

STEM STRATEGY – DEFINITION OF STEM FOR MONITORING AND REPORTING

Purpose

1. This paper sets out further details of the way that STEM has been defined for the purposes of the reporting of data in the STEM Strategy Annual Report and Key Performance Indicators.

Background

2. The definition of STEM used in the STEM Strategy for Education and Training published in October 2017 (as at Annex A) is broad allowing the opportunity for various data interpretations to be applied in what is a complex set of inter-related disciplines and skills.

3. A STEM evidence base report was produced alongside the strategy and was published in October 2017. It was informed by a comprehensive consideration of the various issues around defining STEM across the different sectors. We took, as a starting point, the broad definition of STEM set out in the strategy. The study noted that the definitions would need to be worked on further during the implementation phase of the strategy.

4. The definitions in the evidence base report were also consistent with the definition of STEM used in the Developing the Young Workforce programme for school-level qualifications, apprenticeships and college courses. They were also broadly aligned with the definition of “science-based subjects” in the Higher Education Statistics Agency (HESA) data for the higher education sector.

An indicative definition of STEM for monitoring and evaluation

5. Since the evidence base report was produced we have undertaken some further refinements of the lists of courses and subjects that can be considered to be STEM for the purposes of monitoring and evaluation under the strategy. We have chosen to define STEM in slightly different ways across different sectors, reflecting the different contexts of each sector. The definition is quite broad, recognising the wide variety of courses and occupations that STEM learning leads to. We know that it is often more important to know about the differences that exist within STEM courses, study and occupations, for example, gender imbalance across STEM, than it is to calculate a total ‘amount’ of STEM. This is why we have presented disaggregated data in the supporting information for the Strategy Key Performance Indicators relating to gender.

6. In summary:

- We have matched SQA qualifications and awards to the broad subject areas of Science, Mathematics and Technology and included those qualifications and awards if at least half of the mandatory content can be related to these curricular areas and are generally organised or delivered in faculties and

departments relating to these curricular areas. The teacher definition follows similar criteria. (Annex B)

- For college courses we have used the definition that is in use on the Outcome Agreements for the purposes of KPIs. We have also provided data on medical and veterinary college courses because these have significant STEM content and lead onto STEM-related jobs and careers. (Annex C)
- A similar approach has been taken when determining STEM courses at universities, based on the established HESA definitions. (Annex D)
- We have established a defined list of STEM-related apprenticeship frameworks. These have been chosen because they relate to the subjects listed above and to STEM-related jobs and careers. (Annex E)
- There is no one accepted definition of STEM in the labour market in use in Government. The main issue is that there are some labour market sectors that are very clearly STEM based e.g. engineering and some that are not STEM based but include STEM-related occupations in them e.g. an accountant in a business or a clinician working in health and social work. STEM skills are increasingly important across all sectors and roles and it is very hard to rule some sectors in and some out. We have taken an approach based on work by the UK Commission for Employment and Skills that looked in detail at the proportion of people in jobs and business with degree-level qualifications. We have widened this out somewhat, drawing on the STEM evidence base report. (Annex F)

7. We recognise that there are courses, subjects and occupations not listed in this paper that connect to or rely on STEM knowledge and skills. This is particularly the case for the creative industries and for some disciplines in the social sciences, notably geography. The lists of subjects and courses presented here are not intended to be exhaustive or definitive. Rather, they set out a core set of STEM courses, subjects and occupations that we will use to monitor progress with the STEM strategy aims and objectives. We will keep these lists under review as the strategy progresses, alongside an on-going review of the Key Performance Indicators.

Scottish Government
February 2019

STEM Definition in STEM Strategy

The STEM strategy provided a broad definition of STEM based on skills and capabilities:

STEM stands for Science, Technology, Engineering and Mathematics. We include numeracy and digital skills within our definition of STEM. Both of these are vital to enable everyone to participate successfully in society as well as across all jobs, careers and occupations. STEM education and training seeks not only to develop expertise and capability in each individual field but also to develop the ability and skills to work across disciplines through interdisciplinary learning. STEM education and training helps us acquire the following skills and capabilities:

- Growing our understanding and appreciation of the natural and physical world and the broader universe around us
- Interpreting and analysing data and information
- Research and critical enquiry – to develop and test ideas
- Problem solving and risk assessment
- Experimentation, exploration and discovery of new knowledge, ideas and products
- Collaboration and working across fields and disciplines
- Creativity and innovation – to develop new products and approaches

All of these are increasingly important to success in a changing and technologically-driven world. They are also important for helping us to develop as active citizens, making informed decisions for ourselves and for society.

We recognise, in particular, the importance of creativity and innovation for economic growth and the strong synergies that exist between STEM and creativity.

It also provided descriptions of the separate disciplines of Science, Technology, Engineering and Mathematics as follows:

- **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 we need to interpret and analyse information, simplify and solve problems, assess risk and make informed decisions. Mathematics

and numeracy develops 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.

SCHOOLS: SCHOOL QUALIFICATION SUBJECTS

This table shows the SQA qualification subjects that we are defining as STEM for the purposes of reporting on the strategy. The definition of STEM teachers is aligned to these subject areas.

Secondary school qualifications	
Mathematics	Photography
Applications of Mathematics	Practical Craft Skills
Mathematics	Practical Electronics
Mathematics of Mechanics	Practical Metalworking
Statistics	Practical Woodworking
Sciences	National Certificates
Science	Computer Aided Design and Technology
Biology/Human Biology	Computer Arts and Animation
Physics	Computer Games: Creative Development
Chemistry	Computer Games: Software Development
Environmental Science	Computing with Digital Media
Science in the Environment	Computing: Technical Support
Technologies	National Progression Awards
Computing Science	Computer Games Development
Design and Manufacture	
Engineering Science	Skills for Work qualifications/awards
Design and Technology	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
Fashion and Textile Technology	
Graphic Communication	
Health and Food Technology	
Information and Communications Technology	
Music Technology	

For comparability we will also include a number of historical courses that are precursors to those currently delivered. A full list is available if required.

COLLEGES: FE AND HE STEM SUBJECTS

This table shows the College FE superclasses that were included in the original data study as “STEM”. **Highlighted subjects** will be **excluded** for the purposes of the college related KPIs but figures will be provided for these medical, dentistry and and veterinary related courses, clearly disaggregated from the rest.

C: Information Technology and Information

CA: Computer Technology	Include all courses
CB: IT: Computer Science / Programming / Systems	
CY: Information Systems / Management	
CE: Text / Graphics / Multimedia Presentation Software	
CH: Software for Specific Applications / Industries	
CX: Information Work / Information Use	

N: Catering/Food/Leisure Services/Tourism

NH: Food Sciences/Technology	<p>HND Requires H Chemistry or Biology as entrance Progression routes include BSc Hons Food Bioscience / BSc Applied Food Bioscience / BSc Food Nutrition and Health Destinations include: Lab Analyst; Lab Manager; Trainee Environmental Health Officer</p> <p>Nat 3 /4/ 5 Higher and advanced H not eligible</p>
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P: Health Care/Medicine/Health and Safety

PA: Health Care Management/Health Studies	All medical-related curriculum to be excluded from definition of STEM for the purposes of the KPI
PB: Medical Sciences	
PC: Complementary Medicine	
PD: Paramedical Services/Supplementary Medicine	
PE: Medical Technology/Pharmacology	
PF: Dental Services	
PG: Ophthalmic Services	

PH: Nursing	
PJ: Semi medical/Physical/Psycho/Therapies	
PK: Psychology	
Q: Environment Protection / Energy / Cleansing / Security	
QA: Environmental Protection/Conservation	HND Environmental management and Sustainability has units in Biology, Biodiversity, Ecology, Geology, Chemistry and Physics for Life Sciences, Environmental Science, IT, Financial Accounting and data collection and analysis within core HN Agricultural –not sufficient content
R: Science and Mathematics	
RA: Science and Technology (general)	Include all courses
RB: Mathematics	
RC: Physics	
RD: Chemistry	
RE: Astronomy	
RF: Earth Sciences	
RG: Land and Sea Surveying / Cartography	
RH :Life Sciences	
S: Agriculture, Horticulture and Animal Care	
SB: Agricultural Sciences	HN Agriculture – not sufficient content
SK: Agricultural Engineering/Farm Technology	HN Agriculture – not sufficient content
SN: Veterinary Services	Entry requirements :Five Standard Grade passes at SCQF level 5, including Maths, English and a Science Curriculum includes: Anatomy and Physiology; Pharmacology; Lab Techniques; Anaesthesia
T: Construction and Property (Built Environment)	
TA: Built Environment (general)	Built environment includes: <input type="checkbox"/> HNC Construction <input type="checkbox"/> HNC/HND Architectural Technology <input type="checkbox"/> HNC/HND Construction Management <input type="checkbox"/> HNC Built Environment

	<input type="checkbox"/> HNC/HND Building Surveying <input type="checkbox"/> HNC/HND Quantity Surveying Should include all in our STEM definition apart from : HND Facilities Management (insufficient content)
TD: Building Design/Architecture	Include all
TE: Construction (general)	
TF: Construction Management	
TG: Building/Construction Operations	
TL: Civil Engineering TM: Structural Engineering	The HNC /D Civil Engineering has professional institute recognition. Eg Institute of Civil Engineers & Chartered Institute of Building Progressions: Prepare learners for employment as senior / engineering technicians in the civil engineering industry with a range of employers who design, manage, maintain or adapt infrastructure. Level 6 should also be included
V: Services to Industry	
VG: Engineering Services	The HNC in Building Services Engineering is recognised as satisfying the educational base for registration as an Engineering Technician (Eng Tech), and part satisfaction of requirements for registration as an Incorporated Engineer (IEng), within the Engineering Council (UK) specification of competences, Level 6 should also be included.
W: Manufacturing/Production Work	
WD: Testing Measurement and Inspection	
WE: Chemical Products	
WG: Polymer Processing	

X: Engineering	
XA: Engineering / Technology	Include all courses
XD: Metals working / Finishing	
XE: Welding / Joinery	
XF: Tools / Machining	
XH: Mechanical Engineering	
XJ: Electrical Engineering	
XK: Power / Energy Engineering	
XL: Electronic Engineering	
XM: Telecommunications	
XN: Electrical / Electronic Servicing	
XP: Aerospace / Defence Engineering	
XQ: Ship/Boat Building/Marine/Offshore Engineering	
XR: Road Vehicle Engineering	
XS: Vehicle Maintenance / Repair	
XT: Rail Vehicle Engineering	
Y: Oil/Mining/Plastics/Chemicals	
YB: Oil and Gas Operations	Significant elements of STEM in qualifications
YC: Chemicals/Materials Engineering	Entry requirements include: 2 Highers from Chemistry, Mathematics or Physics. To be included in definition.

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

For consistency with the treatment of subjects at colleges, the data on medical and veterinary courses (A, B and D) will be reported on but clearly separated from the rest.

APPRENTICESHIPS: APPRENTICESHIP FRAMEWORKS

The apprenticeship frameworks that are considered to be STEM are provided below with changes and variations from the original data study noted.

Foundation Apprenticeships

Given the policy focus on Science, Technology, Engineering and Maths (STEM)-related study, we have identified that all frameworks, except Business Skills, Financial Services and the two social services frameworks, fit into the STEM category which would leave the following:

- Civil Engineering
- Creative & Digital Media
- Engineering
- IT: Hardware/System Support
- IT: Software Development
- Scientific Technologies

Modern Apprenticeship

The full list of MA frameworks to be considered as STEM are set out below. Frameworks **in bold** were not cited in the original data report annex but will be included:

- Agriculture
- Aquaculture
- Automotive
- Biotechnology
- Bus and Coach Engineering and Maintenance
- **Construction**
- Construction: Building
- Construction: Civil Engineering
- **Construction (Civil Engineering & Specialist Sector)**
- **Construction (Craft Operations)**
- Construction: Professional Apprenticeship
- Construction: Specialist
- Construction: Technical
- Construction: Technical Apprenticeship
- **Construction (Technical Operations)**
- Creative and Digital Media
- Dental Nursing
- **Digital Applications**
- Electrical Installation
- Electronic Security Systems
- **Electrotechnical Services**
- Engineering

- Engineering Construction
- Equine
- Gas Heating & Energy Efficiency
- Gas Industry
- Heating, Ventilation, Air Conditioning and Refrigeration
- Horticulture
- **Industrial Applications**
- **Information & Communication Technologies Professionals**
- Information Security
- IT and Telecommunications
- Land-based Engineering
- **Life Sciences**
- Life Sciences & Related Science Industries
- Network Construction Operations (Gas)
- **Oil and Gas Extraction**
- Pharmacy Services
- Plumbing
- **Polymer Processing**
- Power Distribution
- Process Manufacturing
- Rail Engineering
- **Rail Transport Engineering**
- Trees and Timber
- Upstream Oil and Gas Production
- Water Industry
- Water Treatment Management
- Wind Turbine Installation and Commissioning
- Wind Turbine Operations and Maintenance

Graduate Apprenticeship

The Graduate Apprenticeship frameworks have been expanded since the original evidence base report and highlighted frameworks below will therefore be added to the definition:

- IT: Software Development at SCQF level 10
- IT: Management for Business at SCQF level 10
- Engineering: Design and Manufacture at SCQF level 10
- Civil Engineering at SCQF level 8
- **Engineering: Instrumentation, Measurement and Control at SCQF level 10**
- **Civil Engineering at SCQF level 10**
- **Cyber Security at SCQF level 10**
- **Cyber Security at SCQF level 11**
- **Data Science at SCQF level 10**

EMPLOYMENT IN STEM INDUSTRIES

In 2017 an estimated 804,000 people were employed in STEM industries in Scotland, an increase of 6.5% from 755,000 in 2014. STEM industries accounted for 30.7% of all employment in 2017 compared with 29.5% in 2014.

Of all people employed in STEM industries 58.2% are men and 41.8% are women.

188,000 (23.4%) people employed in STEM industries are employed in health-related industries as defined by SIC codes 86.1 (Hospital activities), 86.2 (Medical and dental practice activities) and 86.9 (Other human health activities).

Excluding health industries STEM industries account for the employment of 616,000 people, 23.5% of all employment in Scotland in 2017; 70% of employment in STEM industries excluding health is for men employed and 29.9% of employment in STEM industries (excluding health) is women.

The following tables shows the definition of STEM Industries (based on SIC 2007 industry codes used to produce these estimates):

Table 1: Total employment by STEM group and gender in Scotland 2014-2017

	2014	2015	2016	2017
STEM including health				
<i>All</i>				
Total employment (000's)	2,559	2,583	2,581	2,618
Total employment in STEM (000's)	755	769	772	804
% of all employment	29.5	29.8	29.9	30.7
<i>Men</i>				
Total Employment (000's)	1,322	1,323	1,334	1,346
Total Employment in STEM (000's)	439	450	457	468
% of all employment	33.2	34.0	34.3	34.8
% of all STEM employment Men	58.1	58.5	59.3	58.2
<i>Women</i>				
Total Employment (000's)	1,237	1,260	1,247	1,272
Total Employment in STEM (000's)	317	319	314	336
% of all employment	25.6	25.3	25.2	26.4
% of all STEM employment Women	41.9	41.5	40.7	41.8
STEM excluding health				
<i>All</i>				
Total employment (000's)	2,559	2,583	2,581	2,618
Total employment in STEM (excluding Health) (000's)	557	570	591	616
% of all employment	21.8	22.1	22.9	23.5
<i>Men</i>				
Total employment (000's)	1,322	1,323	1,334	1,346
Total employment in STEM (excluding Health) (000's)	399	409	421	432
% of all employment	30.2	30.9	31.5	32.1
% of all STEM employment Men	71.7	71.7	71.2	70.1
<i>Women</i>				
Total employment (000's)	1,237	1,260	1,247	1,272
Total employment in STEM (excluding Health) (000's)	157	161	170	184
% of all employment	12.7	12.8	13.6	14.5
% of all STEM employment Women	28.3	28.3	28.8	29.9
STEM health				
<i>All</i>				
Total employment (000's)	2,559	2,583	2,581	2,618
Total employment in STEM (Health) (000's)	199	199	181	188
% of all employment	7.8	7.7	7.0	7.2
<i>Men</i>				
Total employment (000's)	1,322	1,323	1,334	1,346
Total employment in STEM (Health) (000's)	39	41	37	36
% of all employment	3.0	3.1	2.7	2.7
% of all STEM employment Men	19.8	20.7	20.2	19.3
<i>Women</i>				
Total employment (000's)	1,237	1,260	1,247	1,272
Total employment in STEM (Health) (000's)	159	158	145	152
% of all employment	12.9	12.5	11.6	11.9
% of all STEM employment Women	80.2	79.3	79.8	80.7

Source Annual Population Survey (January to December in each year)

Health industries Includes: 86.1 Hospital Activities, 86.2 Medical and dental practice activities, 86.9 Other human health Activities

SCOTTISH GOVERNMENT STEM INDUSTRY DEFINITION – INDUSTRY CODING

Table 1 Industry Coding

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

STEM Industrial Sectors (3-digit SIC)	
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
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
84.22	Defence Activities (within 84.2 Provision of services to the community as a whole)
85.4	Higher education
85.59	Other education nec (within 85.5 Other education)

STEM Industrial Sectors (3-digit SIC)	
86.1	Hospital activities
86.2	Medical and dental practice activities
86.9	Other human health activities
94.11	Activities of employer member organisations (within 94.1 Activities of business, employers and professional membership organisations)
95.1	Repair of computers and communication equipment