practitioners: communities, families and individuals can lack confidence to engage with STEM-related subjects. Consequently, attitudes towards STEM can be negative. It is important therefore to influence the informal influencers so they are better able to understand the pace and scale of technological change and the increasing technical and scientific nature of the economy. One avenue to achieve this is through Community Learning and Development (CLD).

Overcoming the 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.

Influencing practitioners is equally important, as there is a clear need to stimulate interest in STEM-related subjects throughout school ages. Changing the perceptions and approaches of influencers is a key recommendation in the Kings College London ASPIRES report[25]. It states that the vision of 'science for all' should be promoted and that there should be investment in and prioritisation of Continuous Professional Development (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

[24] http://www.ucl.ac.uk/ioe/departments-centres/departments/education-practice-and-society/aspires
[25] https://kclpure.kcl.ac.uk/portal/en/publications/aspires-report(a0237ac7-cb43-473e-879a-1ea0addff0e3).html

Schools, by developing the confidence and competence of teachers to provide highly engaging and motivating learning opportunities.

4.6 Policy Drivers

There are a number of policy drivers that currently influence demand for STEM. Going forward, the STEM strategy will seek to address the way in which education and training can be improved so as to meet growing demand for STEM skills. This is structured around Excellence, Equity, Inspiration and Connection.

The STEM strategy is integral to the Scottish Government's broader economic strategy, which is focused around four 'Is' priorities: innovation, inclusive growth, investment and internationalisation. The development and improvement of STEM education and training contributes particularly to innovation and inclusive growth.

There are a wide range of plans and strategies in Scotland that focus on, or are relevant to STEM skills. As an 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 with 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.[26] The key strategies driving changes in Scotland's economy that are most relevant to STEM are:

- Scotland's (draft) Energy Strategy;
- The new (2016) Life Sciences Strategy for Scotland: 2025 Vision, which builds on Scottish Life Sciences Strategy 2011;
- Platform for Growth: A Strategic Plan for the Chemical Sciences in Scotland in 2012;
- The Life and Chemical Sciences Manufacturing Strategy;
- The National Plan for Industrial Biotechnology;
- SE's Subsea Engineering Action Plan;
- A Manufacturing Future for Scotland;
- Specific strategic investments in manufacturing, such as the recently-announced Lightweight Manufacturing Centre (LMC), seen as a key step in the creation of the National Manufacturing Institute for Scotland (NMIS);
- The £12 million Oil & Gas Transition Training Fund, administered by SDS;
- The Decommissioning Action Plan;
- The Farmer Review of the UK Construction Labour Model;
- Scotland's Digital Future: A Strategy for Scotland; as well as
- Other Digital initiatives.

There are also Skills Investment Plans (SIPs) that are relevant for STEM skills and the STEM Strategy. These include Chemical Sciences, Engineering, Life Sciences,

[26] http://www.gov.scot/Publications/2016/02/8699

Engineering, ICT and Digital Technologies, Construction, as well as SIPs for Food & Drink, Financial Services, and Creative Industries.[27]

A range of wider strategies and policies are also relevant:

- The Enterprise and Skills Review[28];
- Career Education Standard;
- Scotland's Youth Employment Strategy;
- Scottish Government's Governance review;
- The National Improvement Framework;
- The Digital Learning and Teaching Strategy[29] ; and
- The STEM Improvement Framework.

The plethora of programmes, strategies and initiatives could lead to silo working and duplication of effort. There is currently evidence to suggest there could be better alignment and perhaps simplification to maximise the benefits and impact resulting from support for STEM education and training.

5. Supply of STEM Education and Training Provision

The analysis of the supply of STEM is structured under the following headings:

- Provision in schools;
- Provision in Colleges;
- Provision through Apprenticeships – Foundation Apprenticeships, Modern Apprenticeships and Graduate Level Apprenticeships; and
- Provision in Universities.

It should be noted that there is a wide variety of qualifications being delivered through various teaching and training modes, and so there should not be comparisons between the forms of provision. There is also a degree of overlap across the various levels of education. College data will overlap with MA data to an extent, since much SVQ delivery for MAs will be College-based. School College provision may also be counted twice. Associate students will also be counted at both College and Higher Education Institute. As referred to earlier, the definition of what constitutes STEM provision is outlined in Appendix 1.

5.1 School Provision

National Level: Between 2010 and 2016 there was a fall in STEM entries at SCQF level 3-5 of 9% (partly due to a reduction in Mathematics) and a fall in STEM passes (19%) (Table 7). These decreases should be set against the context of a declining school roll, with the S4-S6 cohort dropping by 5.6% between 2010 and 2016, from 135,405 pupils to 127,851. In addition passes at SCQF Level 3-5 across all subjects also fell by 19% between 2010 and 2016, as schools revised curriculum models and started delivery of the new National qualifications, providing more flexibility for

[27] http://www.skillsdevelopmentscotland.co.uk/what-we-do/partnerships/skills-investment-plans
[28] Scottish Government (2017) *Enterprise and Skills Review: Report on Phase 2*
[29] http://www.gov.scot/Publications/2016/09/9494

learners across the senior phase. From 2015 to 2016 the drop in STEM entries and passes was far smaller at 1% each and STEM National passes fell at a slower rate than all National passes.

Higher level: there has been a 3% increase in STEM entries from 2010 to 2016, whilst the number of passes has remained stable. However, there was a fall in the last year of 5% and 6% in entries and passes respectively, and an overall growth in passes for all Highers.

Advanced Higher: 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 there was a 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.

Table 7: STEM entries and qualifications for Scottish school pupils, 2010-2016[30]

	2010	2011	2012	2013	2014	2015	2016	% or p.p.[31] change 2010-2016	% or p.p. change 2015-2016
SCQF Level 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 Level 6[32]									
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 Level 7[33]									
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

By gender, at school, males make up the majority of passes and entries for STEM-related subjects across all levels (Table 8). There are also fewer female entries in STEM than for all subjects. The female entry share for all subjects is 4.4 percentage points higher than the female entry share for STEM at National level (Table 8), increasing to 9.8 percentage points higher at Higher level and 12.6 percentage points higher at Advanced Higher level.

Table 8: STEM school entries and passes, by gender, 2016

[30] The exclusion of standard level qualifications accounts for the disparity between 2013 and 2014 data
[31] Percentage point
[32] 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.
[33] Revised Highers and Advanced Highers data are included in SCQF levels 6 and 7 from 2012 to 2015

	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: The Scottish Government, 2017

However, the female pass rate in STEM is higher than the male pass rate at all levels and this is particularly marked at Advanced Higher level at +6.5 percentage points. However, 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.

By geography, 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 and 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.

By area of deprivation: 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.

5.2 College Provision

STEM-related subjects accounted for 30% of enrolments (85,063), 32% of credits (552,229) and 32% of Full Time Equivalents (FTEs) students (41,097) (Table 9) in Scottish colleges in 2015/16.

Table 9: 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

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.

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 increased since 2010/11, from 29% in 2010/11 to 32% in 2015/16. The number of STEM FTEs has also increased in absolute terms, from 39,152 to 41,097, despite the overall number of FTEs having decreased within the same period.

By geography: STEM college enrolments and credits are concentrated in the Glasgow college region (Table 10), 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). This is in part driven by variations in subject choices by college where some colleges in Scotland have a more limited STEM offer.

In a number of regions, most notably in Borders, West Lothian, Lanarkshire, Edinburgh, Ayrshire, Glasgow and Tayside the ratio of credits to enrolments is substantially 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. 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.

Table 10: College enrolments and credits in STEM-related subjects 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: Source: SFC, 2017
Please note, this data includes HE provision in colleges

By subject: 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% (Table 11).

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.

Table 11: College enrolments on qualifications in top 10 STEM Superclass – 2015/16

Superclass	Enrolments		Credits		Credits per Enrol-ment	Full Time Equivalents	
	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: Source: SFC, 2017

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.

By age and gender: 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, higher than the 39% across all college enrolments.

5.3 Apprenticeship Provision

Foundation Apprenticeships (FAs): are two year programmes developed during an early pathfinder design and development stage from 2014-17. 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[34] (Table 12).

Over one third of those completing a Foundation Apprenticeship have gone on to a potential Modern Apprenticeship.

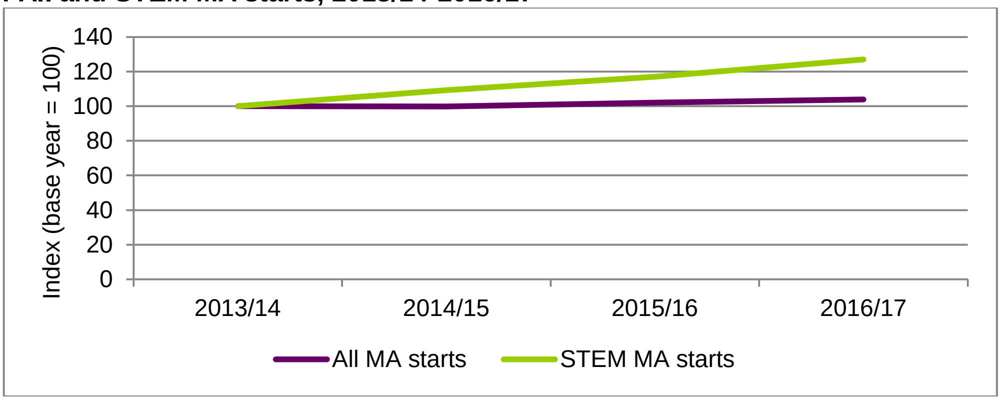
Table 12: STEM Foundation Apprenticeship starts by framework, 2016-18 cohort

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: Source: SFC, 2017

Modern Apprenticeships (MAs): During 2016/17, there were 9,651 registrations on SDS-funded Modern Apprenticeships in STEM-related subjects in Scotland[35]. Of these starts, there were 6,893 achievements, equating to a success rate of 71%. In 2016/17, 37% of all MA starts were in STEM Frameworks up from 30% in 2013/14. STEM MA provision has grown by 27% in the last four years, compared with 4% for all MA Frameworks (Figure 4). In all, 73% of 2016/2017 MA starts were at SCQF levels 6-7, compared to 61% of all MAs.

Figure 4: All and STEM MA starts, 2013/14-2016/17



[34] Frameworks falling under the STEM definition are outlined in the longer report. It should be noted that *Creative and Digital Media* and *Scientific Technologies* frameworks are due to commence in the Academic Year 2017/18.
[35] 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.

Source: SDS, 2017

Construction: Building records the highest number of starts for STEM Modern Apprenticeships at 1,527, followed by *Automotive* at 1,099 (Table 13). 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*.

Table 13: Provision of MAs in STEM-related subjects – 2016/17[36] - Top 10 frameworks with highest number of starts

	Number.	% Female	% Male	Achieve-ments
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: Source: SFC, 2017

The Lanarkshire region records the highest provision of STEM Modern Apprenticeships at 1,728 (18%) in 2016/17.

Graduate Level Apprenticeships (GLAs): These began with a pathfinder of 14 learners in 2015/16. From September 2017 there will be 379 GLAs available across four frameworks IT: Software Development (SCQF level 10 – Honours degree level); IT: Management for Business (SCQF level 10); Engineering: Design and Manufacture (SCQF level 10); and Civil Engineering (SCQF level 8 – DipHE level).

In September 2018, the number of GLAs will increase again by 520 through the introduction of seven new frameworks: Engineering: Instrumentation, Measurement and Control (SCQF level 10); Business Management (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 and Level 11).

[36] Note: only presents MA provision which is SDS funded and does not include any privately funded apprenticeship training and is therefore likely to under represent the number of apprenticeships being delivered across Scotland.

5.4 University Provision

In 2015/16 there were 114,740 enrolments in STEM-related subjects at Scottish universities, across full-time and part-time undergraduate and postgraduate courses. This accounted for 49% of total enrolments (up from 46% in 2010/11) and the number has increased by 5,285 (5%) since 2010/11 (Table 14). In 2015/16, 77% of enrolments in STEM-related subjects at Scottish universities were for undergraduate programmes and 23% were for postgraduate programmes. In all, 79% of enrolments in STEM-related subjects at Scottish universities were for full-time programmes (above the 76% for all subjects), 20% were part-time and 1% was for sandwich programmes. Subjects allied to medicine had the highest number of STEM enrolments at 29,130 and a 25% share of total STEM enrolments.

Table 14: University enrolments by STEM-related subject, 2010/11 and 2015/16

	2010/11		2015/16		Change in Enrolments	
Subject	**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%**	**5,285**	**5%**

Source: HESA/SFC, 2017

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).

Across all STEM-related subjects 52% of enrolments were female. This is lower than the 58% across all enrolments. 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 (Table 15).

For the most part, the gender split within subjects remained broadly stable from 2010/11 to 2015/16. The only notable 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 15: University enrolment in STEM-related subjects by gender, 2010/11 and 2015/16

Subject	2010/11 Female % enrolments	2010/11 Male % enrolments	2015/16 Female % enrolments	2015/16 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

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 per annum – a £1,000 premium relative to the all degree subject average.

6. Conclusions and Recommendations

The full Evidence Base report concludes that 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. This includes key issues to be addressed and gaps in evidence.

6.1 Issues to be addressed

The research identified a number of areas to be addressed such as:

- Maximising the potential of CfE to meet employer demand for STEM skills;
- Ensuring that key influencers have sufficiently up-to-date industry and technical knowledge/experience;
- 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;

- Redressing the imbalance present in all under-represented groups in STEM, though it is recognised that the 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;
- Determining the overall pattern of progression through the STEM pipeline;
- Mapping of engagement and support - an exercise which maps all current STEM supporting and engagement activities (including those new initiatives in the STEM Strategy).

These issues have been considered in development of the final Strategy.

6.2 Addressing evidence gaps

In developing this STEM evidence base, 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 more comprehensive information on destinations of STEM graduates. Some more longitudinal data on University leaver destinations and outcomes is becoming available through the Longitudinal Educational Outcomes (LEO) data and this should be interrogated to examine the impact of STEM education on graduate career destinations[37];

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

- 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.

APPENDIX 1: STEM Definition

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[38]	Practical Electronics
Science	Practical Metalworking
Biology/Human Biology	Practical Woodworking
Physics	
Chemistry	***Skills for Work qualifications***
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	

[38] 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
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

STEM Industrial Sectors (3-digit SIC)	
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

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