Evaluating the Impact of Professional Learning in STEM: Building a STEM Nation

Final Report
for
Education Scotland

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ekosgen

Report completed/submitted by:	Susan Staiano, Richard Weaver, Jeremy Hanks
Proof check completed by:	Claire Boyle
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Report reviewed by:	Susan Staiano
Date:	22nd May 2020

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1 Introduction to the research

Introduction

1.1 Education Scotland (ES) commissioned ekosgen in partnership with Context Economics in January 2020 to undertake research to inform the evaluation of the impact of Round One of the 'Enhancing Professional Learning in STEM Grants Programme'. Part of the strategy to build Scotland's capacity to deliver STEM learning and to close equity gaps in participation and attainment in STEM, the Programme has supported 24 regional and national partners with funding of £759,000 to deliver a variety of projects which support STEM professional learning.

Evaluation objectives

1.2 The research will evaluate programme impact across all education sectors – early learning and childcare, primary, additional support needs (ASN), secondary and community learning and development – as well as support decision-making about future reach and scalability of the approaches and activities undertaken as part of Round One funding. Specifically, the study objectives were to establish to what extent the programme has helped to achieve the following outcomes:

- Improving outcomes for learners in relation to STEM;
- Increasing the confidence, skills and capacities of practitioners in relation to STEM professional learning, teaching and assessment; and
- Reducing equity and equality gaps in engagement, participation and achievement in STEM professional learning.

How the research was conducted

1.3 The research methodology has consisted of the following elements:

- A review of project documentation and programme monitoring information;
- An analysis of education enrolment and attainment data in STEM subjects;
- Consultation with all 24 project Lead Grantees;
- The delivery of an online survey to beneficiary practitioners (212 responses with a 63% completion rate) and online focus groups with 12 participating beneficiary practitioners;
- The delivery of an online survey to end beneficiaries (115 responses with a 70% completion rate) i.e. pupils, students, adult learners and parents;
- Preparation of case studies of eight exemplar projects. These are provided in a separate Annex to this document.

How the report is structured

1.4 The report is structured in the following way:

- **Chapter 2** discusses the policy context for STEM and the challenges associated with increasing participation and attainment in STEM subjects. It also provides a summary of education and attainment in STEM since 2016/17.

- **Chapter 3** describes the STEM Grants programme and individual project themes; it also provides an analysis of overall programme performance against targets, activities, outcomes and impacts.
- **Chapter 4** considers the following aspects of Round One projects: design, targeting and engagement, innovation, equity and equality, delivery modes, sustainability and ES programme management.
- **Chapter 5** draws on the findings from the online surveys with practitioners and end beneficiaries and reports on the programme's benefits, challenges and impacts.
- **Chapter 6** draws conclusions on the key learning from Round One projects and makes recommendations to enhance the impact and effectiveness of future funding rounds of the STEM Grants Programme.

1.5 Appendices include:

- **Appendix 1**: STEM Grants Programme Projects Summary
- **Appendix 2**: Analysis of education and attainment in STEM for 2016-2019
- **Appendix 3**: School entries and passes by gender
- **Appendix 4**: STEM education definitions
- **Appendix 5**: contains Beneficiary Practitioner survey analysis summary
- **Appendix 6**: contains End Beneficiary survey analysis summary

1.6 Two Technical Appendices, containing details of the Practitioner and End Beneficiary surveys, accompany this report.

2 The policy context and challenges around STEM

Introduction

2.1 This chapter sets out the policy context for STEM in Scotland and the challenges relating to engagement, participation and achievement in STEM education.

The wider policy context

2.2 Across the world, Science, Technology, Engineering and Mathematics (STEM) are recognised as being increasingly important to economic growth and development, driving high levels of productivity and innovation. STEM comprises a very wide range of subjects and skills that cut across a number of sectors, affecting almost every aspect of our lives. This highlights a need to ensure education and employment opportunities across the country align with these developments, giving Scotland a competitive position in the changing global markets.

2.3 The importance of STEM is evidenced in a number and variety of policy documents and initiatives dedicated to its development. Scotland's Economic Strategy (SES)[1], published by the Scottish Government in March 2015, aims to create a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth and ensuring that everyone in Scotland has the opportunity to fulfil their potential. The focus on outcomes and a whole economy approach led to the development of an economic framework for Scotland which is centred on two pillars: increasing competitiveness and tackling inequality.

2.4 The SES has four priorities to achieve this: investment, innovation, inclusive growth, and internationalisation. STEM industries and skills are particularly important for encouraging innovation and the development of business and are integral to improving digital skills and capacity.[2] The development and improvement of STEM education and training contributes particularly to innovation and inclusive growth:

- **Innovation**: raising the level of STEM skills will mean that this particularly innovative and competitive sector can continue to grow and develop in Scotland.

- **Inclusive growth**: approaches and actions for reducing inequalities within STEM education and training, meaning that STEM can become a growth area that is accessible, providing economic benefits and jobs across Scottish society.

2.5 The Government's Programme for Scotland (2019-20)[3], sets out the actions and legislative programme for the coming year and beyond. This document highlights the ongoing work on taking advantage of the economic opportunities offered in the STEM sector. The Scottish Government's commitment to this is evidenced in Scotland's STEM Education and Training Strategy.

2.6 The Scottish Government's Education Governance: Next Steps[4] in June 2017 outlines the vision and plans for a school and teacher-led system, recognising that to achieve this requires 'a world-class support system'. With specific reference to professional learning, Next Steps confirmed that Education Scotland leads the renewed focus on professional learning and leadership, bringing clarity and coherence to the national landscape. Central to achieving the vision is the national model of professional

[1] Scottish Government (2015) *Scotland's Economic Strategy*

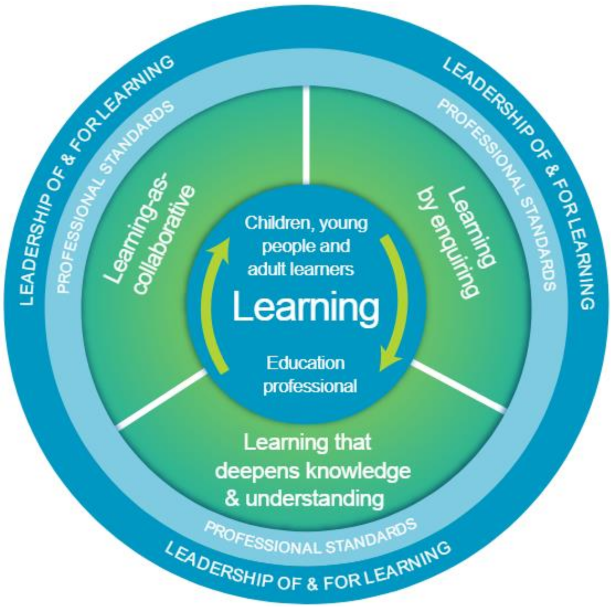
[2] http://www.gov.scot/Topics/Economy/EconomicStrategy

[3] Scottish Government (2019) *Protecting Scotland's Future: The Government's Programme for Scotland 2019-2020*

[4] https://www.gov.scot/publications/education-governance-next-steps-empowering-teachers-parents-communities-deliver-excellence/

learning[5] which identifies the key principles and features of effective professional learning and offers strategic guidance for education professionals on how to support, structure and plan for professional learning.

Figure 2.1: The National Model of Professional Learning



Source: Education Scotland, 2020

The STEM Education and Training Strategy

2.7 The STEM Education and Training Strategy published by the Scottish Government in 2017 is integral to the Scottish Government's broader economic strategy. It aims to build capacity to deliver STEM learning, close equity gaps in participation and attainment, inspire young people and adults to study STEM, and provide better connection between STEM education and training in accordance of the labour market. The strategy seeks to address the way in which education and training can be improved to meet the growing demand for STEM skills and ensure that the STEM skills supply can meet the demand and contribute to growth.

2.8 The strategy outlines four key aims:

- To build the capacity of the education and training system to deliver **excellent** STEM professional learning so that employers have access to the workforce they need;
- To close **equity** gaps in participation and attainment in STEM so that everyone has the opportunity to fulfil their potential and contribute to Scotland's economic prosperity;
- To **inspire** children, young people and adults to study STEM and to continue their studies to obtain more specialist skills; and
- To **connect** the STEM education and training offer with labour market need – both now and in the future – to support improved productivity and inclusive economic growth.

2.9 These key aims are delivered in support of the four priorities of excellence, equity, inspiration and connection. The actions aim to promote excellence through the development of continuous professional learning for educational practitioners, promoting equity through funding initiatives to significantly reduce gaps in participation and achievement, specifically in relation to gender and deprivation; promoting inspiration through engaging a wider proportion of people in STEM learning

[5] https://professionallearning.education.gov.scot/explore/the-national-model-of-professional-learning/

across all sectors; and promoting connection through increased collaboration and stronger partnerships with schools, colleges, universities and employers.

2.10 The STEM Education and Training Strategy has been designed to integrate with and support a range of national policies and programmes to achieve the aims and objectives. The National Improvement Framework (NIF)[6] sets out the vision and priorities for Scottish education and the activity that needs to be undertaken to help deliver those key priorities. This complements the ongoing implementation of Curriculum for Excellence (CfE), Getting It Right for Every Child, and Developing the Young Workforce (DYW), which are the three supporting pillars of the Scottish education system.

2.11 Specific policy implementation includes focus on the development of better STEM education through improving practitioner recruitment, learning and promotion of STEM for education and employers and young people. DYW is a youth employment strategy to prepare young people for work, developing opportunities around STEM apprenticeships. Raising Aspirations in Science Education (RAiSE)[7] programme enhances the confidence and skills of primary school practitioners to improve learning and teaching in STEM education, aligning with both the strategy and the DYW programme. It aims to raise attainment and achievement in primary science and STEM, and tackle inequity and inequality in learners' experiences and their potential to achieve.

2.12 A number of actions are required as part of the strategy to address inequalities in STEM, particularly around the participation of women, minority ethnic communities, disabled people, and those who are care experienced and from disadvantaged backgrounds. The Gender Pay Gap Action Plan[8] will continue to reduce the pay gap for employees in Scotland and tackle labour market inequalities faced by women. Furthermore, the Scottish Attainment Challenge seeks to achieve equity in educational outcomes, focusing on closing the poverty-related attainment gap by ensuring every child has the same opportunity to succeed.

2.13 Extending provision of information around STEM in school careers advice and promoting links between schools and STEM employers is another key action.[9] Enhancing practitioner learning and the use of the digital technology strategy can enhance equip children and young people with the digital skills they need for improved educational outcomes. Creativity is a vital element in the delivery of CfE and STEM learning and the Creativity Portal is a one-stop shop for teachers, community learning leaders and educators across lifelong learning.

The challenges around STEM

Access for disadvantaged groups

2.14 Within the STEM educational and employment sector there is the challenge of representation in: gender and age; people from ethnic backgrounds; those living in deprived areas; and disabled or care-experienced. Whilst the STEM Strategy for Education and Training is not concerned with the makeup of the existing workforce, considering how to attract underrepresented groups into STEM-related subjects and occupations is within its scope.

2.15 Research undertaken by Kings College London's [ASPIRES research] shows that these disadvantaged groups are all adversely affected by a lack of 'science capital' (science-related qualifications, understanding, knowledge about science and 'how it works', interest and contacts) in the household growing up. This means that people from these backgrounds are less likely to choose STEM-related subjects and therefore less likely to consider a STEM career. Widespread evidence shares

[6] Scottish Government (2019) *National Improvement Framework and Improvement Plan: summary document*

[7] https://education.gov.scot/improvement/learning-resources/raise/

[8] Scottish Government (2019) *A fairer Scotland for women: gender pay gap action plan*

[9] http://www.gov.scot/Publications/2016/11/4147

these ideas (e.g. UK Association for Science and Discovery Centres)[10], highlighting that the STEM workforce does not represent the UK population, with considerable underrepresentation of people from a variety of backgrounds, particularly those on low income.

2.16 Ensuring fair access is important to increase equality across STEM education and employment, particularly those from poor socio-economic backgrounds. Individuals growing up or working in disadvantaged areas may experience broader limitations in access to STEM education and training opportunities. The availability of STEM education pathways may be limited by what the school, regional college and local partners can offer, but there may be heightened complications in accessing this in other areas, e.g. difficulties at home, poverty, and disruptive educational environments. Further, there is a data gap regarding how many children from deprived areas progress to STEM careers, or indeed how many people living in deprived areas work in STEM careers. Similarly, there is a lack of data regarding those with disabilities or additional support needs. Whilst there are few statistics available, groups such as the UK-wide STEM Disability Advisory Committee[11] have been established to remove barriers and strengthen the inclusion of disabled people in STEM and reduce the gap between disadvantaged groups for progressing forward.

2.17 Additionally, an ageing workforce presents an increasingly stark challenge. Retiring STEM workers take skills, experience and knowledge thus creating replacement demand which requires higher level skills which are more difficult to find. Further, attraction and retention of young people in STEM is below what is required, which poses a threat to knowledge transfer, and ongoing capability of STEM sectors.[12] There is an indication that because of this, fewer young people are establishing careers in STEM, or the focus is greater on graduate level entries.[13] The need to attract and retain talent in STEM sectors is therefore critical in meeting skills challenges, and in avoiding increased levels of skills shortages.[14]

Gender imbalance

2.18 For STEM Education and Training in Scotland, gender imbalance is a key challenge, along with other sectors of the economy. Within gender and employment, underrepresentation and traditional gender roles are the key issues that can make it challenging to create the necessary growth in STEM industries as set out in the strategy.

2.19 Women are under-represented in a range of STEM sectors, as identified by ekosgen's 2016 work on occupational segregation and it is estimated that women make up 20% of the workforce[15]. Whilst, it is also important to mention that boys can be affected by gender imbalances too, as Education Scotland found that boys are underrepresented in biology and life sciences pathways[16]. This underrepresentation is often related to initial social attitudes and stereotyping of expected roles of women/men and girls/boys. This is set out at an early age according to A Centre for Employment Research and Close the Gap study in 2015[17]. These attitudes influence behaviour and choices relating to the range of subjects to study, sector to enter and career to follow, so can be limiting for career aspirations. This underrepresentation of women in particular is prevalent in many industries, but more particular for STEM employment such as construction and engineering. It could be recognised as creating barriers which exclude individuals to uptake work in male-dominated work environments and a

[10] https://www.sciencecentres.org.uk/documents/4/UK_Science_and_Discovery_Centres_pchCPKE.pdf
[11] http://www.stemdisability.org.uk/
[12] http://www.hrmagazine.co.uk/article-details/plugging-the-skills-gap-of-britains-ageing-workforce
[13] https://arstechnica.co.uk/science/2017/04/scientists-have-stopped-retiring-us-sees-its-researchers-aging/
[14] Energy and Utilities Skills (2017) *Many Skills One Vision: Renewal and Skills Strategy 2020*
[15] ekosgen (2016) *Occupational Segregation in the Highlands and Islands, report for HIE*
[16] https://education.gov.scot/media/zkggmehq/genderbalancebriefing_tcm4-869326.pdf
[17] University of Strathclyde Scottish Centre for Employment Research/Close the Gap (2015) *Mapping of women's participation within the manufacturing cluster labour market in Scotland*

culture change would be necessary to mitigate this. Achieving the necessary growth across all STEM industries in Scotland will be more challenging if this gender imbalance of representation continues.

2.20 Education Scotland, the Scottish Funding Council and Skills Development Scotland are just some of the organisations working to tackle unconscious bias, gender stereotyping and gender gaps in education and employment[18]. In particular, the First Minister's National Advisory Council on Women and Girls[19] has been established as guidance for the Gender Equality Taskforce on Education and Learning[20]. Examples of proposed initiatives to encourage female participation in STEM education and workforce include Close the Gap's 'Be What You Want"[21] campaign to address occupational segregation by enabling young people to make informed decisions about subject and career choice and to broaden their outlook and encourage them to consider non-traditional jobs. The Improving Gender Balance & Equalities Programme (IGBE)[22] is a recently completed three year pilot programme that has been running in six school clusters, whilst the IGBE team at Education Scotland have been working to expand and extend this work. It has sought to identify and tackle the challenges facing pupils due to gender stereotypes and help schools identify and address issues around gender and subject choice with a particular focus on STEM subjects. Further, each college and university has now produced a Gender Action Plan (GAP) outlining how they will advance equity and reduce gender disparities within STEM subject areas[23].

Employer responsibility

2.21 STEM skills can be in high demand but difficult to obtain from applicants and meeting the demand is a real issue experienced by employers. Employers have a key role to play in creating positive perceptions of STEM jobs and careers. The current mainstream perceptions of STEM impacts adversely on recruitment as it discourages people from considering it as a career; overcoming the persistent view of STEM as a vocation that is 'hard' rather than a good, rewarding career choice is a key challenge for employers, educators and careers advice professionals alike. There is a persistence with employers to seek university graduates, regardless of specialisation, excluding individuals from various economic backgrounds or skill levels for other parts of business. Akin to this is the difficulty for understanding STEM employers' preferences for subjects studied in order to guide the education and training required to suit employment. Further, the need for career progression poses difficulties for a lot of employers in retaining the required workforce, but also as a reminder to extend the training and development opportunities within the STEM sectors. Businesses conducting open days, giving talks at schools, colleges and universities, providing more internships and work placements are all ways to positively engage young people and graduates alike.

Delivering STEM

The delivery infrastructure for STEM

2.22 It is important to understand the wider delivery infrastructure for STEM learning and the ecosystem within which the STEM Grants Programme-supported projects are delivered. This could be within a school context, where a significant proportion of STEM learning and training takes place – through curriculum areas and other contexts for learning, including interdisciplinary learning, and training initiatives for practitioners such as projects funded under the STEM Grants Programme. It may also be in a further or higher education context, or through employers or community groups or events.

[18] Scottish Government (2019) *Protecting Scotland's Future: The Government's Programme for Scotland 2019-2020*

[19] https://onescotland.org/equality-themes/advisory-council-women-girls/

[20] https://www.gov.scot/groups/gender-equality-in-education-and-learning-taskforce/

[21] www.bewhatyouwant.org.uk

[22] https://education.gov.scot/improvement/learning-resources/improving-gender-balance-3-18

[23] Scottish Government (2019) *STEM Strategy for Education and Training, First Annual Report*

2.23 STEM Ambassador Hubs[24] provide support across the UK to individuals or groups with an interest in delivering STEM learning. Offering a range of support, opportunities and local expertise, 19 STEM Ambassador Hubs throughout the UK work to develop collaborative links between groups and individuals to enhance the STEM education offer for young people. There are three Hubs located in Scotland: North Scotland, East Scotland and West Scotland, covering all 32 local authority areas. Each Hub has a Lead Organisation and these act as main coordinators for STEM Ambassadors across Scotland.

2.24 Aberdeen Science Centre is the Lead Organisation for the STEM Ambassador Hub in North Scotland, with a coordination team based in the Centre to coordinate events and activities bringing together STEM Ambassadors from different backgrounds and young people[25]. STEM Ambassador Hub facilitation is overseen by Science Connects in West Scotland. Based at the University of Glasgow, Science Connects provides opportunities and support for over 3,000 STEM Ambassadors based in the West of Scotland[26].

2.25 The East Scotland Lead Organisation is the Scottish Schools Education Research Centre (SSERC) which offers a wide range of services designed to support STEM curriculum areas not available from other sources[27]. As well as having a Lead Coordination role for STEM Ambassadors and wider STEM engagement activities, SSERC also offers an Advisory Service intended to offer guidance and training around the removal of risk barriers, for instance health and safety, to young people when it comes to their education in STEM. SSERC works with a variety of partners, including the Scottish Government, the National STEM Learning Centre (NSLC) and the Primary Science Teaching Trust, to deliver a programme of CLPL (Career Long Professional Learning)[28] to early years, primary and secondary teachers, as well as student teachers and technicians. Courses are available at various times throughout the year, and in various modes, such as day courses, residential meetings and online learning.

2.26 SSERC also works with all local authorities across Scotland to offer teachers the chance to raise their confidence levels and understanding of STEM. This is done through the Primary Cluster Programme (PCP)[29], which is funded by the Scottish Government and STEM Learning, and is supported by The Edina Trust. The process sees each cluster across all local authorities nominate a group of teachers to take on STEM mentor roles – as a cluster mentor group, these teachers then design and implement a bespoke programme of professional learning for all teachers in the cluster, with the support of SSERC.

2.27 Local authorities and schools in Scotland have taken a lead in disseminating approaches to STEM learning and teaching to their cluster schools. This type of local cluster collaboration can lead to greater understanding of teaching approaches and new ideas shared across primary secondary schools, giving pupils an improved platform from which to learn STEM subjects. Learning-as-collaborative is a key feature of the national model of professional learning.[30] It recognises that the education professional as a learner, reflects on practice and shares professional learning with others. They will consider their own assumptions, context and relationships in relation to STEM, as well as engaging in professional learning that deepens knowledge and understanding.

[24] https://www.stem.org.uk/stem-ambassadors/local-stem-ambassador-hubs

[25] https://www.aberdeensciencecentre.org/stem-ambassadors

[26] https://www.gla.ac.uk/explore/scienceconnects/

[27] https://www.sserc.org.uk/about/

[28] CLPL is an extended approach to what was previously known as Continuing Professional Development (CPD), reflecting the changes to teacher education in Scotland to support teachers taking increased responsibility for their ongoing professional learning and development and engaging in more reflective and enquiry based approaches. http://www.ideas-forum.org.uk/education/schools/professional-learning

[29] https://www.sserc.org.uk/sserc-primary-cluster-programme-findings-indicate-impact-and-success/

[30] https://education.gov.scot/improvement/self-evaluation/a-national-model-of-professional-learning/

2.28 The Raising Aspirations in Science Education (RAiSE) Programme began in 2016 as a £2 million pilot programme. It aimed to improve science and STEM learning in primary schools. It is led by Education Scotland and is being funded through a partnership between the Wood Foundation, Scottish Government and participating local authorities.

2.29 An external evaluation of the pilot programme was concluded in May 2019 and a very positive evaluation report was released. The programme steering group agreed to a national invite being made available so that all local authorities who had not participated to date, could engage with the programme on a rolling basis.

2.30 The national invite for participation will commit up to an additional £4 million in funding to the programme. Eighteen local authorities have engaged with the programme to date.

2.31 Since January 2018, schools have also been able to draw on support and expertise from their Regional Improvement Collaborative (RIC)[31]. These bring together a range of professionals across local authorities, Education Scotland and other education and health experts, in order to provide ongoing support for teachers and other school staff working with children and young people with the aim to improve wellbeing, attainment and outcomes. Each Collaborative is led by a Regional Improvement Lead who is employed by one of the local authorities in the region, and each Collaborative also has a Regional Improvement Plan.

2.32 There are six RICs in Scotland – The Northern Alliance, The Tayside Improvement Collaborative, The West Partnership, South West Improvement Collaborative, South East Improvement Collaborative, and Forth Valley and West Lothian Improvement Collaborative – each designed to deliver targeted support to schools based on specific needs, including around STEM learning and access. By nature, the Collaboratives also encourage collaborative working and innovative approaches across schools and the education system as a whole.

2.33 Colleges across Scotland have played a key role in the development of Regional STEM Hub Partnerships. These are a representative collaboration of relevant partners across Scotland[32]. These Hubs operate at a regional level under the Scottish Government's National STEM Hub Steering Group, and are managed through a number of regional Steering Groups.

2.34 It is within this landscape that the STEM Strategy and its range of actions and activities is being delivered. Many of the strategy's initiatives are aligned with and supported by the aforementioned organisations, partnerships and their approaches to promoting the teaching and learning of STEM.

Activity and progress to date

2.35 The STEM Strategy Second Annual report was released in March 2020 to track progress to date for the STEM Education and Training Strategy.

2.36 In the second year, the focus has been building upon the infrastructure put in place in the first year to progress with the aims and actions of the Strategy. Listed below are some of the key achievements:

- A further 11 STEM Bursaries have been awarded to encourage STEM career changes into teaching;
- £1.9 million of STEM professional learning grants were awarded by Education Scotland in support of 162 projects;
- An online professional learning module to promote child-led and play-based approaches in STEM was produced for the ELC sector and teachers in early level primary school;

[31] https://www.gov.scot/publications/empowering-schools-consultation-provisions-education-scotland-bill/pages/8/

[32] https://esp-scotland.ac.uk/stem/

- Educational Scotland has recruited a team of eight STEM Education Advisors to support schools in delivery quality STEM learning;
- To inspire and engage people of all ages and backgrounds in STEM, the national campaign 'Aye for Ideas' was launched in June 2019; and
- The 13 regional STEM Hubs are being developed by colleges to strengthen collaborative work between partners such as universities, science centres and employers.

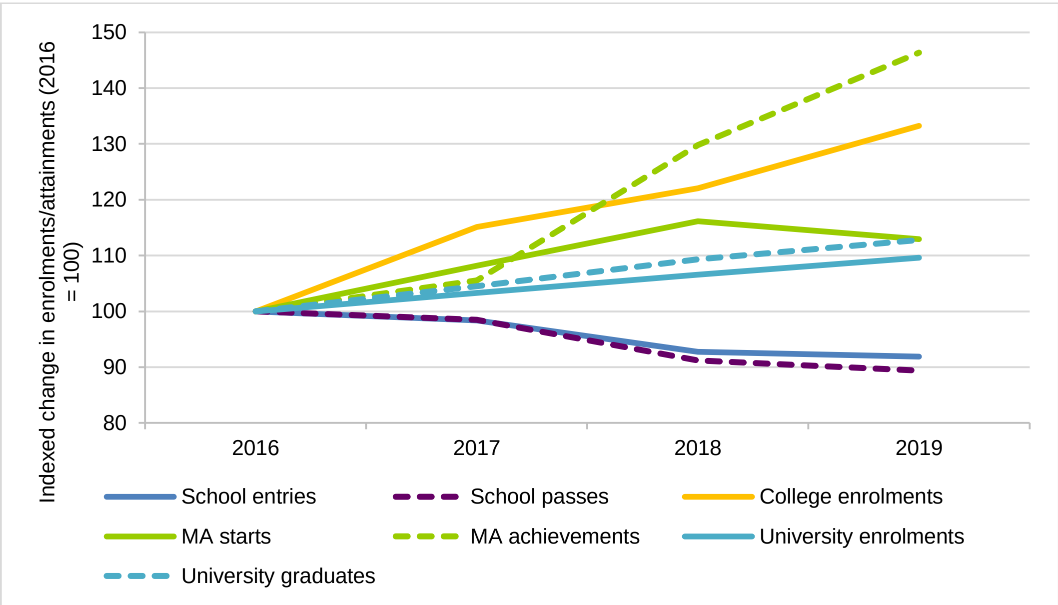
2.37 In progression to the third year of the Strategy, an increased level of activity is expected. In particular through the new Education Scotland teams, the STEM National Award pilot and the Young STEM Leader Programme. Some key intentions moving forward are to deepen engagement with schools and other partners, pilot a self-evaluation framework for Improving Gender Balance, and launch the Idea No. 59 innovation exhibition. These will raise the engagement and profile of STEM and inspire people to think about STEM careers in the future as well as its incorporation into ELC settings and schools.

Summary of STEM education and attainment

2.38 This section presents a summary analysis of education enrolment and attainment in STEM and analyses this by the Scottish Government's urban/rural classification (as far as possible as data will allow). The detail can be found in **Appendices 2-5.**

2.39 Figure 2.1 shows the overall indexed trend in STEM education and attainment in Scotland between 2016 and 2019 (or equivalent latest year of data). There has been a fall in the number of entries and passes across all school levels (National, Higher and Advanced Higher), although the trend at National level may be partly explained by a decrease in school pupil population, and curriculum/examination changes. Anecdotal evidence also suggests an increasing trend of pupils opting for perceived 'easier' subjects, particularly at Higher level. However, there has been a significant rise in FE College STEM provision, and rises across STEM provision at university and the apprenticeship family.

Figure 2.1: Overall indexed trend in STEM education and attainment (2016 to 2019)



Source: SQA, SFC, SDS and HESA[33], 2020. Please note trends are indexed from 100 in 2016

[33] Scottish Qualifications Authority (SQA), Scottish Funding Council (SFC), Skills Development Scotland (SDS), and Higher Education Statistics Agency (HESA)

2.40 Table 2.1 shows a simplified, summary view of overall STEM take-up, and by gender, across a range of education provision from school to university. The table shows the proportion of overall entries/enrolments that are in STEM subjects. It also shows the proportion of male and female learners that take-up STEM subjects. For example, 26% of overall college enrolments are in STEM subjects, while only 17% of female college enrolments are STEM and 35% of male college enrolments are STEM. Further details on the breakdown of STEM subjects by gender across school, college, apprenticeships and university provision is given in **Appendices 2 and 3**.

Table 2.1: STEM share of overall provision, and by gender (2019)

Education	Total (%)	Female (%)	Male (%)
School – National level	**45**	41	48
School – Higher level	**34**	29	41
School – Advanced Higher level	**51**	41	63
College provision	**26**	17	35
Modern Apprenticeships	**37**	5	57
University provision	**50**	45	57

Source: SQA, SFC, SDS and HESA, 2020

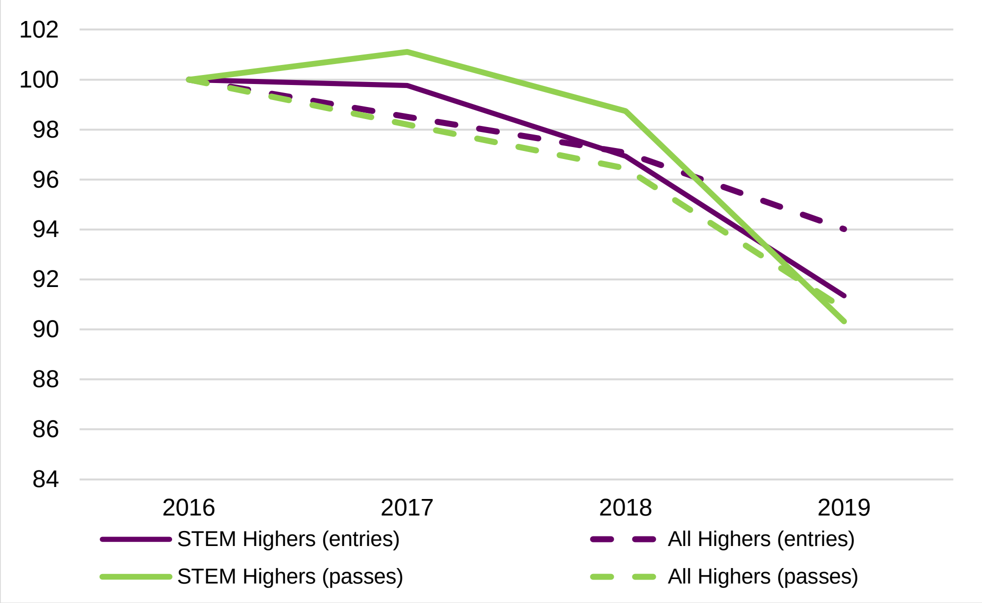
2.41 There is an imbalance towards males across all education levels shown in the table. STEM provision is more gender balanced at National and Higher levels in school than at Advanced Higher level, albeit there is still an imbalance towards males across all three levels. Over half of male Modern Apprenticeships are in STEM-related frameworks, while this is only a small proportion for females. This is due to the high volume of starts on typically male-dominated frameworks such as construction and engineering. Half of all university enrolments are STEM-related, although again there is a lower rate for females than for males.

Schools

2.42 Between 2016 and 2019 there has been a fall in STEM entries (-8%) and passes (-11%) at SCQF level 3-5 (National level). This can in part be explained by changes in the number of qualifications being taken; however, the flexible senior phase is opening new learning pathways.

2.43 At Higher level there has been a 9% decrease in STEM entries over this period, whilst the number of STEM passes has fallen more sharply, by 10%. This is slightly more pronounced than the overall decline in entries (down 6%) and passes (down 9%) for all Highers in Scotland, as shown at Figure 2.2.

Figure 2.2: Index of total and STEM entries and passes for Highers, 2016-2019



Source: SQA, 2020

2.44 There has been relatively little change in the number of STEM Advanced Higher entries and passes from 2016 to 2019, although this masks a growth in entries and passes between 2016 and 2018. The pass rate has dropped slightly over the period.

2.45 Overall, STEM pass rates have fallen across all three levels during the period 2016 to 2019, despite a small increase in pass rates at the Higher and Advanced Higher levels between 2017 and 2018.

2.46 At school, males make up the majority of passes and entries for STEM-related subjects across all levels. However, the female pass rate is higher than the male pass rate at all levels and this is particularly marked at Advanced Higher level (4.1 percentage points higher) and Higher level (3.2 percentage points higher).

2.47 The gender split is more notable in certain subjects than others. Whilst *Mathematics* is broadly even at National and Higher level, males make up around three quarter of passes in *Computing Science, Technology and Physics* across all levels, while females make up the majority of *Biology* passes.

2.48 In total 96.1% of school leavers in Scotland in 2017/18 had a National STEM qualification, 38.4% a Higher and 8.8% an Advanced Higher. The majority of these qualifications included *Mathematics*. Ninety-two percent had a National *Mathematics* qualification, with 23.3% at Higher and 4.6% at Advanced Higher[34].

2.49 The 'urban with substantial rural areas' geographical group tends to have high percentages of learners gaining STEM National level qualifications. The 'larger cities' group tends to have a lower proportion of STEM achievers, particularly so for Higher and Advanced Higher levels. The breakdown of STEM attainment by local authority is given in **Appendix 2**.

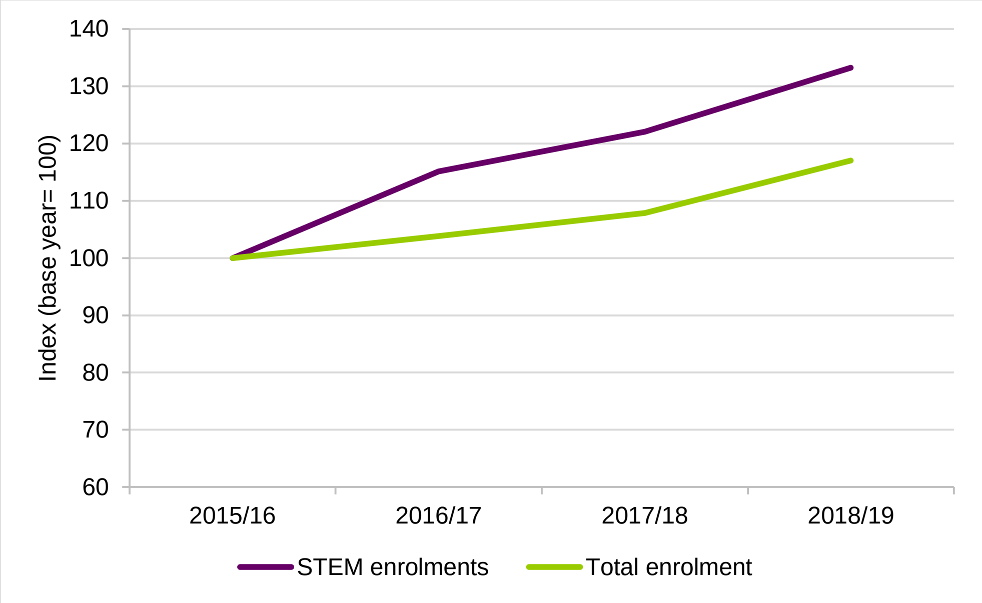
2.50 There remains a significant attainment gap between the most and least deprived parts of the country. In 2017/18 nearly 58.2% of school leavers from the least deprived SIMD quintile achieved a Higher pass or better, compared to 21.6% from the most deprived SIMD quintile.

[34] School leaver attainment and initial destinations: statistics – Tables and Charts supporting file (Scottish Government, 2019)

College and Further Education

2.51 STEM-related subjects accounted for 26% of enrolments (84,938) in Scottish colleges in 2018/19, and STEM enrolments, as well as their share of overall provision, have grown strongly in recent years. This is shown in Figure 2.3.

Figure 2.3: College enrolments in STEM-related subjects (2015/16-2018/19)



Source: SFC, 2020

2.52 As with the general trend for college enrolments, STEM enrolments have grown since 2015/16 but at a faster rate than overall enrolments. The STEM share of overall enrolments has increased from 23% in 2015/16 to 26% in 2018/19.

2.53 STEM college enrolments are concentrated in the Fife and Glasgow college regions, accounting for 45% of all STEM enrolments in Scotland, and 56% and 24% of all enrolments in those regions respectively. STEM enrolments are also high in Aberdeen and Aberdeenshire, Edinburgh and the Lothians and Forth Valley, at over 6,000 enrolments each.

2.54 There are concentrations of STEM enrolments in *Engineering* in the Fife college region, *Computing and ICT* in the Glasgow college region, and *Science and Mathematics* in the Edinburgh and the Lothians college region.

2.55 *Engineering* accounted for the highest share of STEM college enrolments in 2018/19 at 42%, and has been the highest over the last four years. There has been strong growth in *Engineering* and *Science and Mathematics* enrolments over this time, although enrolments in *Computing and ICT* fell slightly.

2.56 Over half (55%) of STEM college enrolments were by people aged 19 or younger in 2018/19, making the STEM student profile significantly younger, on average, than across all college enrolments (41%).

2.57 At college level, males are more likely to study STEM courses. Males accounted for two thirds of STEM enrolments (67%) in 2018/19, but only 49% of all college provision. This STEM gender gap has narrowed in recent years, although some subjects are still heavily dominated by one gender.

Apprenticeships

2.58 Foundation Apprenticeships are two year programmes that have been developed from 2014-2017 with the first cohort for the fully designed and certified frameworks starting in 2016. There were 912 starts on STEM related frameworks for the 2018-20 cohort, a significant increase from 657 starts on the previous cohort.

2.59 The Foundation Apprenticeship STEM-related frameworks with the highest number of starts for the 2018-20 cohort were *Engineering* (305), *Social Services and Healthcare* (190) and *Creative and Digital Media* (135).

2.60 Foundation Apprenticeships are being delivered in 30 local authorities, with the most widespread provision for *Engineering* (22 local authorities), *Creative and Digital Media* (20) and *Social Services and Healthcare* (19).

2.61 In 2018/19 over 10,000 people registered for STEM Modern Apprenticeships (MA) in Scotland. Since 2016/17, STEM MA starts have grown faster than all MA starts. The STEM achievement rate stands at 78%, above the all MA rate of 76%.

2.62 In 2018/19, *Construction: Building* recorded the highest number of starts for STEM MA at 1,600, followed by *Construction: Civil Engineering, Automotive, Construction: Technical* and *Engineering*.

2.63 The urban areas of Scotland account for around seven in 10 (69%) STEM Modern Apprenticeships, driven by particularly high provision in Glasgow City and North and South Lanarkshire.

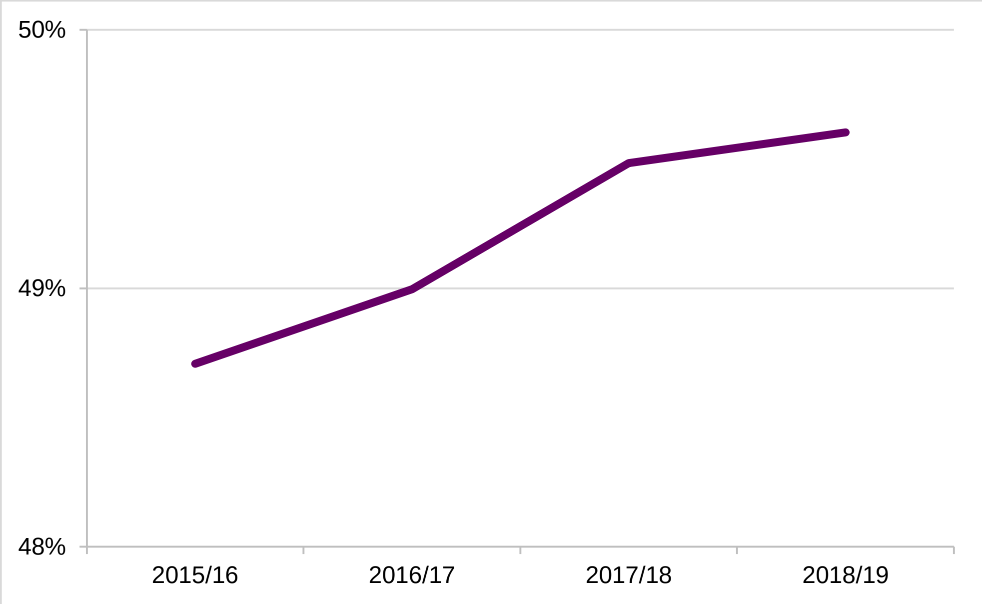
2.64 Males accounted for 95% of starts in STEM MAs, reflecting male dominance across the majority of frameworks and the workforce (almost 100% on the various construction frameworks). A small number of frameworks were dominated by female starts, for example *Dental Nursing* (97%) and *Equine* (76%).

2.65 Graduate Apprenticeships (GAs) began in 2015/16, and in 2018/19 there were 921 starts. Nearly all of the current GA frameworks are in STEM related subjects.

University and Higher Education

2.66 In 2018/19 there were 125,775 enrolments in STEM-related subjects at Scottish universities. This accounted for 50% of total enrolments and the number has increased by over 11,000 (10%) since 2015/16, with STEM's share of all enrolments also increasing (see Figure 2.4).

Figure 2.4: University enrolments in STEM-related subjects as a share of total enrolments (2015/16-2018/19)



Source: SFC, 2020

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

2.68 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 2018/19 at 16,400 and 14,285 respectively. STEM share of total enrolments was highest at Scotland's Rural College at 80%, reflecting its specialist nature. The biggest absolute increases in STEM enrolments from 2015/16 to 2018/19 were recorded at University of Edinburgh (+2,285), the University of Glasgow (+1,580) and the Open University (+1,375). At 12 of Scotland's 18 Higher Education Institutions, STEM growth outstripped overall growth in enrolments.

2.69 Across all STEM-related subjects 53% of enrolments were female. This is much lower than the 59% across all enrolments but it counters the trends in Apprenticeship enrolments considered earlier in this chapter. Reflecting gender norms, women were more represented in subjects associated with care. They made up 82% of enrolments in Subjects Allied to Medicine and Veterinary Science but just 19% in Engineering and Technology and 20% in Computer Science.

2.70 Overall in 2018/19, over 36,700 students qualified from Scottish Higher Education Institutions (HEIs) in STEM related subjects. This accounted for 45% of total qualifiers and the number has increased by almost 4,200 (13%) since 2015/16.

2.71 Over this period, the largest increase in absolute qualifiers has been in those studying *Biological Sciences,* an increase of almost 1,200, while the largest proportional increase has been in *Agriculture and Related Subjects* qualifiers, an increase of 55%. The only decline has been in *Medicine and Dentistry* qualifiers, which fell by 2%[35].

[35] Please note, data on STEM initial teacher education (ITE) subject recruitment was not available at the time of reporting.

3 The STEM Grants Programme

Introduction

3.1 This chapter examines the STEM Grants Programme in detail, with a summary of the programme and the 24 Round One projects. It also presents an analysis of project delivery, including the number of sessions and hours delivered, as well as breakdowns by geography and sector.

Programme overview

3.2 The STEM Grants Programme was launched in October 2018 to build the capacity and confidence of practitioners and to support the implementation of the STEM Education and Training Strategy for Scotland[36]. This was introduced across a range of partners to support practitioners across early learning and childcare (ELC), primary, additional support needs (ASN) and secondary school, community learning and development (CLD), and school-based technical support staff. The aim is to increase access to STEM learning opportunities and encourage confidence in practitioners across Scotland. These focus on the sciences, maths and numeracy, digital learning, engineering and technologies. Round One of the programme focused on regional and national partners and the projects funded were selected in response to the results of the 2017 Annual STEM practitioner survey[37].

3.3 The key findings from the survey which informed the project appraisal process and the projects funded included:

- An appetite for access to more online learning modes and resources;
- A demand for more localised learning, for example, local and national showcase events to share ideas and practice, more hands-on/face-to-face professional learning from a specialist organisation and open day visits to other schools with interesting practice; and
- Time to work collegiately in schools clusters and in schools.

3.4 Projects funded by a STEM grant are eligible for Education Scotland Endorsement. A programme which has been endorsed by Education Scotland demonstrates that it is informed by the national model of professional learning and links effectively to the relevant professional standards and current policy context. These programmes are featured on the Education Scotland Professional Learning and Leadership website and are promoted through social media channels.

3.5 Round One funded projects have been designed to: create opportunities for practitioners to meet, learn and share expertise; provide space to work collaboratively; build confidence of education practitioners in relation to STEM; deepen and extend the subject knowledge to improve STEM learning and teaching; support STEM subject-specific learning; enable strong links between STEM and the young workforce, equality and equity, digital skills and more; and ensure that professional learning reaches new audiences and geographies and builds on existing STEM professional learning provision.

3.6 The diversity of projects funded has enabled an almost full geographical coverage as well as a mix of themes. This has allowed projects to be flexible and meet the needs of each local area.

3.7 A team of eight regional STEM Education Officers has been in place since January 2019 midway through Phase one of the Round One projects. The team's work is aligned to the work of the six RICs and it plays a lead role in coordinating and leading the provision of STEM CLPL. Following a successful three-year pilot, the learning from the Improving Gender Balance Programme[38] is being extended

[36] Education Scotland (2019) *Enhancing Professional Learning in STEM: Overview of grant funding 2018/19*

[37] https://education.gov.scot/improvement/Documents/STEMProfessionalLearningSurveyFindingsJune2017.pdf

[38] https://education.gov.scot/improvement/learning-resources/improving-gender-balance-3-18

regionally by an Improving Gender Balance & Equalities team of six officers whose role it is to lead and support this work in school/ELC-early learning and childcare and school-settings.

Projects overview

3.8 This section presents an overview of the 24 projects, including delivery and aims. The projects are split into three groups: **Organisations and Charities**, **Local Authorities**, and **Further and Higher Education**.

Organisations and charities

3.9 **Aberdeen Science Centre's** programme delivered 12 sessions in clusters across Aberdeen City and Aberdeenshire reaching up to 240 practitioners, incorporating engaging professional learning sessions on a variety of STEM topics to increase knowledge, skills, confidence of early learning and childcare practitioners and primary school teachers.

3.10 **Dynamic Earth** aimed to transform the Creative Science workshops into the first in a series of three online STEM learning modules. The creation of an online platform for innovative professional learning was developed to widen the reach of STEM professional learning for a range of practitioners including primary, additional support needs and community learning and development across Scotland.

3.11 **The Institute of Physics** planned to create three new professional learning hubs in rural areas in Scotland. These were to support high quality, bespoke professional learning for physics teachers and build relationships with schools and clusters in areas with deprivation in relatively remote and rural locations.

3.12 **The Royal Society of Chemistry** aimed to increase primary teacher confidence within STEM subjects and promote a seamless transition in learning from P7 to S1. This was to engage with practitioners to identify their professional learning needs and provide online opportunities for teachers in rural areas to participate in professional learning. A further aspect of the project sought to provide early-career mentoring for secondary school Chemistry teachers.

3.13 **Scottish Childminding Association** set out to develop and deliver a range of professional learning courses and workshops to promote and increase involvement with STEM learning for childminders across Scotland. As part of this, SCMA developed three STEM interactive e-learning courses.

3.14 **Scottish Technicians' Advisory Council** developed two professional learning courses for school technicians which take account of recent technological advancements. The two new courses focus on developing knowledge and skills required to safely operate 3D printers, laser cutters, data loggers, sensors and associated software.

3.15 **Youth Scotland** developed professional learning opportunities to upskill primary teachers, CLD practitioners, parents and volunteers in the use of Youth Scotland's Hi-5 STEM activity toolkit, supporting up to 160 participants by delivering eight practical workshops across Scotland to increase their knowledge of STEM.

Local authorities

3.16 **Aberdeenshire Council** aimed to develop a partnership approach to enhance STEM professional learning for those working in CLD settings. This delivered training through six focus group sessions to capture interesting practice in STEM within CLD contexts and then share more widely for others to benefit from this learning.

3.17 **East Ayrshire Council's** first project supported practitioners as they encourage girls to consider STEM subjects and careers. The project gathered data on girls' attitudes to STEM subjects and career aspirations together with seeking practitioners' views on how to effectively engage girls with STEM. It included face-to-face professional learning supported through online forums to develop practitioners' knowledge and understanding.

3.18 **East Ayrshire Council's** second project set out to inspire practitioners, build confidence, skills and knowledge in STEM subjects and help ensure equitable and engaging learning environments. Sessions were supported by staff from the Forestry Commission, the Environment and Forestry Network and the Collaboration Cluster Team. This resulted in five interdisciplinary lessons focusing on developing STEM skills.

3.19 **Glasgow City Council** supported planning for the extension of the successful STEM Glasgow programme of professional learning for practitioners to three interested local authorities within the Regional Improvement Collaborative. This enabled a greater number of practitioners to benefit from the Primary STEM Leaders Programme providing experiential professional learning for practitioners.

3.20 **Highland Council** enabled professional learning in STEM to be accessible to colleagues across a large geographical area though the use of an online platform. Professional learning opportunities were made available to all practitioners in the Highlands and include two sessions for practitioners in early learning and childcare, two sessions for primary practitioners and three sessions for secondary practitioners.

3.21 **Midlothian Council** worked in partnership with East Lothian Council and City of Edinburgh Council to plan a comprehensive, cross-authority STEM professional learning programme. The programme aimed to equip 60 CLD practitioners with the knowledge, skills and confidence to deliver STEM programmes within their own settings and will develop on unconscious bias, addressing gender imbalance and promoting equity of access and opportunity for all learners.

3.22 **North Ayrshire Council** embarked on the creation of a mobile STEM hub with a future plan to host this within one of their secondary schools. The hub was designed to be an inspirational learning space for practitioners and STEM Ambassadors to meet, learn and share knowledge, skills and expertise.

3.23 **South Lanarkshire Council** sought to facilitate the delivery of 350 hours of professional learning of four STEM-based activities through the new Youth, Family and Community Learning Service. This varied range of professional learning opportunities provided practitioners with the skills and confidence to inspire learners across communities whilst closing the equity gap and growing the learning culture within CLD.

3.24 **Stirling Council** set out to expand their current STEM Network to include eighty primary and early learning and childcare practitioners from across the authority. The main aim of the strengthened STEM Network is to implement a new Stirling STEM Challenge to tie in with British Science Week.

3.25 **West Dunbartonshire Council** expanded on the Step Up project – which focuses on raising attainment in numeracy using creative activities, including further STEM contexts. Professional learning sessions were held locally to share the new resources and be made available through Education Scotland's online digital platform to benefit learners and practitioners nationally.

Further and Higher Education

3.26 **College Development Network** set out to pilot professional learning and teaching resources related to the Internet of Things (IoT). Working with two primary schools, one secondary school and a local college, the project focused on practical activities linked to local issues and real-life industry. Practitioners gained hands-on experience which can be applied in their own settings to embed STEM skills within the curriculum.

3.27 **Forth Valley College** looked to develop effective STEM practice in ten local primary schools who will be involved in piloting on-line STEM support materials. Six local STEM knowledge exchange events were to be delivered to provide professional learning and networking opportunities for sixty practitioners. There was also be a three day course for eighteen secondary science practitioners to develop science skills.

3.28 **Glasgow Clyde College** delivered three one-day workshops across Scotland for up to 25 CLD and family learning practitioners, creating opportunities for practitioners to meet, learn together and develop their expertise. The main aim was to raise the skill levels and confidence to enable them to provide high-quality community based STEM learning across the country.

3.29 **New College Lanarkshire** led a multi-agency, collaborative project to support the delivery of a cohesive pipeline of STEM activities from early years to SCQF level 6/7. The first stage was undertaking a scoping exercise with stakeholders to identify the priorities for the future development of innovative professional learning opportunities aligned to the needs of practitioners, with an output to inform the future development of STEM-related units for the early learning and childcare curriculum.

3.30 **University of Aberdeen** engaged with a wide range of stakeholders including teachers, pupils, parents, academic societies, science associations and the wider community to identify the skills and knowledge gaps of practitioners involved in the delivery of STEM education. The project considered how to embed equality, diversity and inclusive practice within the delivery of the science curriculum.

3.31 **University of Dundee** encouraged children, families and communities to develop STEM capital and promote STEM careers. The project drew on research to enhance the skills, competence and confidence in science education of primary teachers. It expanded collaboration as part of a university-school-community partnership and helps generate relevant STEM learning in the curriculum.

3.32 **West College Scotland** developed a comprehensive professional learning programme for primary practitioners. A suite of digital resources were produced to enable practitioners to run their own coding clubs and Mini Game Jam events. It planned to deliver three complementary training sessions to engage 75 practitioners from across Scotland.

3.33 Overall some 75% of the projects funded aimed to engage with the primary sector and half with the secondary sector. Community Learning and Development was targeted by over a third of all projects whilst the college and additional support needs sectors were targeted to a lesser extent. Many projects aimed to engage with more than one education sector.

Table 3.1: Education sectors projects aimed to engage with

Sector	Number of projects	% of total projects
Primary	18	75%
Secondary	12	50%
ELC	10	42%
CLD	9	38%
ASN	3	13%
College	3	13%

Source: Education Scotland (2020) (n=24)

Funding

3.34 Twenty-four regional and national partners were funded in Round One of the STEM Grants Programme. It was organised in two phases. Many of the projects used Phase One funding to support project scoping and development with project delivery commencing in Phase 2. Organisations were awarded a total of £187,000 of funding in Phase One in October 2018 to support STEM professional learning. Of these organisations, twenty-two progressed into a second phase of funding in financial year 2019/20 and were awarded a total of £572,000 to extend and further develop their programmes.

3.35 Table 3.2 shows the breakdown of funding across each organisation for both Phase 1 and Phase 2 of the programme. As previously noted, an increased pot of funding was made available for the second phase. The Royal Society of Chemistry received the most funding overall (16%), however this was due to a significant rise in Phase 2 to over £106,000 and a combination of three project-elements contained within the same bid. Aberdeen University also received significantly more funding in Phase 2, bringing its overall total to just under £98,000 – 13% of the overall funding allocated across the two phases.

3.36 New College Lanarkshire and Dundee University also received significant proportions of the total funding, each at 11%. Some organisations requested and received less funding in Phase 2 than in Phase 1, including Forth Valley College and Scottish Childminding Association. Only two organisations funded in Phase 1 of the programme did not request or receive funding in Phase 2: West Dunbartonshire Council and College Development Network.

Table 3.2: Phase 1, Phase 2 and total funding across each organisation

Organisation	Phase 1	Phase 2	Total	% Total
The Royal Society of Chemistry	£11,784.42	£106,010.18	£117,794.60	16%
Aberdeen University	£15,753.48	£82,138.05	£97,891.53	13%
New College Lanarkshire	£9,386.30	£71,516.20	£80,902.50	11%
Dundee University	£24,461.11	£55,705.56	£80,166.67	11%
Highland Council	£6,066.67	£52,520.00	£58,586.67	8%
Institute of Physics	£7,241.91	£39,419.60	£46,661.51	6%
Glasgow City Council	£979.17	£40,145.83	£41,125.00	5%
Forth Valley College	£23,456.89	£15,411.56	£38,868.45	5%
Aberdeenshire Council	£10,803.28	£13,066.67	£23,869.95	3%
Youth Scotland	£4,633.33	£18,533.33	£23,166.66	3%
Scottish Childminding Association	£16,286.67	£6,766.67	£23,053.34	3%
Dynamic Earth	£9,095.83	£12,955.42	£22,051.25	3%
Aberdeen Science Centre	£3,756.67	£13,774.44	£17,531.11	2%
East Ayrshire Council	£6,875.00	£8,541.67	£15,416.67	2%
Midlothian Council	£472.22	£10,780.83	£11,253.05	1%
Glasgow Clyde College	£3,750.00	£5,700.00	£9,450.00	1%
Scottish Technicians' Advisory Council	£7,395.00	£1,965.56	£9,360.56	1%
West College Scotland	£3,514.62	£5,174.40	£8,689.02	1%
South Lanarkshire Council	£7,264.17	£920.00	£8,184.17	1%
East Ayrshire Council	£2,152.22	£4,304.44	£6,456.66	1%
Stirling Council	£1,553.03	£3,871.25	£5,424.28	1%
North Ayrshire Council	£2,500.00	£2,500.00	£5,000.00	1%
West Dunbartonshire Council	£4,159.17	£0.00	£4,159.17	1%
College Development Network	£3,600.00	£0.00	£3,600.00	<1%
Total	**£186,941.16**	**£571,721.66**	**£758,662.82**	**100%**

Source: Education Scotland (2020)

3.37 Phase 1 and 2 funding, as well as overall funding across both phases, is shown across the organisation types as identified earlier in the chapter. Further and Higher education institutions received 42% of funding overall, as well as the most funding across both phases, increasing from just under £84,000 in Phase 1 to around £236,000 in Phase 2.

3.38 Funding for organisations and charities increased 231% between Phase 1 and Phase 2, with total funding accounting for just over one-third (34%) of overall funding allocated. Around one-quarter of funding was given to local authorities (24%).

Table 3.3: Phase 1, Phase 2 and total funding across each organisation type

Organisation	Phase 1	Phase 2	Total	% Total
Further and Higher Education	£83,922.40	£235,645.77	£319,568.17	42%
Organisations and Charities	£60,193.83	£199,425.20	£259,619.03	34%
Local Authorities	£42,824.93	£136,650.69	£179,475.62	24%
Total	**£186,941.16**	**£571,721.66**	**£758,662.82**	**100%**

Source: Education Scotland (2020)

Delivery models

3.39 A key aim of the STEM Grants Programme Round One was to increase access to and availability of training. Given there are practitioners living and/or working in more remote areas across Scotland, equity and equality in access to training is important in order to give all practitioners across all education sectors and geographies the opportunity to participate.

3.40 As shown in Table 3.5 later in this Chapter, there were few practical training sessions in more remote areas such as Shetland and Orkney.

3.41 There is also the challenge of practitioners who do not have the capacity to travel to training sessions, for reasons including a lack of time or cover in their role – this is especially true of, for instance, teachers in secondary schools who have a significant amount of contact periods with pupils throughout the day.

3.42 Accordingly, organisations delivering STEM training across the programme sought to overcome these challenges by offering a varied range of training delivery models. As well as sessions held in person, organisations also offered online one-off training, online training over a number of sessions, access to online resources, mobile professional development hubs, opportunities to undertake assessments in STEM online, and more. This meant practitioners based in remote areas such as Shetland and Orkney were able to access training despite a lack of physical sessions in their area.

3.43 **Appendix 1** details the delivery models associated with each project and Chapter 4 discusses the variety and impact of the various models adopted.

Reviewing grant performance[39]

3.44 A total of 8,392 practitioners attended STEM professional learning sessions, accumulated through all 24 programmes, as shown in **Appendix 1**. As displayed at Table 3.4, the vast majority of these (44%) were in the Primary school sector. Secondary school (25%) and early learning and childcare (21%) were the next frequent sectors for delivery. There were fewer attendees across community learning and development, classroom assistants, college/further education, additional support needs and technical support with between 26 and 508 practitioners.

[39] Please note data included in this section does not incorporate information from Aberdeenshire Council, College Development Network, Midlothian Council, and Scottish Technician's Advisory Council, as information was not available.

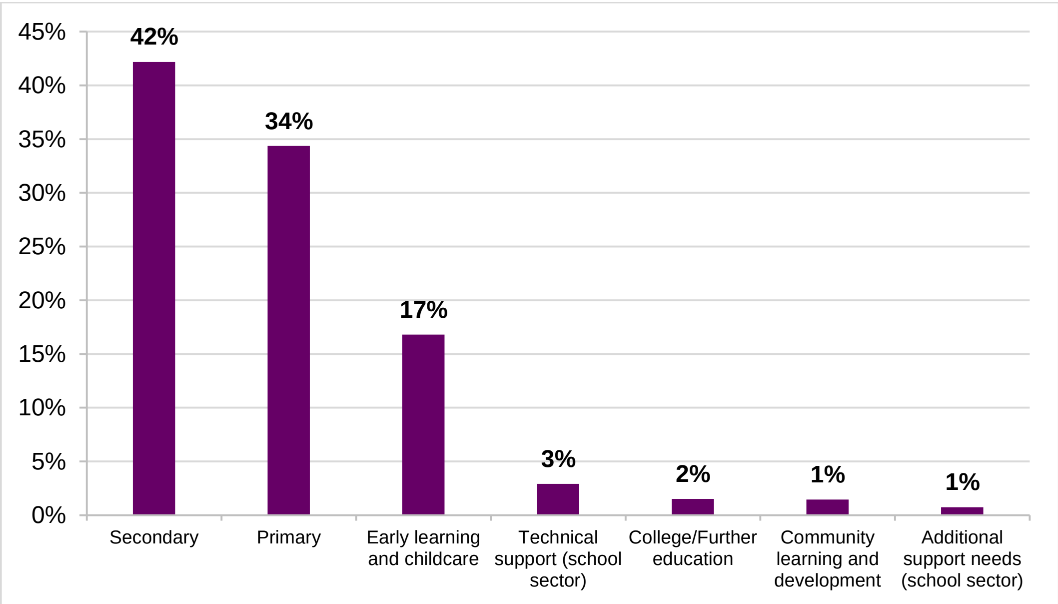
Table 3.4: Number of attendees across education sectors

Sector	No.	%
Primary	3,718	44%
Secondary	2,057	25%
Early learning and childcare	1,756	21%
Community learning and development	508	6%
Classroom assistants (school sector)	192	2%
College/Further education	101	1%
Additional support needs (school sector)	34	0%
Technical support (school sector)	26	0%
Total	**8,392**	**100%**

Source: Education Scotland Project Summaries Data (2020)

3.45 As shown in Figure 3.1, almost half of all STEM learning hours were undertaken by the secondary school sector (42%), with around 34% undertaken by primary school and 17% by ELC. This is despite a far greater number of primary school practitioners attending sessions, indicating that secondary practitioners spent more time undertaking STEM learning than their primary colleagues. A possible explanation for this is secondary practitioners may have attended longer CLPL events than primary practitioners. Secondary practitioners may have also engaged with more online sessions, which have the capacity to last longer as they are undertaken at the behest of the learner.

Figure 3.1: Number of CLPL hours across education sectors (N=34)[40]

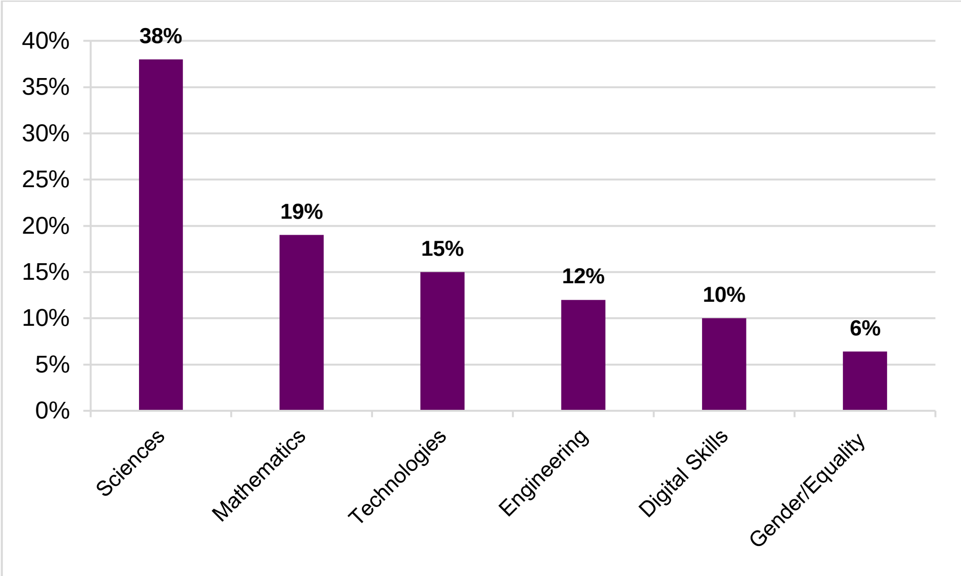


Source: Education Scotland Project Summaries Data (2020)

3.46 The mixture of focus groups, workshops, online learning and more aimed to cover a broad range of STEM subjects, with sessions covering a fairly even spread of subjects, albeit with Sciences the most common at 38%, as show in Figure 3.2. Around one-fifth of sessions were built around learning in Mathematics (19%), with Technologies at 15% of overall sessions. 6% of sessions covered Gender/Equality.

[40] College/Further education and Community learning and development bars are the same size due to rounding – College/Further education hours represented 1.5% of overall CLPL hours, while Community learning and development hours represented 1.4%.

Figure 3.2: Sessions covering the key STEM themes (N=710)



Source: Education Scotland Project Summaries Data (2020)

3.47 Available data on where the sessions were delivered indicates that Glasgow accounts for the highest proportion at 16%, followed by Angus at 13%, as shown in Table 3.5. This was followed closely with Stirling (9%), Edinburgh City (8%) and Aberdeen City (6%), reflecting the geographical spread which is mostly in and around the more densely populated cities. Rural areas experienced somewhat lower delivery, although 3% of sessions were delivered online which may account for this.

Table 3.5: Geographical spread of STEM learning sessions[41]

Local authority	**No.**	**%**	**Local authority**	**No.**	**%**
Glasgow	42	16%	Argyll & Bute	4	2%
Angus	35	13%	Scottish Borders	3	1%
Stirling	29	9%	Dumfries & Galloway	3	1%
Edinburgh City	22	8%	West Lothian	2	1%
Aberdeen City	18	6%	Perth & Kinross	2	1%
Falkirk	14	5%	Moray	2	1%
Aberdeenshire	11	4%	Midlothian	2	1%
Fife	10	4%	Renfrewshire	1	<1%
East Ayrshire	9	4%	East Renfrewshire	1	<1%
South Lanarkshire	8	3%	East Dunbartonshire	1	<1%
South Ayrshire	6	3%	Shetland	0	<1%
Highland	6	3%	Orkney	0	<1%
Dundee	6	3%	North Ayrshire	0	<1%
West Dunbartonshire	5	2%	Inverclyde	0	<1%
North Lanarkshire	5	2%	Eilean Siar	0	<1%
Clackmannanshire	4	2%	East Lothian	0	<1%
			Other (Online)	*9*	*3%*
			Total	**260**	**100%**

Source: Education Scotland Project Summaries Data (2020)

3.48 Overall, 27% of participants that attended sessions were from Glasgow, by far the highest number across all local authority areas. This is unsurprising given Glasgow also had the highest number

[41] Does not include date from Aberdeenshire Council, College Development Network, Midlothian Council and Scottish Technician's Advisory Council information was not available.

of sessions, as previously noted. Of these participants from Glasgow, over half were from primary schools (54%). Stirling (13%) and South Lanarkshire (12%) had the next highest number of participants, however the vast majority of participants in South Lanarkshire were early learning and childcare (96%), whereas Stirling had mainly primary school participants (62%).

3.49 Looking at it from a sector perspective, primary school participants were predominately from Glasgow (35%), Stirling (19%), Falkirk (11%) and Edinburgh (7%), while participants in secondary schools were more evenly spread across all local authorities, with 17% from Glasgow, 14% from West Dunbartonshire and 10% from each of Fife and Edinburgh.

3.50 The majority of ELC practitioners were from South Lanarkshire (55%), while over half of all CLD practitioners were based in Angus (58%).

Summary

3.51 A variety of projects built around professional learning in STEM were delivered across 27 local authorities in Scotland in 2018 and 2019 as part of the STEM Grants Programme Round One. These projects were split across three categories – Organisations and Charities, Local Authorities and Further and Higher Education – with each project targeting at least one education sector.

3.52 Over 75% of projects sought to engage with the primary sector, with half targeting the secondary sector. Around 44% of attendees were from the primary sector, however secondary practitioners accessed 42% of the total CLPL hours, perhaps indicating longer sessions across projects aimed at secondary practitioners.

3.53 STEM professional learning reached practitioners across the whole of Scotland, in part through the delivery of online learning and training sessions, but also due to the volume of sessions offered.

4 Round One projects

Introduction

4.1 This chapter draws on consultations with Lead Grantees and focuses on project design, targeting and engagement, innovation, equity and equality, different delivery modes and sustainability. Some overall lessons around ES programme management are also highlighted.

Project design

4.2 As detailed in Chapter 3, the STEM grants programme in Round One covered a wide range of projects and delivery models. The intention was to support a variety of different projects covering many aspects of STEM, operating at different scales through differing approaches, and this was certainly achieved. Projects ranged from school-based coaches (e.g. Institute of Physics) to STEM mentors, to forms of CLPL with teachers attending sessions in person and online, but with new content and materials. The national model of professional learning and the criterion used to quality assure programmes ensures that participants are provided with a high quality learning experience that is commensurate, regardless of the variety of opportunities on offer. Programmes cover entirely new content, were taken out to schools and through other outreach (e.g. Forth Valley College) to newly developed materials for practitioners not typically receiving STEM-related CLPL (e.g. childminders and early years practitioners). Projects were delivered over short and long-term periods, and included capacity building professional learning (e.g. Game Jam coding via West of Scotland College) to whole community engagement and research (e.g. "Fund of Knowledge" approach in rural Stirlingshire). Some have built on extensive previous investment (e.g. digital infrastructure in the Highlands), whereas others were developed wholly as new pilot activity.

4.3 The projects involved different lead organisations (local authorities, institutes and associations), geographic areas, target groups, delivery modes and subject matter. The STEM grants programme funding has allowed new content to be developed, new approaches to be piloted, further practical support to be made available more widely (e.g. using STEM-related equipment such as 3-D printers) or additional activity building on existing digital capabilities. Many of the projects included several strands or elements, some linked within an overall project and others with discrete elements within the project.

Targeting and engagement

4.4 Phase 1 (of Round One) focused principally on pilot and set up activities, and so some of the greater levels of engagement were seen in Phase 2 following on from the first phase. There were however a wide range of approaches across the Round One projects, which has provided valuable lessons for project leads and for Education Scotland.

Targeting

4.5 In terms of end beneficiaries, there was a significant focus from Round One projects on upper stage primary school children through to early years of secondary school, and notably the P7 Transition into S1 phase. There were fewer projects targeting only secondary school age children and secondary school practitioners (one example being the 'Women in Wellies' project in East Ayrshire) with projects that did include secondary school practitioners typically finding this group more difficult to engage. Consultees reported that secondary school practitioners are more specialist and generally more confident in STEM, and therefore their support needs are different in terms of CLPL. In terms of targeting, there were exceptions to this, with the Royal Chemistry Society for example specifically targeting secondary school teachers, particularly those new to the profession, with some success.

4.6 The focus on later age primary school children was not always deliberate, but rather a response to practitioner demand for support, reported by consultees. Many projects (e.g. the West of Scotland

College coding clubs, Highland Council STEM CLPL) found that the greatest support needs (from practitioners) were amongst primary school teachers. By contrast to more specialist secondary school teachers in STEM, consultees report that many primary school teachers have less confidence when it comes to STEM. Primary school teachers benefited greatly from the confidence brought by greater levels of STEM-related CLPL and support. Several projects had primary school teachers as the key audience at the outset of the project, such as the primary STEM leaders project led by Glasgow City Council, which delivered STEM CLPL to primary school teachers in three local authority areas following previous success in the Glasgow City area.

4.7 The other main target group were practitioners in Early Years, which included those in nurseries but also those outside the education mainstream, notably in childminding. Through their STEM Grants Programme project, the Scottish Childminders' Association has provided important support in STEM CLPL to its (4,00+) members (out of 4,700 registered childminders), with very good levels of engagement and uptake (and where 99.98% of the workforce is female, helping to overcome the perception that STEM can be male dominated). Many of the childminders are older (than other Early Years practitioners) and so the good engagement levels through the project can be regarded as particularly positive. Local authorities and other organisations have also focused on Early Years, including the Highland Council online STEM CLPL project. The New College Lanarkshire project also focused on Early Years, recognising that historically STEM learning in the area (and via the STEM partnership Hub) has been focused on the senior phase and post-16, especially as a route into STEM-related careers.

4.8 Other projects also targeted those outside teaching, including one project focused on Technicians (in schools) and several which worked in a community learning setting. The projects targeting community learning practitioners gained considerable traction, with community learning practitioners positively engaging with STEM CLPL. One project specifically targeted youth worker community learning practitioners, again with considerable success.

4.9 Typically, projects targeted the practitioners in order to build their capacity to deliver STEM. As such, there was less direct targeting of pupils although this was often the ultimate aim (and much new content for engaging pupils has been developed – see below). Some projects specifically sought to engage parents (e.g. those related to Early Years) and one specifically, the whole community via household surveys and work with community residents including non-parents (University of Dundee).

Engagement

Practitioner engagement

4.10 As highlighted above, the highest levels of engagement were from primary school teachers and Early Years practitioners, those with the most to gain from increased confidence in STEM. Given the lower levels of Early Years practitioners' confidence in STEM, some consultees (e.g. Aberdeen Science Centre) were positively surprised by their high level of engagement and demand (e.g. Aberdeen Science Centre). At primary school level, projects reported extensive primary teacher engagement, for example in the three local authority areas taking part in the Glasgow City Council primary STEM leader project. At secondary school level, it was those projects which built confidence that were the most successful (early career Chemistry teachers) and in those schools with fewer secondary teachers. Secondary school teacher engagement in Highland, for example, was much higher in one-teacher departments than those with larger departments, where teachers can support each other more easily.

4.11 In some cases, external organisations found it more difficult to engage teachers when this had to be mediated through the local authority. This related mostly to the delivery model (see below), i.e. how to account for time spent on the project rather than teaching. This was the experience of the Institute of Physics, for example, where there were some practical challenges in getting school cluster teachers together in rural areas. For other projects, such as the Highland Council CLPL project, the STEM grants programme has allowed the local authority to utilise its enhanced digital capabilities effectively to bring together teachers in rural areas online – where even twilight sessions were difficult to organise given the large geographic areas involved.

4.12 Engagement was more difficult for certain groups, notably technicians (the Scottish Technicians Advisory Council Technicians' project, one strand of the Forth Valley project). However, this was not a result of a lack of interest, but rather the lack of supply cover for technicians to release them for the project. It can also be difficult to engage practitioners where overall numbers are quite low (e.g. technology teachers in the Highland area), where there are practical challenges of bringing practitioners together from a low base number.

4.13 Engagement has sometimes taken time for lead organisations to cascade through the systems and networks, and on occasions this has been resource intensive (e.g. the Royal Chemistry Society project mentor strand). The Institute of Physics also found it has taken time to build networks. However, for other groups, especially those in community learning for example, engagement has been particularly strong. As with those in Early Years, confidence in STEM for those in community learning can be weak, and so support via the STEM Grants Programme project has been valued.

4.14 Overall, feedback from participants, even where there may have been challenges with achieving engagement levels, has been almost universally positive (e.g. Institute of Physics project, with the school based coach providing leadership to other teachers). One strand of the Glasgow City Council project ("STEM in a Context") adopted a 'train the trainer' approach which was made available to local authorities not taking part in their primary STEM leader project. Engaging practitioners here may have been expected to be more challenging than in the primary STEM leaders strand where there is a direct relationship with the local authority. However, with thought given to venue location and session timings, practitioners have been successfully engaged, with the feedback very positive, and the local authority has further stepped up efforts to make venues for sessions as easily accessible as possible.

4.15 A number of barriers, previously acknowledged to prevent practitioners from engaging in professional learning, have been overcome by some projects, such as distance or location, timing of sessions, etc.:

> *"It was very near my place of work so easy to get to, and it was during an in-service day so no disruption to teaching… and childcare responsibilities means I want development close to my work/home." [Secondary school teacher]*

> *"RSC Mentor/Mentee Training was centrally located for variety of Schools, only around 1 hour away for me and suited for childcare arrangements." [Secondary school teacher]*

> *"Two full days were given to attend training during the school year and multiple highlights were held in the centre of Glasgow allowing it to be accessible to all GCC schools." [Primary school teacher]*

4.16 Projects have used various methods to raise awareness and promote their project activities relying on STEM Ambassador Hub staff, local authority networks and contacts, and their own social media and website platforms. Some noted that word of mouth (e.g. Aberdeen Science Centre) was the largest source of workshop attendees.

Learner engagement

4.17 Learner engagement has varied according to the project, and in a sense is one step removed given that the majority of learners are involved as a result of the CLPL initiated or enhanced by the STEM Grants Programme-supported project. Nonetheless, there have been good levels of learner engagement across the range of projects. Pupils have taken part enthusiastically in newly developed online content and learning modules, competitions, STEM sessions and activities. As with practitioner engagement, this has typically been greatest amongst primary school pupils, especially P5-P7 where take up of activities amongst practitioners has been greatest.

Local authority engagement

4.18 There have been generally good levels of engagement from local authorities, in many different parts of Scotland, both urban and rural areas. Some (e.g. Highland Council) have embraced the STEM agenda, building on strong investment in digital capabilities, given the advantages of remote working capabilities, and others, such as Glasgow City Council and the Lanarkshire Councils, have a strong track record in STEM (with the former taking approaches out to other local authorities). Several local authorities have been able to build on their participation in the Raising Aspirations in Science Education (RAiSE) programme. There are also examples of local authority non-teaching staff delivering STEM activities (e.g. North Ayrshire, by those in other local authority departments such as IT). Where local authority engagement has been not as pronounced, this is typically in smaller local authorities, which have less capacity to deliver additional activities or to do things in a different way to accommodate STEM Grants Programme projects.

Other partner organisation engagement

4.19 A number of other partners have also been involved in the STEM Grants Programme, either directly as Lead Grantees, or as partner organisations. Project leads include Science Centres, science-based organisations and institutes and Further and Higher Education Institutes. Science Centres have both been leads and supportive partners, for example, and a number of Round One projects involved active leads by Colleges, who have delivered activity both for practitioners in schools and other settings, as well as for their own staff. Projects have been developed collaboratively in many instances, for example with industry, such as the New College Lanarkshire Early Years project developed under the auspices of the STEM Hub Partnership and via Regional Improvement Partnership collaborative working for STEM in community learning across eight northern local authorities.

4.20 Key points in relation to targeting and engagement:

- Projects have targeted a wide range of groups through a wide variety of engagement practices and methods;
- There has been particular interest and engagement amongst Early Years and primary school teachers and in community learning, where confidence to deliver STEM learning is lowest;
- Engagement has been achieved through member networks, local authorities and via school clusters. Some secondary school practitioners have been harder to engage, where the need for STEM CLPL may require different approaches;
- External organisations can find it difficult to engage with local authorities, particularly if this is a less familiar way of working for the external organisation or the local authority;
- Partnership working has been a feature of many STEM Grants Programme projects, and this has increased engagement levels in many cases;
- There is scope for even further engagement, for example extending STEM CLPL into the Third Sector, given the success of STEM CLPL in community learning.

Equity and equality

4.21 Projects have increased access to STEM CLPL for practitioners and to STEM activities for end beneficiaries. Projects have covered urban and rural areas, with practitioners in many areas able to access STEM CLPL through the STEM Grants Programme-supported projects via online resources, either across Scotland (e.g. the Dynamic Earth project is now taken up in 30 of the 32 local authority areas with an even spread across RESAS areas: urban with substantial rural areas (41%), larger cities

(30%) and mainly rural areas (26%), with significantly fewer signups from Islands and remote areas (i.e. Orkney, Shetland, Argyll & Bute and Eilean Siar)) or in the geographic areas that the project is operating.

4.22 Some projects have specifically sought to increase access to STEM end beneficiaries who may be regarded as harder to reach. The South Lanarkshire Summer Camps, via the Youth, Family and Community Learning Service is a good example with its emphasis on those most at risk of not achieving a positive destination. The Forth Valley College strand to "Engage New Audiences" is another good example, where energetic outreach has taken new STEM content and resources out to schools, including schools in areas with higher levels of relative deprivation. The East Ayrshire Council 'Women in Wellies' project specifically sought to create a more inclusive learning environment for girls, especially in a deprived rural setting through the use of the outdoors and linked to horticulture, tourism, the environment and farming (identified as most relevant to the local rural East Ayrshire socio-economic context). Here, the STEM Grants Programme-supported project focused on secondary school teachers (S3-S6 pupils), increasing awareness of alternative pathways for learners in STEM careers.

4.23 There have been some very good examples of reach into rural areas, including the Aberdeenshire community learning project which has extended reach into northern region outposts (and where the project has out achieved its target number of community learning practitioners), and the Highland Council project where the STEM Grants project has benefited from prior investment which has made Google Chrome available to all students from P6 and above. The Institute of Physics school-based coaches also targeted schools in rural areas, in this case Dumfries and Galloway, Moray and Angus; the South Lanarkshire project also specifically targeted resources in the rural parts of the local authority area. The University of Dundee project deliberately focused on a deprived rural community.

4.24 STEM Grants Programme-supported projects have generally been open to all practitioners in a locality, subject to capacity in the project to deliver this level of support. Project activity has been greatest where there have been schools which are responsive or where existing networks are already strong. Some lower levels of project activity were evident where there has been lower local authority capacity – typically smaller and some rural local authority areas, which may have reduced access to STEM for learners compared to more active areas. Some projects, inevitably given that they have been pilot projects, have worked in specific localities where there were existing personal contacts established or routes into particular schools or practitioner groups.

4.25 On the whole, the STEM Grants Programme has brought STEM CLPL to new groups and has increased the availability of professional learning. The Scottish Childminders' Association project is a good example, bringing STEM related professional learning to a wide group of practitioners, many of whom who were utilising STEM techniques (e.g. inquiry-based approaches) without fully realising they were doing so, which has in turn increased practitioner confidence and extended the reach of STEM learning. The Aberdeenshire-led community learning development project used the strapline "Unlocking STEM in CLD" and this has been effective in breaking down the barriers for community learning professionals who may in the past have been fearful of STEM, despite already using STEM learning in many settings (e.g. outdoor, cooking and so on). The Youth Scotland project helped increase the confidence of practitioners to deliver Hi5, their Scottish Credit and Qualifications Framework (SCQF) L2 provision they had developed with Glasgow Science Centre. All these are examples of projects which increase equity and equality.

4.26 Key points in relation to equity and equality are:

- Projects have been increasing access to STEM CLPL for practitioners across Scotland and in many cases they have specifically brought additional CLPL to new groups of practitioners and geographies.
- Strong engagement of Early Years and community learning practitioners is increasing access to STEM among young learners and those not typically involved in STEM learning.
- Many projects have increased access to STEM CLPL in rural areas, with online approaches extending reach to the rural north of Scotland in particular, where there have been advances in the digital infrastructure to facilitate online learning.
- A smaller number of projects have specifically targeted areas of deprivation. One focused on gender and areas of rural deprivation, another on a relatively deprived rural community.
- On the whole, projects have been open to all practitioners across a group (e.g. Childminders) or a geography, and so access to STEM CLPL has increased considerably as a result of Round One projects.

Delivery models

4.27 There have been a wide range of delivery models and many of these have involved some degree of partnership working. Many of the projects worked closely with the Scottish Schools Education Research Centre (SSERC), including the Scottish Technicians Advisory Council project (which ran its courses in tandem with SSERC and at some of their locations, extending the project's reach and where its technology centre in Glasgow is a training agency for SSERC) and the Scottish Childminders' Association, where SSERC helped with writing the content.

4.28 Several projects have worked through school clusters, via the secondary school and the associated primaries. These have varied in their success; in some examples, the secondary has been harder to engage and in others, certain primaries within the cluster have been more responsive than others. It can be difficult to get people together for joined sessions within the cluster. The Institute of Physics project, whilst meeting overall targets, found the consistency of attendance/uptake to be variable across the 6-8 schools in the cluster, again with primary schools typically more interested/engaged. In this case, the project was seen by some schools as too much of a "bolt-on" to existing teaching demands, and even with twilight sessions it was difficult to bring teachers in a cluster together. For other projects, such as Game Jam competition, the cluster approach has been entirely appropriate, although even in these examples there is a recognition that it takes time to broker arrangements between primary schools and the secondary school.

4.29 Bringing practitioners together, and recognising that some face barriers on time availability and workload demands can be challenging, and so many delivery approaches have been online, or a mix of online and face-to-face approaches. Some projects (e.g. the Dynamic Earth project, the Forth Valley College project) have allowed practitioners to proceed through the online course at their own pace. Dynamic Earth employed e-learning consultants to take their creative content and make it as accessible and engaging online as possible. The Scottish Childminders' Association offered e-learning and themed network nights and workshops. The West of College coding CLPL project offered two face-to-face sessions and one online for its two-hour CLPL, via GLOW, which significantly increased the project reach. In this case, the online approach extended the coding club's project reach extensively, including to Aberdeenshire and the Western Isles, where one school participated in the competition via Skype. In one project workshop delivery has been filmed and streamed live online to allow practitioners in the Western Isles and Orkney to take part (i.e. Aberdeen Science Centre), thereby increasing access for primary school and ELC practitioners. This approach however, is not without its challenges where network speeds in some areas are not sufficient and does not allow for the same quality of learning experience.

4.30 Other projects too have used newly developed online resources and materials combined with outreach, to good effect. A good example is the Forth Valley College project which developed activity-based training materials based around new digital content (see content innovation below) which the College then took out across the Forth Valley local authority areas. School practitioners could play the new online content to the class, or use it as training with the online content set up so that not all the tasks needed to be completed at the one time. The resources were free, practitioners could book slots for the College to come and deliver support to practitioners which included on-the-day activities, and the feedback has been very positive, especially from probationers and others with lower levels of STEM confidence. The project allowed the College to develop the new content and significantly enhance their existing primary STEM engagement activity.

4.31 There have been some delivery challenges where an external organisation is seeking to gain access to practitioners in schools, either by working through the local authority or where the external organisation is using its existing contacts (e.g. the Institute of Physics project or the Royal Chemistry Society in recruiting Chemistry mentors). The Dynamic Earth project faced challenges getting teachers to take up the participative feedback session at the end of the course. The Institute of Physics project sought to have a coach based in a lead secondary school and faced practical and logistical challenges in setting up this model.

4.32 Some delivery models have been particularly effective where there has been a strong member network e.g. Scottish Childminding Association where a large majority of registered childminders are members of the organisation. The Association has been able to reach its membership effectively as a result of the strong network established. It also found that the online courses were particularly well used, allowing childminders to access support in their own time and negating the need to take time out to meet in person. As with other projects, the learning has been free to access, another positive in terms of engagement. Youth Scotland have similarly reached large numbers either in-house or through their networks via open access to a wide range of locations and venues.

4.33 A number of delivery models involve taking existing content and extending the reach of this content. This includes the Game Jam coding competition which was already developed and had worked well in Glasgow, but the model was to give more STEM practitioners the confidence to run the coding clubs in schools themselves. Primary STEM leaders had previously been successful in Glasgow and the STEM Grants Programme-supported project extended this to East Renfrewshire, East Dunbartonshire and South Lanarkshire, with content adapted in response to feedback obtained. Youth Scotland provided support and training for practitioners to deliver the already developed Hi5 STEM toolkit. The South Lanarkshire Family and Community Learning project involved taking existing Lego Mindstorms and other activities to new audiences.

4.34 Some of the challenges in delivery have been associated with high targets and, in hindsight, unrealistic expectations for the project. Examples are the Royal Chemistry Society and its own high target for the mentor activity, or certain strands of the South Lanarkshire community learning project. One project envisaged a physical STEM hub for the local authority area, although in practice this did not work effectively as a place to deliver STEM learning. It was subsequently felt better to deliver CLPL through outreach. However, a virtual hub has been developed, as an alternative, to host resources, whilst the physical base is being used as a safe-place to house the STEM physical equipment such as headsets which are available on load to schools.

4.35 Some projects, such as the Institute of Physics' project, required long lead-in times to set up the school-based coaching arrangements. This was also the case for the University of Dundee Funds Of Knowledge Project. For projects like these needing long lead-in and set-up times, a longer time period for delivery of projects beyond Round One timescales may have been appropriate. University-led projects can in general take longer to establish given the need to recruit external or researchers etc., which requires some consideration in future funding rounds.

4.36 As mentioned, some delivery models have involved face-to-face workshop style professional learning, often for particular reasons (e.g. the technicians needing to be able to practice with live equipment). However, as cited above, bringing people together physically has sometimes been challenging, but not always so, especially where there have been good engagement levels and the geography allows people to meet quite easily (the primary STEM leaders twilight sessions in local authorities near Glasgow were effective for example). Bringing people together has also been successful where project activities are more standalone or one-off, and where they can be tied in with existing events (e.g. the Forth Valley College Knowledge-exchange Event which coincided with the large STEM at the Helix event).

4.37 Many projects have been developed through effective partnership working. These are too numerous to mention, (New College Lanarkshire for example) however some interesting and effective collaborations have emerged through the Round One projects. One good example is the Aberdeen City and Shire community learning project with the Aberdeen Science Centre. The community liaison worker at the Science Centre proved invaluable to the local authority community learning project lead, with the Science Centre officer so inspired by STEM in a community learning setting that they are taking community learning professional qualifications.

4.38 It is important to note that the delivery models taken by various projects have been considered engaging and enjoyable by the practitioners taking part. This has added to the value of the professional learning experience:

> *"Often training sessions can be invigorating and refreshing… the resource allowed so much exploration whilst the adults were still sharing and enjoying. We all need a wee bit of novelty sometimes!"*

4.39 The key points in relation to delivery models can be summarised as:

- There are strong levels of partnership working, particularly in the development of new materials and content, for example between local authorities and Science Centres, and this collaboration has been effective;
- A mix of online and outreach has been an effective delivery model, with outreach helping to engage and enthuse practitioners around good quality materials and resources;
- On the whole, online resources and new content are an effective way of reaching time poor practitioners;
- School clusters can be an effective route to practitioners, although primary schools are generally more active and engaged than secondary schools (there are of course exceptions);
- Working through strong member networks has been effective, which can achieve wide reach, although if the project requires to go beyond the member network this can be more challenging; and
- Ensuring face-to-face workshops/learning sessions are accessible (e.g. in local areas) and at times practitioners can access them (notably twilight sessions) are more effective than other approaches.

Innovation

Content innovation

4.40 The Round One projects include innovative new content. The Forth Valley College project has involved the creation of four new STEM characters (the Famous Four – Suzi the Scientist, Tim The Technologist etc.), each with different STEM skills, on a mission to save the planet, using a whole host of skills and techniques, from using renewable energy to reducing pollution to devising engineering solutions etc. This is matched to the P5-P7 Science curriculum and has been a popular method of engaging young people and primary school teachers.

4.41 The Scottish Childminding Association STEM Grant project is another good example of newly developed materials. Courses developed have included an 'Introduction to STEM, STEM and the senses', 'STEM and outdoor learning' and 'Science Enquiry skills'. Resources include an activity resource booklet with a strong home-learning thread. This has been an excellent way to engage and involve parents in their child's STEM learning. Glasgow City Council's STEM in a Context project developed resources specifically relevant to the local authorities in the West Partnership area. The New College Lanarkshire project developed new STEM learning materials for those in Early Years; Aberdeenshire and City local authority community learning departments co-designed and delivered a new programme in conjunction with the Science Centre. The Dynamic Earth project developed two new online courses with engaging, practically focused, interactive video content, with wide appeal to practitioners across the learning spectrum.

Learning modes

4.42 There has been innovation with respect to learning modes. For the Dynamic Earth project, for example, the online learning requires participants to complete a module, which can be done at their own pace in their own time, before progressing to the next stage. Other approaches have linked learning to accreditation, for example the New College Lanarkshire project for Early Years practitioners. Here the pilot envisaged a two credit award as part of the STEM CLPL course developed, but following feedback from beneficiary practitioners (as part of Round 2 delivery), this is likely to be dropped to one unit, which in time it is hoped will be SCQF levelled and become a national unit that any College can use as part of the L6 curriculum.

Project delivery models

4.43 The chapter has already discussed project delivery approaches, however some innovative delivery models are worth highlighting. Some of the cluster approaches have been very effective in particular, for example Game Jam coding project bringing learners together from schools into teams.

4.44 Extending reach via online resources and online communication channels has been a feature of Round One projects. Some of this has been innovative, for example the West Scotland College coding club using Office 365 Team meetings after using GLOW previously. This involved inviting all teachers on to it, hosting resources and meetings and using Skype for CLPL, sharing successes and asking questions, so that there were in this case 70 teachers in all participating. Some teachers use it just for the resources, others for more intensive, confidence building support. Many of the projects have successfully engaged 100+ practitioners through online engagement routes.

4.45 The partnership approach has been successful, for example the Regional Improvement Partnership for community learning in the eight north of Scotland local authorities, led from Aberdeenshire. Delivering accredited CLPL as part of the project has been welcomed by many practitioners as a way of formalising STEM learning into their wider skills-set. The STEM Funds of Knowledge, led by the University of Dundee, was an innovative approach, the first of its kind in the UK, and one which has engaged non-parents and other community members in scoping STEM learning, households and individuals not typically given a voice in STEM. Although resource intensive and longer-term, the project identified a wealth of STEM capabilities and interest within the community.

4.46 Utilising motivated professional staff in local authority non-teaching roles as STEM ambassadors, is also an innovative model for cascading STEM learning (e.g. via coding clubs, libraries). This was the approach adopted in North Ayrshire, an interesting use of professional expertise in STEM that can be harnessed in local areas.

4.47 The key points in relation to innovation are:

- That Round One projects have employed a wide range of new approaches, utilising newly developed content, and this new content has been a feature of the Round One funded projects;
- In many instances the funding has enabled practitioners and partner organisations to collaborate and plan new programmes of activity based around STEM; and
- New ways of bringing practitioners together around STEM learning online have been developed, and this continues to evolve.

Sustainability

4.48 The vast majority of Phase 1 projects were supported into Phase 2, with the majority of these involving greater reach and numbers in the second phase. There was a strong link between Phase 1 and Phase 2 projects, with the applications asking for details of both at the initial application stage.

4.49 Many of the projects are already capable of further roll out and are scalable, given that STEM Grants Programme has funded the development of new content, or funded the routes to wider access in others, or both. Some new content is freely available online, and for others, online access could be widened at very low cost. Some of the new content developed (e.g. by Glasgow City Council, Forth Valley College) could be made available to more schools in more areas, with relatively modest additional resources required to provide beneficial outreach support.

4.50 Some activities are being taken on by teachers and other practitioners to run themselves e.g. Game Jam Coding, and this capacity building element has been a good feature of Round One projects. There has been evidence (e.g. Highland, South Lanarkshire community learning, North Ayrshire, the Scottish Childminders' Association) of the project building capacity with practitioners being advocates for STEM outside the project (in Highland linked to the online virtual school, volunteering at inset days). Feedback from the Glasgow City Council led primary STEM leaders project was that local networks are being created in participating local authorities, with practitioners going on to share resources and support each other post project.

4.51 Some partners plan to take their activities forward, as a result of the STEM grant project. The Royal Chemistry Society is one example, although further external funding would enable this more easily. Others (e.g. North Ayrshire Council non-teaching STEM ambassadors) are at capacity with the resources they have (which includes strong volunteer commitments to run Saturday coding clubs), and they could do more if there were some modest additional resources. The Scottish Childminders' Association has been asked to run STEM workshops at its conference, such has been the increase in interest and demand for STEM CLPL. It plans accredited courses and to do more work with STEM and young leaders. STEM CLPL is now a standing item for the north Scotland community learning partnership quarterly newsletter.

4.52 Some projects would be more resource intensive to sustain, and/or the set-up costs may count against widespread roll-out. For others, Phase 1 projects had already delivered considerable uplifts in volume in Phase 2, with plans for further increases in roll out with more content being developed all the time (e.g. further 'train the trainers' style approaches).

4.53 On the whole, there are encouraging indications that STEM learning activity will be sustained. Feedback indicates that many projects are delivering support that is relevant, covers topical science subjects, that links to the curriculum and Quality Improvement Framework, with resources and materials developed being shared within newly forming networks. This has been the learning from Glasgow City Council and their primary STEM leaders and Stem in a Context strands: local authority and cross-local authority networks are developing organically to share knowledge, expertise, resources and activities. There is evidence that primary STEM leaders are stepping up to deliver activities for other schools in their cluster and for different cluster schools to host events etc. as networks mature, in time allowing Glasgow City Council to take a step back from front-line delivery.

4.54 Building capacity has been a feature of the STEM Grants Programme-supported projects, and some of this is about building capacity in the long-term. The young leaders' element of the Youth Scotland project builds capacity in young people so they can deliver more STEM related activity (e.g. in a youth club or community setting). This is being built into youth awards programmes, with the greatest success of the project regarded as "engaging those who do not always see themselves as good at science". The Women in Wellies project found 72% of girls were inspired to think about new jobs in the STEM/rural environment, starting to change long-held perceptions of gender and STEM, although the challenge here is to continue the initial momentum and to extend the events/concept more widely, with teachers inspiring other teachers.

4.55 The key points in relation to sustainability:

- A lot of the new content and resources developed are online and could be made available more widely at little additional cost;
- Outreach and face-to-face engagement activity is more expensive to deliver, although even here relatively modest resource could extend reach further, alongside the online resources developed;
- There are indications that many practitioners are feeling more confident and able to deliver STEM related activities in schools and communities, as a direct result of the Education Scotland funded STEM Grant programme;
- Some local networks are developing with practitioners coming together to share resources and best practice; and
- Continuing to cascade training to more practitioners through the projects and networks would further extend the reach of STEM CLPL learning.

Programme management

4.56 There are strong levels of additionality, with the majority of grantees saying that their STEM CLPL activity could not have taken place without the funding. Even where the STEM Grants Programme supported the expansion of an existing project, the funding allowed new CLPL materials to be developed (as one example new videos and worksheets were produced to support the Game Jam coding competition roll out).

4.57 There has been very good feedback on the quality of support from Education Scotland's Regional Officers who managed the grant process. This has been welcomed by many Lead Grantees, particularly those less experienced in delivering STEM CLPL, such as community learning. In some cases, the interest/enthusiasm and subsequent involvement of ES officers has in turn led to greater understanding by ES of how learning works in practice on the ground (e.g. community learning settings).

4.58 Some criticisms were made and challenges identified relating to the short timescales for applications and funding approvals, and delays Phase 1 to Phase 2. Some negative feedback was also given in relation to partial grant awards and the limited explanation as to the rationale for this. One project that did not bid for Phase 2 funding felt that the set-up time under Phase One, without being able to take it forward at Phase 2, meant the project was very piecemeal and too small a scale to be very beneficial.

4.59 Some have also been concerned that whilst Round One projects were invited at the local authority and national level only, in Round 2, schools have also been able to apply directly. One consultee noted this has made it more difficult for local authorities to know when a school is running a project until after the fact in some instances, although it is also worth noting that applications were only processed by Education Scotland once they were signed off by a senior manager in a local authority to avoid this scenario. There have been some other cases where a project, rather than Programme approach has led to frustrations regarding duplicated efforts (e.g. two organisations doing similar scoping activities) or where more than one organisation was delivering similar activity in the same location.

4.60 Key programme management points are:

- The Round One Grants have been welcomed by the successful project applicants, with the funding supporting additional activity that otherwise could not and would not have been funded in the vast majority of cases;
- Some grant administration issues negatively impacted on project delivery timescales, especially those requiring set-up including recruitment of staff or researchers;
- A more programmed and communicated approach would avoid the potential for duplication of activity and effort which was identified in a small number of cases; and
- Education Scotland officer support was praised and extremely welcome, especially by less experienced applicant organisations.

Summary

4.61 The review of Round One projects reveals a wide range of project activity, which on the whole has been successful at reaching more practitioners, and in ways that suit the practitioner and their situation. There has been a dominance of online approaches as a way of increasing reach, and these have been effective, although they still require upfront work to engage practitioners and organisations, including local authorities and they are most effective when accompanied by outreach and positive practitioner engagement.

4.62 There is strong evidence that the STEM CLPL grants have been valued most where STEM confidence is lower, notably amongst generalist primary school teachers, early learning and childcare practitioners and those involved in community learning. As such, ongoing support may be needed to maintain and fully embed confidence instilled through the Round One projects. However, there are encouraging signs that the new networks are emerging and that practitioners are coming together to share resources, approaches and learning in relation to the delivery of STEM learning.

5 Programme benefits, challenges and impacts

Introduction

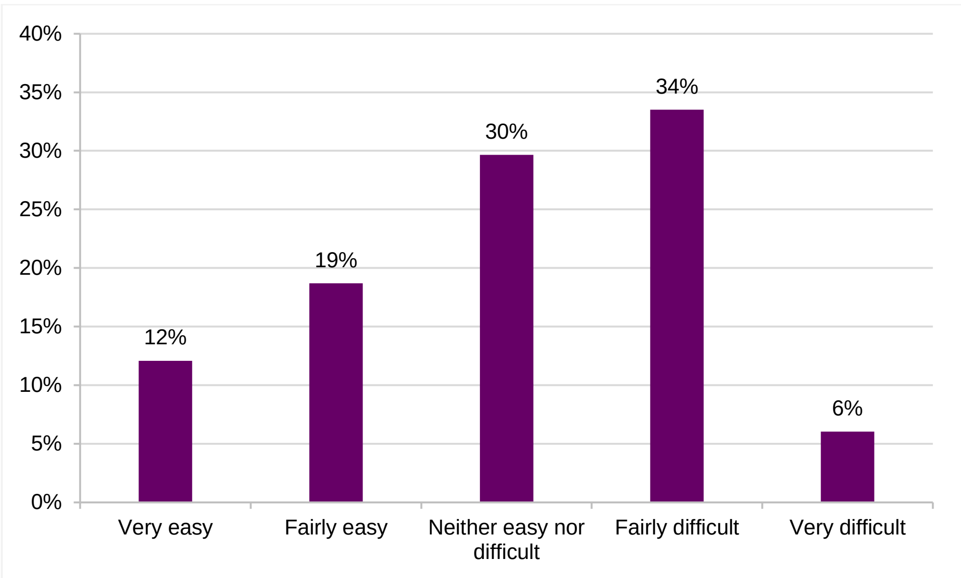
5.1 This chapter draws on the findings from the online surveys with practitioners and end beneficiaries and reports on the programme's benefits, challenges and impacts thematically following the STEM Strategy's key aims of Excellence, Equity, Inspiration and Connection.

Improving access to STEM professional learning

Prior professional learning

5.2 Prior to undertaking the STEM professional learning supported by Education Scotland, many STEM practitioners found it difficult to access professional learning. Around 40% of respondents reported difficulty in accessing CLPL. For primary school respondents, this was 47%, and 40% for secondary school respondents. There was a more even spread in terms of ease for those in ELC. CLD respondents were split in terms of ease of access, although 7% found it very difficult.

Figure 5.1: Ease of access to STEM professional learning prior to Education Scotland-supported training

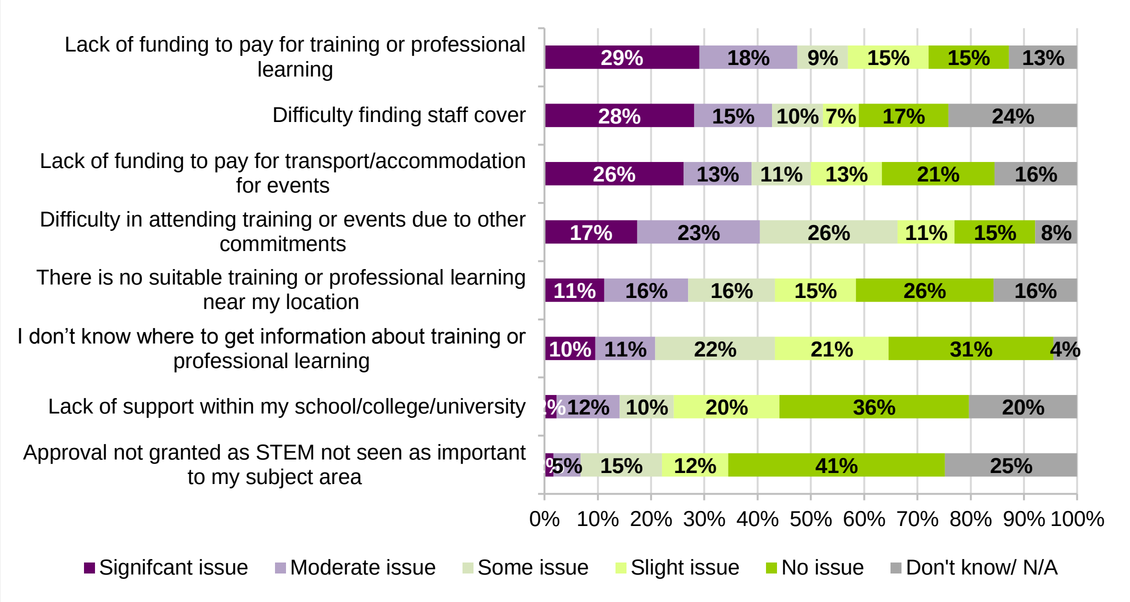


ekosgen survey of practitioners, 2020 (N=182)

5.3 Timing of courses was an issue for a lot of respondents. Often, this meant participants could not find adequate cover to attend sessions – 43% of respondents reported this. Around 40% of respondents could not access, or had difficulty, due to prior work commitments.

5.4 The location of training was also an issue (27%), particularly for those located in more remote areas as they would have to travel a long distance, often at inconvenient times. For some, there was a lack of awareness about what was on offer.

Figure 5.2: Barriers to accessing prior STEM professional development



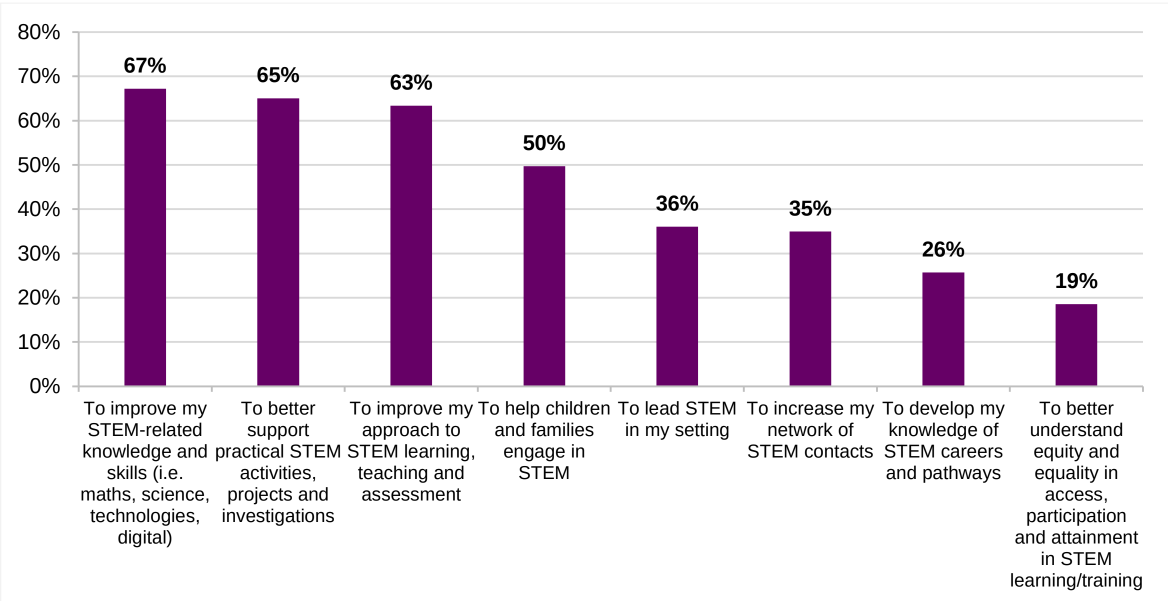
ekosgen survey of practitioners, 2020 (N=180)

5.5 Frequency of training tended to be a few times a year at most (31% of respondents), or never (27%). Only 12% accessed training regularly. For those who undertook online learning supported by ES, 26% had never accessed training previously, with a further 45% only accessing once/twice a year or every few years.

Motivation

5.6 Improving capability, skills and expertise is a major driver for undertaking the ES-supported STEM professional learning. More than two thirds of respondents (67%) reported that they did so to improve their STEM-related knowledge and skills. Improving approaches to teaching and the ability to support practical STEM activities were similarly important (65% and 63% of respondents respectively).

Figure 5.3: Motivations for engaging with Education Scotland-supported STEM professional learning



ekosgen survey of Practitioners, 2020 (N=183)

5.7 An important factor for primary school respondents was to better support practical STEM activities (77%), and to improve STEM knowledge (74%). Helping children and families was also significant (47%).

5.8 Better supporting practical STEM activities and improving STEM knowledge were also important factors for secondary school respondents (67% and 69%), while 75% of CLD practitioner respondents wanted to better understand equity and equality in access, etc. ELC STEM practitioners' main motivation was to increase their network of contacts (70%).

Prior skills and capabilities

5.9 Self-assessment of skills and capabilities by practitioners overall prior to engaging with ES-supported professional learning was reasonable. Most practitioners rated their capability as fair across most competency areas. For creating engaging and motivating learning experiences for learners, and learning, teaching and assessment, the most common rating was good or very good. However, practitioners most frequently reported that they were poor or very poor at engaging families, parents and communities (Table 5.1).

Table 5.1: Skills, knowledge and practice prior to learning

	Very good or good	Fair	Very poor or poor	Not relevant
Creating engaging and motivating learning experiences for learners	44%	41%	14%	1%
Learning, teaching and assessment	40%	34%	23%	2%
Improving learner attainment and outcomes	38%	40%	20%	2%
Pedagogy	37%	37%	20%	6%
Developing learners' skills in a progressive way	36%	38%	23%	2%
Collaborating with peers to share practice and learn with each other	33%	35%	31%	2%
Leading STEM in your settings	31%	30%	33%	6%
Knowledge and access to resources and support	31%	38%	30%	1%
Supporting practical enquiry, investigative work and STEM projects	26%	45%	26%	3%
Bring knowledge of STEM careers and pathways into learning	24%	36%	31%	8%
Improving progression in learning across transitions and sectors	23%	39%	29%	9%
Engaging parents, families and communities	22%	27%	45%	6%

ekosgen survey of practitioners, 2020 (N=162)

5.10 For ELC and Primary practitioners, who were the most engaged practitioner groups, there is a somewhat different picture. For ELC practitioners, fewer rated themselves as good or very good, with greater proportions self-assessing as fair (Table 5.2).

5.11 In contrast, Primary practitioners were somewhat more likely to more positively rate their competency prior to engaging with the professional learning than ELC practitioners, but in general still rated themselves less positively than overall. The one area where primary teachers were more likely to rate themselves as good or very good versus practitioners as a whole was in pedagogy (46% v. 37%; Table 5.3).

Table 5.2: Skills, knowledge and practice prior to learning: ELC practitioners

	Very good or good	Fair	Very poor or poor	Not relevant
Leading STEM in your settings	26%	35%	35%	4%
Learning, teaching and assessment	26%	43%	22%	9%
Collaborating with peers to share practice and learn with each other	26%	39%	26%	9%
Developing learners' skills in a progressive way	26%	48%	17%	9%
Creating engaging and motivating learning experiences for learners	26%	52%	17%	4%
Knowledge and access to resources and support	22%	35%	39%	4%
Pedagogy	17%	35%	26%	22%
Supporting practical enquiry, investigative work and STEM projects	17%	43%	30%	9%
Engaging parents, families and communities	17%	43%	39%	0%
Improving progression in learning across transitions and sectors	17%	39%	22%	22%
Bring knowledge of STEM careers and pathways into learning	13%	39%	22%	26%
Improving learner attainment and outcomes	13%	52%	26%	9%

ekosgen survey of practitioners, 2020 (N=162)

Table 5.3: Skills, knowledge and practice prior to learning: Primary school practitioners

	Very good or good	Fair	Very poor or poor	Not relevant
Pedagogy	46%	45%	22%	1%
Creating engaging and motivating learning experiences for learners	45%	39%	16%	0%
Learning, teaching and assessment	39%	40%	21%	0%
Collaborating with peers to share practice and learn with each other	28%	34%	37%	0%
Leading STEM in your settings	27%	25%	42%	6%
Improving learner attainment and outcomes	27%	46%	25%	1%
Knowledge and access to resources and support	24%	42%	34%	0%
Developing learners' skills in a progressive way	22%	40%	36%	1%
Supporting practical enquiry, investigative work and STEM projects	22%	46%	30%	1%
Bring knowledge of STEM careers and pathways into learning	22%	40%	36%	1%
Engaging parents, families and communities	18%	19%	58%	4%
Improving progression in learning across transitions and sectors	16%	42%	37%	4%

ekosgen survey of practitioners, 2020 (N=162)

Excellence

We will promote **Excellence** by:

- Improving the supply of STEM talent into the profession
- **Improving STEM learning and teaching, and delivering enhanced professional learning**
- Prioritising STEM in the expansion of apprenticeships
- Maintaining our research excellence in our universities

Scottish Government (2017) STEM Education and Training Strategy for Scotland

5.12 The Round One projects have made a very considerable contribution to the Excellence aim, notably improving STEM learning and teaching and delivering enhanced professional learning. It has achieved this in a number of ways.

5.13 It has improved the quality of materials available to STEM practitioners, including new content (e.g. Forth Valley College's online resources, Glasgow City Council's expanded primary STEM leader project, Game Jam coding events delivered by West College Scotland). This has often been engaging and stimulating new interactive content for use by STEM practitioners in the classroom, and also in non-teaching settings (e.g. North Ayrshire Saturday coding clubs). Practitioners are also more aware of the availability of this resource:

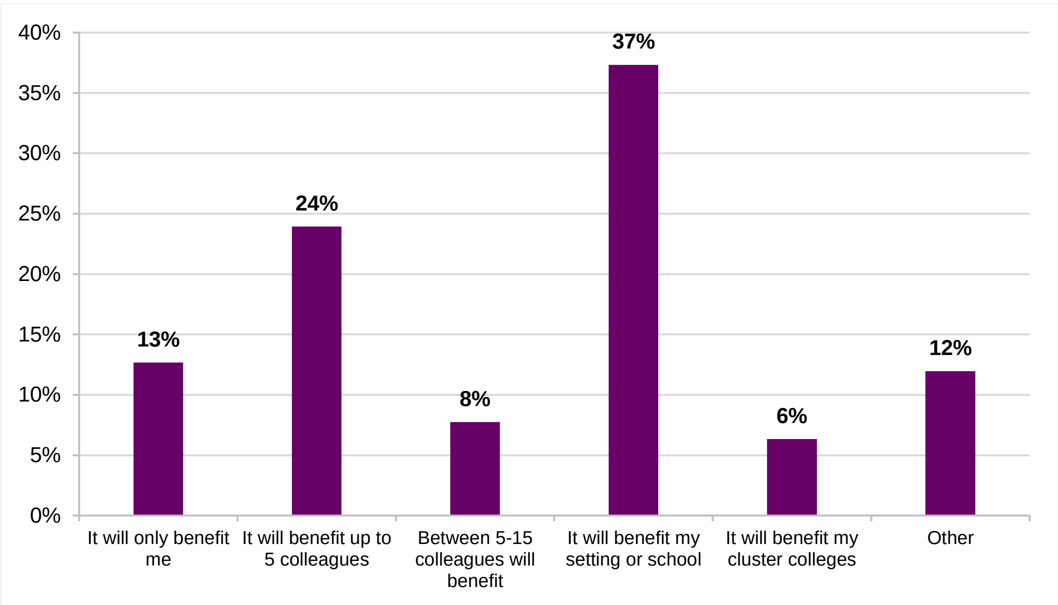
> *"[I know] what resources are out there." [CLD practitioner]*

5.14 The Education Scotland-supported professional learning has helped to broaden access. Firstly, it has also extended professional learning content to a wide range of practitioners who would not otherwise have accessed STEM CLPL, for example the Dynamic Earth project which translated existing face-to-face creative STEM content into e-learning (with new and enhanced content too). This achieved much greater reach than participatory workshops could have done.

5.15 Secondly, it has helped to bring a wide range of sectors into contact with STEM professional learning, including groups that would not otherwise have received STEM CLPL. Notably this includes ELC practitioners (e.g. Scottish Childminders' Association, New College Lanarkshire) and those in community learning (Youth Scotland, Aberdeenshire-led community learning project).

5.16 Third, by using STEM experts and practitioners who have benefitted from learning to cascade STEM learning more widely through school clusters, the learning and value that can be drawn from this has been pushed more widely. This includes the use of experts in physics and chemistry (e.g. drawing on the support of professional institutions, an added benefit of the projects delivered by the Institute of Physics and the Royal Society of Chemistry for example). This has been most effective with primary school practitioners. The majority of surveyed practitioners reported that it would bring benefits to their colleagues (32%) and educational settings (43% in total); only 13% felt that it would only benefit them individually.

Figure 5.4: Wider benefit from cascading of knowledge gained through supported professional learning



ekosgen survey of practitioners, 2020 (N=142)

5.17 This broadened access and increased cascading of knowledge is raising engagement across education settings:

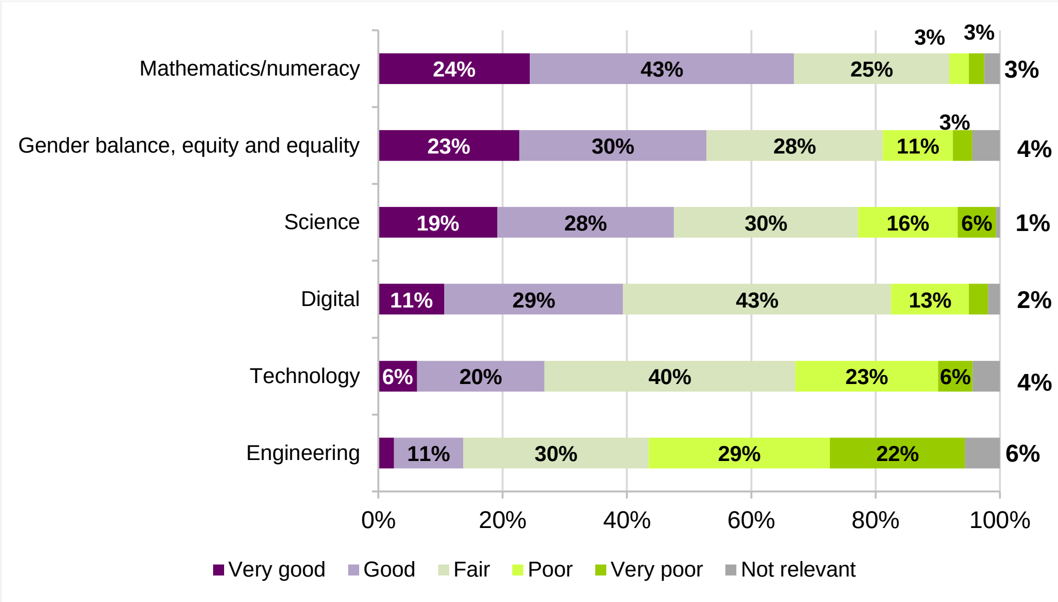
"Whole school engagement across all curricular areas is occurring all the time due to better staff understanding of how STEM can be implemented in lessons." [ASN teacher]

5.18 Delivered projects have also helped to increase the recognition of accreditation in STEM CLPL. For example, New College Lanarkshire have moved towards accredited units in STEM in childcare, and STEM CLPL accreditation via the Childminders' project. Similarly, the Youth Scotland project has led to the professionalisation of STEM CLPL into its awards structures (including for young leaders). CLPL projects are also able to apply for Education Scotland Programme Endorsement. Endorsement provides those who commission programmes, as well as those engaging in professional learning, assurance that programmes offer relevant, significant and sustained quality learning. Such experiences develop depth of professional learning, knowledge, skills and understanding which ultimately impacts on the quality of learning.

5.19 Finally, projects have also enabled practitioners to bring non-teaching STEM expertise (e.g. IT departments and ICT expertise) into STEM learning environments (e.g. North Ayrshire through its mobile STEM hub).

5.20 The impact this has had is well-evidenced by the practitioners themselves. Self-assessment of STEM skills across a range of STEM disciplines shows improvement in capability after training versus before training (Figures 5.5 and 5.6).

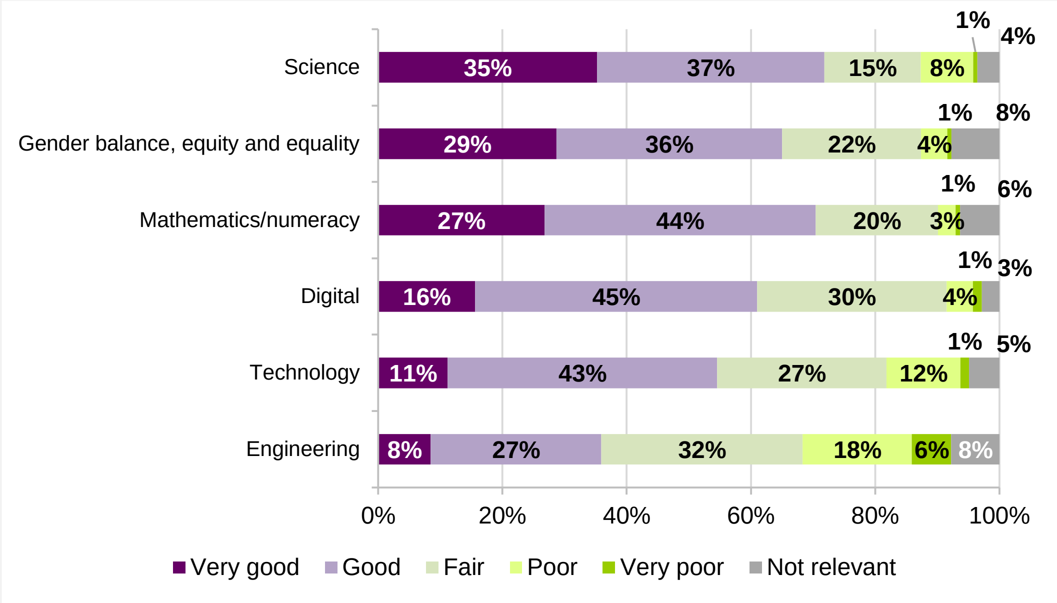
Figure 5.5: STEM skills prior to engaging



ekosgen survey of practitioners, 2020 (N=162)

5.21 All disciplines showed improvement. However, the reported improvement was greatest in science, where there was a 25 percentage point increase in practitioners that reported their skills in science were either good or very good. Whilst the proportion of practitioners that reported their skills in Engineering were either good or very good almost trebled with a 22 percentage point increase, this was the only discipline where the proportion reporting good or very good skill levels after learning remained under 50% (35% reported this was the case).

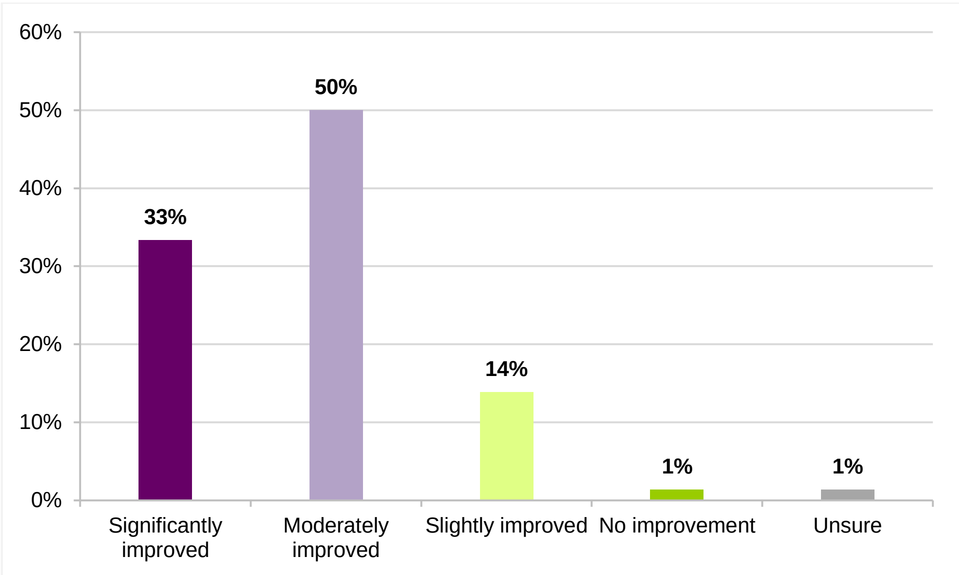
Figure 5.6: STEM skills after engaging



ekosgen survey of practitioners, 2020 (N=162)

5.22 Around 88% of respondents felt that their training moderately or significantly improved their capabilities with regard to STEM teaching (Figure 5.7). Around 96% of face-to-face ongoing learning respondents felt this, compared to 81% single face-to-face and 69% online learners.

Figure 5.7: Improvement in STEM teaching capabilities



ekosgen survey of practitioners, 2020 (N=144)

5.23 A range of improved competencies and specific skills were reported by practitioners (Table 5.4). Increased confidence was the most highly reported skill following engagement with STEM learning (81%):

> *"Through [my supported professional learning], I have improved confidence that I am delivering high quality teaching and can further improve…The idea that I can make subtle changes/improvements is quite a boost." [Secondary school teacher]*

> *"[It] gave me confidence in my own skills which was probably the most important aspect and also the motivation to update my skills in this area…raising the profile of STEM in*

CLD has given me the confidence to develop learning plans that I might not otherwise have done and to seek out more training opportunities." [CLD practitioner]

"I previously had studied Physics at university but hadn't used the degree since leaving uni some 24 years ago, so I felt quite rusty. The sessions I attended gave me back my confidence and enabled me to teach children from my knowledge as well as new ideas." [CLD practitioner]

"My confidence dealing with other practitioners and understanding how the benchmarks are used across different sectors has increased significantly. Learning and sharing with others has helped and knowing your skill level in an area can help others in the group makes you feel valued." [ASN teacher]

5.24 Good or very good communication and problem-solving were also reported by more than three-quarters of respondent practitioners. Additionally, around 73% of respondents felt that their adaptability, focus, creativity and critical thinking were either good or very good following their STEM learning. Examples include greater confidence to deliver specific practical lessons (i.e. in coding), and in the use of additional, practical learning resources.

Table 5.4: STEM skills, knowledge and experience following learning

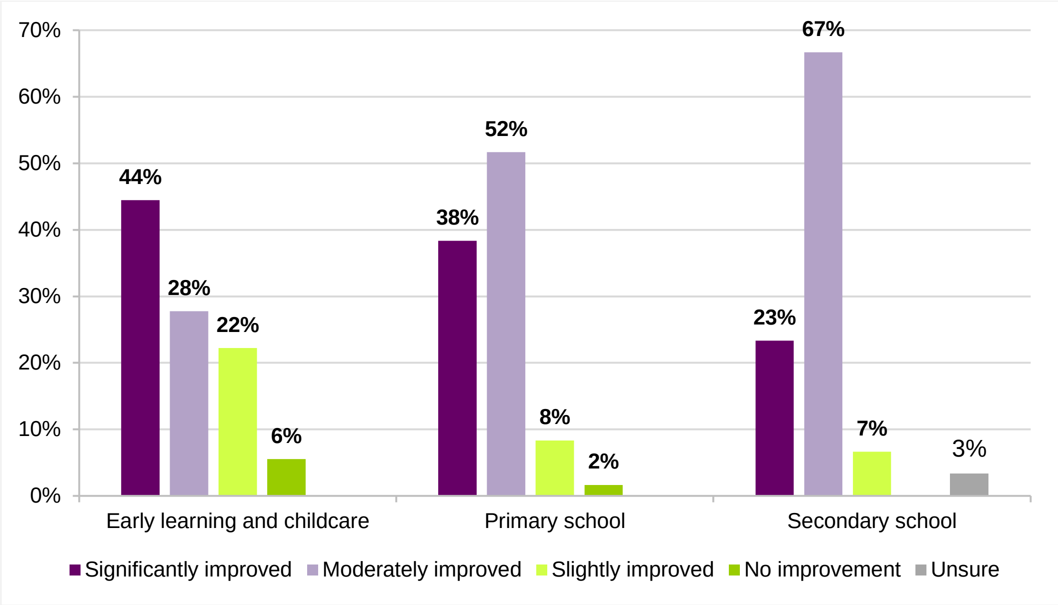
	Very good or good	Fair	Very poor or poor	Not relevant
Confidence	81%	12%	5%	2%
Communication	79%	14%	4%	4%
Problem-solving	76%	16%	3%	6%
Adaptability	73%	19%	3%	4%
Focus	73%	18%	4%	6%
Creativity	73%	18%	6%	2%
Critical thinking	73%	18%	3%	6%
Team-working	71%	15%	5%	9%
Innovation	69%	23%	6%	3%
Leadership	63%	24%	4%	9%

ekosgen survey of practitioners, 2020 (N=143)

5.25 Primary practitioners specifically were more likely to report improved confidence (85% reported good or very good confidence), as well as improved leadership – 78% reported this as being good or very good, some 15 percentage points higher than overall. ELC practitioners were more likely than overall to report good or very good problem-solving (83%), but much less likely to report good or very good team-working.

5.26 As demonstrated by Figure 5.8, the improvement in teaching capability was greatest amongst ELC and Primary practitioners. A greater proportion of each reported significant improvements in their capability. Secondary school practitioners were more likely to report moderate improvement, a finding to be expected given that they are subject specialists and therefore more likely to already have a degree of confidence in STEM teaching.

Figure 5.8: Improvement in STEM teaching capabilities by sector



Source: ekosgen survey of practitioners, 2020 (ELC=18, Primary=60, Secondary=30)

5.27 Importantly, the STEM learning accessed has helped to improve a range of meta-skills. More than three quarters of respondents reported that their knowledge and access to resources and support (78%), and skills in creating engaging and motivating learning experiences for learners (77%) were either good or very good. The majority of respondents reported good or very good skills in a range of other meta-skills; only engaging parents, families and communities did less than half report good or very good capability.

Table 5.5: STEM skills, knowledge and experience following learning

	Very good or good	Fair	Very poor or poor	Not relevant
Knowledge and access to resources and support	78%	16%	5%	1%
Creating engaging and motivating learning experiences for learners	77%	17%	4%	1%
Supporting practical enquiry, investigative work and STEM projects	73%	16%	7%	4%
Collaborating with peers to share practice and learn with each other	72%	16%	6%	7%
Improving learner attainment and outcomes	68%	21%	8%	3%
Learning, teaching and assessment	67%	22%	4%	7%
Developing learners' skills in a progressive way	67%	21%	10%	2%
Pedagogy	64%	23%	6%	7%
Leading STEM in your settings	56%	23%	10%	11%
Bring knowledge of STEM careers and pathways into learning	53%	31%	5%	10%
Improving progression in learning across transitions and sectors	50%	26%	10%	13%
Engaging parents, families and communities	48%	28%	13%	11%

Source: ekosgen survey of practitioners, 2020 (N=143)

5.28 The online focus group discussions identified further evidence of improvement in skills and capability:

> *"I used my training to develop and deliver a science explorers class for P1-P3 and P4-P7 Children which I delivered in the community centre… I wasn't able to before…as I needed new ideas and how to deliver this to children." [CLD practitioner]*

> *"Importantly, it started us talking about how it links in with skills development and creativity." [Primary school teacher]]*

Equity

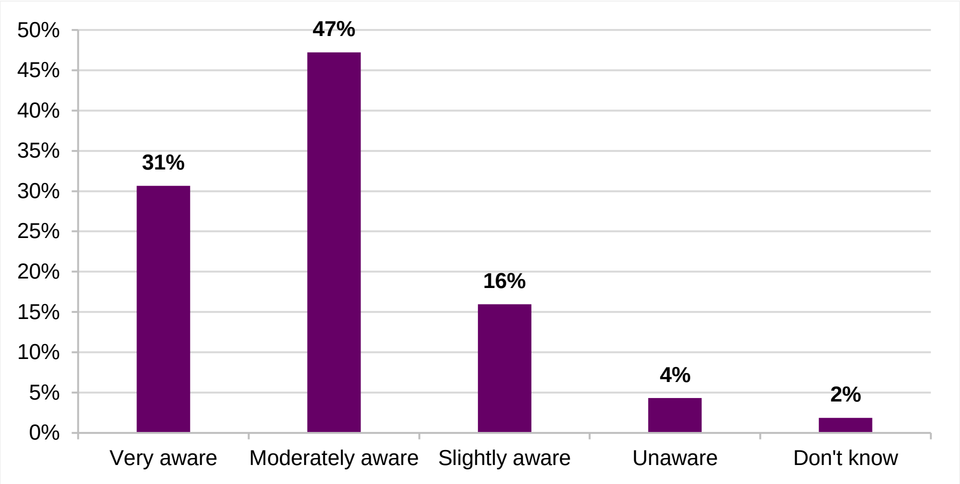
We will promote **Equity** by:

- Tackling inequity in STEM learning and careers
- **Improving participation in STEM further and higher education courses and apprenticeships**
- Increasing access to public science engagement events

Scottish Government (2017) STEM Education and Training Strategy for Scotland

5.29 Prior to undertaking the STEM Grants Programme-supported CLPL, respondents reported an already reasonably good level of general awareness of equity and equality issues with regard to STEM education. Around 78% were already very or moderately aware, with only 4% unware. CLD, primary and secondary respondents were more aware than the others at 88%, 79% and 79% respectively; however, only 18% secondary respondent were very aware of equity and equality issues.

Figure 5.9: General awareness of equity and equality issues



ekosgen survey of practitioners, 2020 (N=163)

5.30 Nevertheless, the Round One projects have made a strong contribution to the Equity aim of the STEM Education and Training Strategy, notably addressing inequity in STEM learning and careers. The following sections explore this in more detail.

Enabling STEM skills in specific education sectors

5.31 Projects have brought STEM learning to groups of practitioners who do not consider themselves as STEM practitioners or experts, but who are engaging with STEM in everyday professional situations. In particular, Round One projects have brought a greater understanding and awareness of STEM for those in Early Years/Childminding. This is important from the point of view of addressing inequity and inequality at the start of the STEM learning pipeline.

5.32 As detailed in Chapter 4, 99.98% of registered childminders are female, and the project delivered by the Scottish Childminding Association has demonstrated that many childminders are utilising STEM learning in their workplace without knowing it. Others have been encouraged to make greater use of STEM as a result of the project. This has the potential to address perceived gender bias in STEM, by raising awareness of STEM teaching amongst a large cohort of STEM practitioners.

5.33 Based on feedback from practitioners through the survey on online focus group, Round One projects have also instilled greater confidence in primary school teachers, increasing the reach of STEM into more schools for the benefit of more school pupils. Often this has been hand-in-hand with innovative new materials, such as the Forth Valley College Famous Four themselves seeking to break down stereotypes (e.g. Mandy the Maths buff).

5.34 To a lesser extent, Round One projects have contributed to improved participation in FE/HE, with a small number of projects facilitating this. The New College Lanarkshire project, for example, has included work placements in STEM for childcare college students.

Gender inequality

5.35 Some projects have had a specific focus on gender imbalances in STEM education and careers. For example, the #WomenInWellies project in East Ayrshire, which encourages girls to consider STEM subjects and careers.

5.36 However, projects with an exclusive or significant focus on gender issues were relatively limited. Therefore, there was ample scope for more of the Round One projects to have made this a more explicit focus, and helped to tackle gender inequality in STEM learning, and ultimately careers.

Equity, equality and disadvantaged groups

5.37 Supported projects have also brought STEM to deprived areas and to disadvantaged groups, which typically do not take up STEM learning and careers in the same way as other areas. Many of these have focused on doing so through STEM in community learning settings. The South Lanarkshire Family learning project was an example of this, as was the University of Dundee Funds of Knowledge project. Glasgow Clyde College's delivery also focuses on supporting learning in a community context.

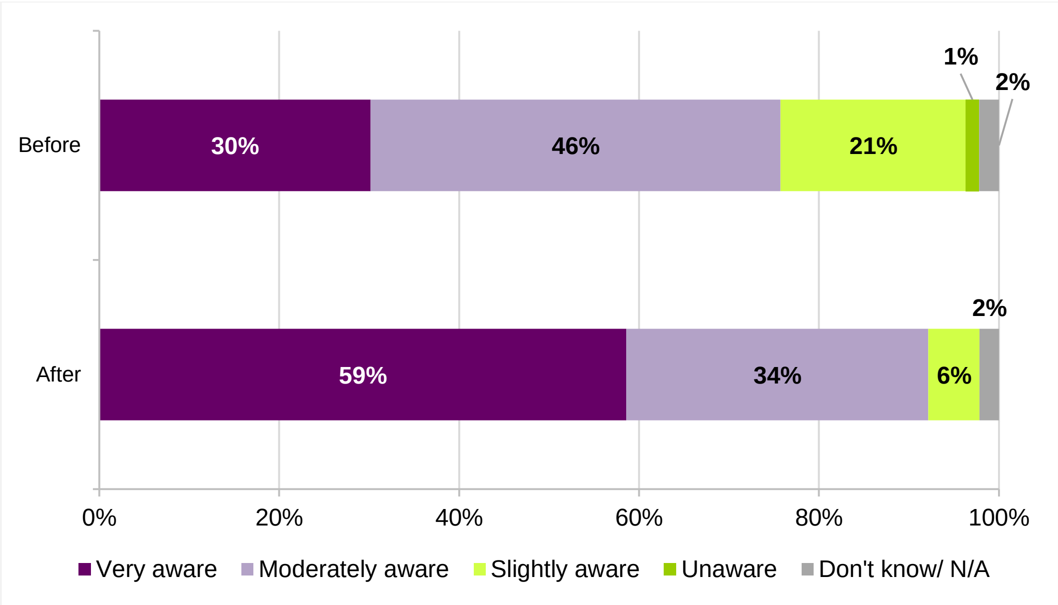
5.38 This aspect of delivery has thus been a strong and successful part of the Round One project portfolio, extending STEM into areas and settings that may not otherwise have been reached.

Proactively ensuring equity and equality in STEM education

5.39 As a consequence of delivery, there has been an overall improvement in awareness of the need to proactively ensure equity and equality issues are addressed in and through STEM education, rather than a more general awareness of issues (Figure 5.10). The proportion of those who are very aware of the need to do so has doubled, from 30% to 59% overall. This is highest amongst primary school STEM practitioners (69%), and CLD practitioners (60%); the latter also demonstrated the largest proportional increase in those who were now very aware (+39 percentage points).

5.40 This suggests that there has not only been an increase in awareness, but also in the confidence to address issues of equity and equality.

Figure 5.10: Recognition of the need to ensure equity and equality in STEM education, before and after professional learning



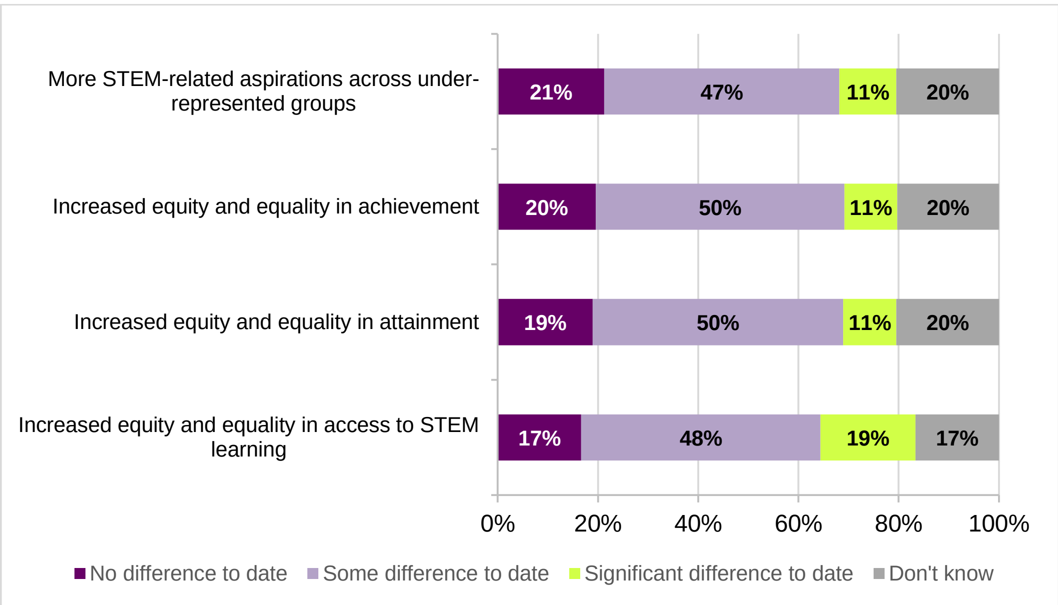
ekosgen survey of practitioners, 2020 (N=136; 140)

5.41 This is reflected in the view of one practitioner:

> *"[I now know] that anyone can do STEM regardless of social background and gender. However we need to encourage girls and low income families into seeing the job opportunities and benefits of STEM careers." [CLD practitioner]*

5.42 More broadly, STEM practitioners report improvement in equity and equality measures (Figure 5.11). For example, more than two thirds (67%) report that there has been increase in equity and equality in access to STEM education for learners. Around 60% also think that there has been improvements in equity and equality in attainment and achievement, and a similar proportion that consider there an increase in STEM-related aspirations amongst under-represented groups.

Figure 5.11: Improvement in equity and equality measures



Source: ekosgen survey of practitioners, 2020 (N=132)

Inspiration

We will promote **Inspiration** by:

- **Creating positive STEM role models, mentors and coaches**
- **Promoting the opportunities and benefits of STEM learning and careers**
- Recognising and celebrating success

Scottish Government (2017) STEM Education and Training Strategy for Scotland

5.43 The Round One projects have also been inspiring in many cases. There are some good project-specific examples of this. For example, the Aberdeen Science Centre-led community learning project has inspired community learning practitioners across the north of Scotland. As a result of this, demand for STEM CLPL continues to grow, and the hands-on and close involvement of the Science Centre liaison officer has greatly enhanced the project. The project is inspiring practitioners across the eight north of Scotland local authority areas.[42]

5.44 Other projects have also inspired practitioners. By supporting practitioners with professional learning for example, the Royal Chemistry Society has provided positive mentor and other support to early career Chemistry teachers to good effect, maximising the benefit of its member base. CLD practitioners have also been particularly enthused:

> *"With such a wide remit we can't be all things to all people [in CLD] and I think that it did meet the remit of inspiring us to take the next step ourselves." [CLD practitioner]*

5.45 Many projects have been inspiring young people to engage in STEM learning through motivated practitioners and high quality content/resources. The Forth Valley College Famous Four (and related outreach support) is a very good example of this. The approach taken by the Four is inspiring primary school practitioners, which is in turn engaging and inspiring learners at a crucial early stage of education. Other good examples include the North Ayrshire coding clubs/wraparound support, and the Dynamic Earth project. Similarly, as discussed above, projects upskilling those in early years and childminding to deliver more STEM-related learning in family home, outdoor and nursery settings is serving to inspire practitioners and young learners alike to engage in more STEM learning.

5.46 The majority of projects have been about inspiring more STEM learning and activity amongst practitioners, giving them the confidence to do more, rather than an overt focus on preparing learners for STEM careers. This has partly been a result of a strong focus on Early Learning and Childcare and Primary learners, rather than Secondary school or later. Some projects (e.g. Women into Wellies) have targeted greater awareness of STEM careers, but most of the project activity has been about breaking down barriers to STEM learning at lower age ranges. For New College Lanarkshire – used to focusing on post-16 and senior phase – the focus on early years was deliberate.

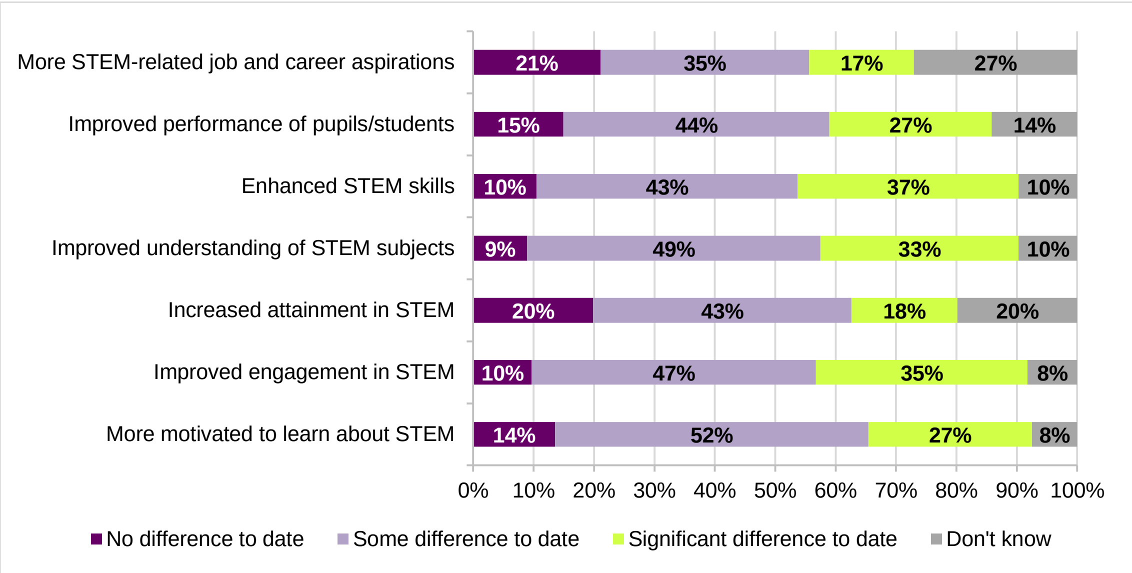
5.47 This has ultimately helped to create a host of STEM leaders and ambassadors, as positive role models for other practitioners and learners. For example, the Glasgow City Council primary STEM leaders project is a good example of this, with STEM leaders galvanising STEM activities and learning amongst school clusters, as has been the work in Highland Council area to ensure STEM professional learning reaches practitioners that would otherwise miss out due to travel times to learning sessions – helping to inspire practitioners in more remote areas. Leadership of and for learning is a key feature of the national model of professional learning. It recognises that leaders in the widest sense understand that people are drivers and enactors of change for improvement. They support and provide time for meaningful engagement in sustained professional learning and development opportunities.

[42] Aberdeen City, Aberdeenshire, Argyll & Bute, Eilean Siar, Highland, Moray, Orkney, Shetland

Inspiring learners: the view from practitioners

5.48 This has resulted in a number of improvements amongst learners as reported by the practitioners surveyed. As Figure 5.12 demonstrates, the change has been considerable. The majority of practitioners report at least some improvement across key measures. Some 37% report enhanced STEM skills amongst their learners. Around one third also report increased engagement with (35%) and understanding (33%) of STEM subject matter. A further 27% report improved motivation and performance of students. This manifests itself in terms of increased enthusiasm of learners in class, better critical thinking in learning environments, and greater uptake in opportunities offered by school around STEM. Importantly, some practitioners report more positive reviews from students and staff about impact of training on them.

Figure 5.12: Improvements amongst STEM learners as observed by practitioners



Source: ekosgen survey of Practitioners, 2020 (N=134)

5.49 For some practitioners, the benefit to the learners, and to the wider learning environment is clear:

> *"I think the benefit is they are learning new ideas and discovering science in a fun environment. The sessions are very interactive which encourages the children to join in not because they have to but because they want to. By the end of the course children were bringing their own ideas into the classes and talking about experiments they were doing at home or talking to their parents about." [CLD practitioner]*

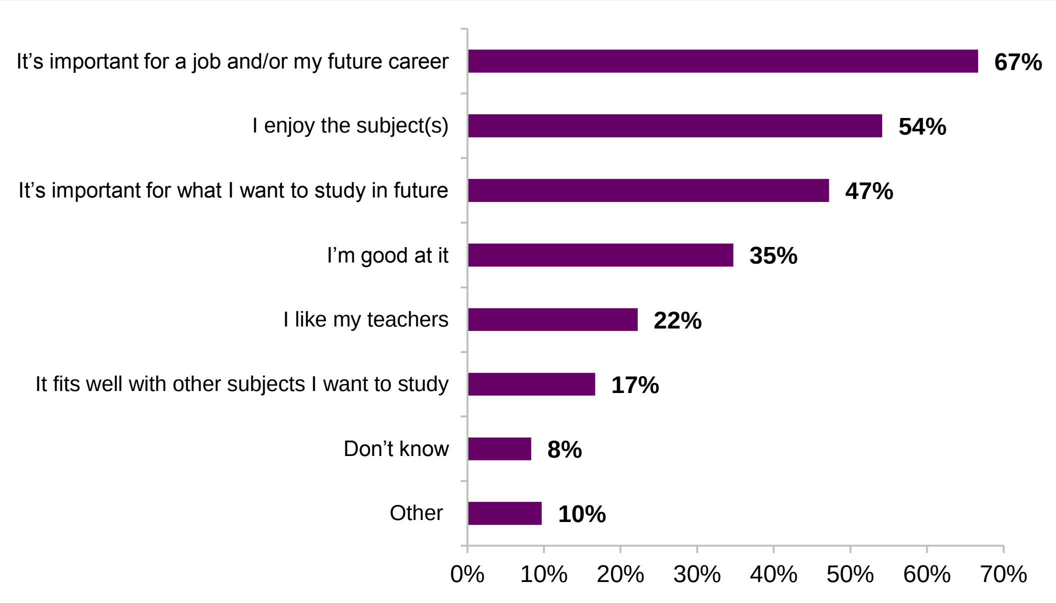
> *"I can see a huge benefit to our whole school in terms of enthusiasm and engagement in STEM." [Primary school teacher]*

> *"Pupils actively ask to be involved in STEM and are enthusiastic to participate on projects." [ASN teacher]*

Inspired learners: the view from the learners

5.50 Evidence gathered from learners themselves through a short survey appears to support this view. Most school and college learner respondents are studying a STEM subject because they recognise its importance for future employment (67%) or learning (47%). More than half do so because they enjoy doing so (54%).

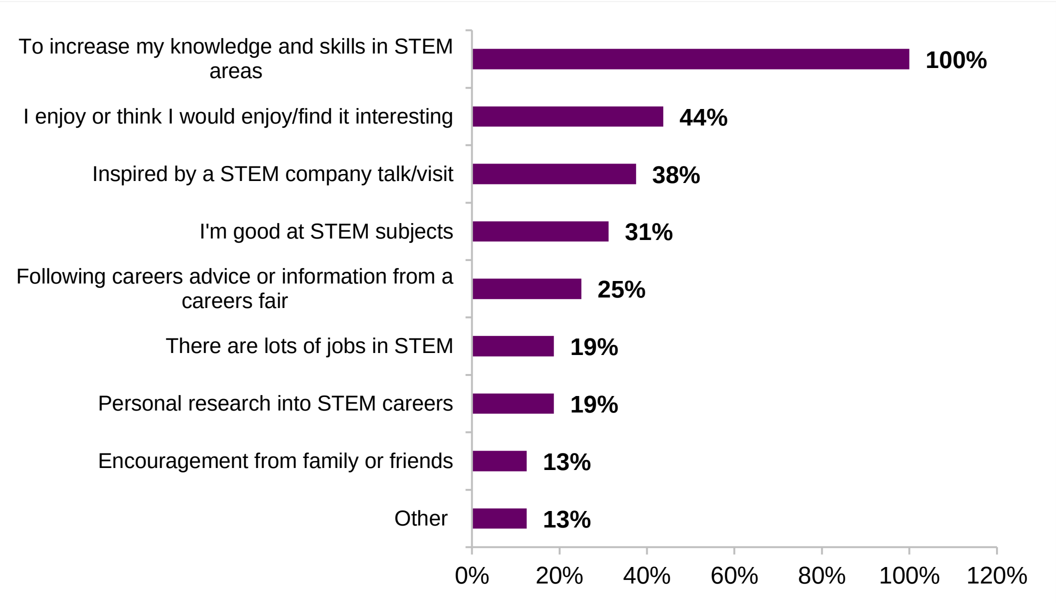
Figure 5.13: Reasons for studying/choosing to study a STEM subject: school/college learners



Source: ekosgen survey of learners, 2020 (N=72)

5.51 Similarly, adults and CLD learners overwhelming choose to study STEM subjects to increase their knowledge and skills in STEM areas (Figure 5.14).

Figure 5.14: Reasons for studying/choosing to study a STEM subject: adult/CLD learners



Source: ekosgen survey of learners, 2020 (N=72)

5.52 However, only a relatively small proportion of learners reported that they think teachers are encouraging or helpful. For school and college learners, this was 27%; for adult learners and CLD learners, this was 19%. This is a challenge recognised by one teacher in particular:

> *"I think it really raised the importance and relevance of the STEM subjects. It has improved my confidence and therefore enjoyment of the subjects. I feel this will feed down to the pupils. Actually, I think most pupils take to these subjects easily and it is our teaching attitude that can be a hindrance if we are not careful." [Primary school teacher]*

5.53 Despite this, many STEM learners reported that they are likely or more likely to pursue a STEM career in future. For those at school and college, 53% reported that they are likely to pursue a STEM career; almost all respondents said they would because they enjoy it or find it interesting (93%), whilst 59% said they would because there are a lot of STEM-related jobs available; another 52% said they would do so because they are good at STEM subjects. Interestingly, 41% stated that they would pursue a STEM career because of family influence.

Connection

We will promote **Connection** by:

- **Improving the support available to schools**
- **Delivering up to date advice and information on STEM careers**
- Increasing the responsiveness of colleges, universities and the apprenticeship programmes to the needs of the economy

Scottish Government (2017) STEM Education and Training Strategy for Scotland

5.54 The Round One projects have promoted connections in STEM learning in a variety of ways. This has been achieved in four main ways.

5.55 First, supported projects have made STEM CLPL more readily available to teachers in schools. Examples range from: Highland, where the Round One project delivered by Highland Council has delivered significant volumes of STEM CLPL utilising their strong digital infrastructure; to the Glasgow City Council STEM in a Context strand delivering support to schools across the West Partnership local authority areas.

5.56 Certain projects have also sought to boost school-specific STEM CLPL. This includes the project delivered by the Institute of Physics, which engaged school-based coaches in school clusters in three rural local authority areas. Other projects have involved partnership and collaborations which have increased access to STEM CLPL for practitioners, including those involving Science Centres, STEM industry institutions and other external organisations.

5.57 Given that the Round One projects have been pilot activities in many cases, projects have had a specific geographic focus or a particular practitioner group as the key target audiences. There were also a relatively small number of projects supported under Round One, and so the connections that have been made, whilst valuable, are not Scotland-wide or across all practitioner groups. However, there is evidence that reach and engagement has been good, and that many practitioners now have a greater understanding of STEM. Further, the projects have arguably sped-up or even instigated the formation of practitioner networks, when this would not have otherwise happened:

> *"…[Y]ou would have to invest a lot of time to put these networks in place. With the professional learning I undertook, this accelerated this aspect and put us in touch with organisations we may not have even considered." [Primary school teacher]*

5.58 Networks for discussion are an important component of self-reflection, and wider reflection within an education setting. These connections are allowing a greater degree of reflection, whether this may not otherwise take place due to resource constraints:

> *"In a department of two experienced chemistry teachers with full timetables, we can find ourselves fixed with how to teach aspects of courses. With the loss of subject specialist Principal Teachers there are less official meetings and discussions for reflecting and discussing practice and planning. By widening the network of educators, we have identified that we as a department are doing some high quality work. Then by reflecting*

on, discussing and taking on board strategies and ideas from a wider network, further improvements can be made." [Secondary school teacher]

"Networking across sectors is challenging as there are different demands on staff and finding time to talk and work together on projects is the barrier. Working as a group through the CLPL allowed Headteachers to see the value in the collaborative work that has happened. It also gave the group time out of class to work productively." [ASN teacher]

"Any chance to get together with teachers of my subject in my authority is extremely valuable. We are able to share ideas about how we teach bits of the course and how we deliver the course more generally (timings, content, class structure, etc.). It reassures us that we all face similar challenges." [Secondary school teacher]

Summary

5.59 The Round One projects have improved access to STEM professional learning by removing barriers to CLPL. There has been some high quality content prepared and high levels of enthusiasm for delivering STEM CLPL that is inspiring STEM practitioners, notably in Early Years, primary schools and community learning.

5.60 In doing so, they have enhanced the confidence and capability of STEM practitioners across the different education sectors. Round One projects have contributed to Excellence, Equity, Inspiration and Connections. Skills, confidence and capability have been enhanced, and learning has been cascaded more widely amongst peers and within settings by beneficiary practitioners. Projects have boosted practitioner confidence; however given low levels of prior confidence in STEM this may need to boosted on an ongoing basis (at least in the short-term).

5.61 Awareness of the need to proactively address equity issues has been increased amongst STEM practitioners. This is supporting an improvement in equity and equality measures amongst learners.

5.62 Projects have inspired leaners to engage more with STEM learning, and this is driving more positive views and aspirations of STEM careers. The have also driven the development of practitioner networks. This is very positive, given that younger learners are those STEM career professionals of the future.

6 Lessons learned and recommendations

Introduction

6.1 This chapter draws conclusions on key learning from Round One projects and makes recommendations for areas to be considered which may enhance the impact and effectiveness of future funding rounds of the STEM Grants Programme.

Key findings and lessons learned

Delivery

6.2 Delivery has covered a wide range of project types and delivery modes. These have been used to target a number of different practitioner groups. Demand and engagement has been particularly high amongst early years and primary school STEM practitioners. Some secondary school practitioners have been harder to engage, though the need for STEM CLPL appears to be lower in this sector.

6.3 Projects have been developed collaboratively, engaging a variety of different delivery partners. Strong levels of partnership working have been demonstrated. Reach and engagement levels were better where the project aligns and works with other STEM delivery organisations and their resources.

6.4 Local authority engagement in delivery has been challenging in some areas, though this is generally where smaller local authorities have limited capacity to deliver, or where supported projects have introduced new ways of working that do not immediately complement business as usual delivery for the local authority. However, there is room to broaden delivery engagement, e.g. into the third sector as part of wider CLD professional learning.

6.5 Round One projects have also broadened the reach of professional learning to new groups of STEM practitioners, and geographies previously less well-served by learning delivery, including areas of deprivation. Improvements in digital delivery has been particularly beneficial for rural and remote parts of Scotland. The specific focus of projects on early years and primary learning is increasing access to STEM amongst young learners.

6.6 A particular point of learning is that the mix of online and outreach has been an effective delivery approach: engagement and enthusiasm driven by the outreach has been supported by access to good quality materials and resources provided through online channels. Such digital resources are an effective means of reaching practitioners where there are time constraints to participation in professional learning. Though geography and timing remain barriers where face-to-face learning sessions are required, these can be overcome to an extent through strong prior engagement and alignment with other events.

6.7 Since much of the delivery of projects has been online, and resources have been made available digitally, many projects are sustainable. It is notable that projects that can easily be scaled up have low-cost resources and equipment. Additionally, with the commitment of a modest increase in resource (e.g. through future rounds of funding), some face-to-face learning delivery could be extended. Alongside this, the cascade of learning will continue the reach of project delivery.

6.8 Some grant administration issues, and challenges associated with the time-pressured nature of Round One delivery may have negatively impacted on some project delivery. However, the degree of additionality associated with the funding is very high – in most cases, activity would not have been delivered without it. Further, support from the Education Scotland regional STEM Education Officers was highly valued.

Impacts and benefits

6.9 Prior to undertaking supported professional learning, many practitioners found it difficult to access STEM professional learning generally. Timing, location, other commitments, funding and lack of cover are all sizeable barriers.

6.10 Though a substantial proportion of practitioners reported a reasonable level of competency across various STEM teaching capabilities, improving STEM-related knowledge and skills and enhancing teaching and practical support were significant drivers to engage with supported professional learning. The impacts and benefits realised by practitioners as a result of engaging with STEM CLPL are discussed below.

Excellence

6.11 By broadening access to STEM professional learning, the programme has extended the reach of training to a wide range of practitioners, including those who would not otherwise have accessed STEM professional learning. It has also improved the quality of teaching materials available to practitioners. Importantly, practitioners involved in Round One projects are cascading knowledge, and helping to upskill peers in their education settings.

6.12 The vast majority of supported practitioners have seen moderate or significant improvements in their teaching capability. At this stage, there is evidence to suggest a reciprocal impact of increased interest and improvement amongst learners (Inspiration, below); it is anticipated that this will continue and the STEM Grants Programme continues to support greater levels of and access to STEM CLPL. This includes their confidence and communication, as well as problem-solving and adaptability. A greater proportion of ELC and Primary practitioners than overall reported significant improvements in their STEM teaching capabilities. Support has benefited the practitioners most where an everyday life or topical science approach is used. The dynamic relationship between learners (the learning of children, young people and adults) and the education professional's learning are deeply connected. Learning should be informed by the learner's experience, voice and needs. In turn, the STEM professional learning undertaken should impact positively on the learners in the classroom.

Equity

6.13 Round One projects have helped to improve awareness of the need to proactively ensure equity and equality issues are addressed in and through STEM education. There has not only been an increase in awareness, but also in the confidence to address issues of equity and equality. STEM practitioners report improvement in equity and equality measures in their learners, including increased aspiration across under-represented groups.

6.14 A number of projects have improved access to professional learning in specific sectors. Practitioners in Early Learning and Childcare and Primary education in particular have benefitted, with projects helping to improve knowledge and confidence in STEM teaching in these sectors.

6.15 Certain projects have brought STEM learning to areas of disadvantage and disadvantaged groups. Rural areas and areas of deprivation have benefitted. However, whilst gender inequity and inequality is a focus of the STEM Education and Training Strategy, only a limited number of projects explicitly deal with gender issues in STEM. This is an area that can receive greater attention in future rounds of funding.

Inspiration

6.16 Round One projects have also been inspiring in many cases. The majority of projects have been about inspiring more STEM learning and activity amongst practitioners, and this has helped to create more confident practitioners, and a cohort of STEM leaders and ambassadors.

6.17 In turn, this is leading to improvements amongst learners. Practitioners have observed increased STEM-related career aspirations and improved performance, understanding and skills, as well as greater motivation to learn. This is corroborated by evidence from learners themselves.

Connection

6.18 Whilst there is not yet any national-scale connection across practitioner groups and between projects, reach and engagement at local/regional level is good. Supported projects have made STEM professional learning more readily available to teachers in schools, and opened up different professional learning avenues to practitioners.

Recommendations

6.19 The following section presents a number of recommendations to improve the design, delivery and management of the STEM Grants Programme and to inform decision making around the appraisal for future rounds of project applications and funding under the programme.

Recommendation 1: Targeting and engagement. There are a number of areas worth consideration with respect to education sectors and other groups.

- There is merit in expanding reach in those education sectors and groups where significant benefit/impact has been evidenced to date through Round One projects, i.e. primary sector and ELC practitioners and where these groups have demonstrated an appetite for STEM learning.
- Consideration of other, more innovative means of engaging with those practitioner groups i.e. secondary teachers and non-teaching staff, which have traditionally been harder to engage for the reasons previously discussed in this report. This could for example be involving secondary sector practitioners in the co-design of a project(s).
- In order to achieve one of the key aims of the STEM strategy of *'to close **equity** gaps in participation and attainment in STEM* there is the ongoing need to ensure a balance of projects targeting all education sectors and geographies.
- Evidence has shown from Round One projects that going forward there is a need for projects in STEM learning to have an explicit focus on addressing gender inequality and also to target and engage with parents, families and communities more directly. There is also scope for extending STEM CLPL into the Third Sector. Experience from both the Youth Scotland and the Aberdeenshire 'Unlocking STEM in CLD' projects suggest that wider engagement with young people and families could be secured by rolling out STEM learning to third sector organisations' staff and client groups.
- Whilst the use of digital learning modes has been very evident across many of the 24 Round One projects there is still work to do to include certain geographies (as highlighted earlier in Chapter 3) not reached in Round One.
- When targeting core practitioner groups in subsequent programme rounds there is the need to ensure that duplication and/or overlap of project content and design is minimised by promoting partnership working at cluster and regional (RIC) levels.

Recommendation 2: Build innovation (in design and delivery) into the project application criteria of future funding rounds. Whilst many Round One projects have delivered innovation in for example, content development, blend of learning modes, delivery models and capacity building, continuing to push the boundaries of how innovative approaches can increase access and participation levels in STEM learning should be a key objective. Thus encouraging applicants to think in a more structured way about 'new' innovation in project engagement methods, content design and delivery should be proactively encouraged.

Recommendation 3: Scalability: Whilst constant innovation in project design and delivery is important so too is identifying and supporting those projects with the potential to be scaled up and rolled out to more and new practitioner groups and geographies. Those Round One projects with the potential to be scaled up include one or more of the following elements:

- Low-cost equipment and resources
- developing tool kits for 'train the trainer' in order to build STEM teaching capacity and roll out STEM learning activities thus widening access and participation
- making use of digital technology platforms
- involving STEM ambassador/leader activity to widen reach and participation levels

All of these elements, individually or in combination, can facilitate project scaling up thus maximising project investment. The potential of a project to be scaled up should be considered at the design stage and this could be considered as a project criteria/theme for the next round of project funding.

Recommendation 4: Consider continued funding for 'successful' projects: For those projects which have reached or exceeded targets and received good evaluative feedback from practitioner/other types of groups and partners, consider continued funding for the project's 'Version 2'. However, the focus of the project design and planning should be on the process and resourcing required for scaling up and rolling-out to wider audiences.

Recommendation 5: Complementarity of projects. There is the potential for organisations to design and plan projects in partnership, within and across RICs, to build national level connections. This will allow for the co-ordination of CLPL activity and can minimise duplication of project content and delivery to the same practitioner groups. It may also allow for progression pathways within CLPL practitioner settings. Whilst having the potential to further increase access to CLPL and also to reach into harder to engage groups, this, in theory, would be a more cost effective use of STEM Grants Programme resources and economies of scale could potentially be achieved.

This type of approach would also build on the current spirit of partnership working by further encouraging cluster and collaborative working across different settings, local authorities and other organisations. It is an important strand of a strategy to embed a consistent, longer-term approach to practitioner capacity building and improvement in STEM access and attainment for learners.

Recommendation 6: Review the funding/process for scoping and designing new projects. Where elements of projects require new resourcing/staffing cognisance of potentially longer project set-up and lead in times is needed. This is especially the case where the recruitment of new staff is required and, in some cases lengthy public sector procedures and processes must be adhered to.

Recommendation 7: Improving performance monitoring and measurement at project and programme level. Whilst we recognise that programme monitoring has evolved and improved for Round Two of the STEM Grants Programme, there are benefits to developing and implementing a more structured approach to both individual and overall programme monitoring. This would involve: developing a suite of relevant project and programme performance indicators across a number of areas/themes and providing project grantees with clear definitions and guidance for data collection. An overarching monitoring system will provide consistency and rigour to data collection and analysis and allow for the provision of a robust evidence base for future planning and decision making.

Closing remarks and next steps

6.20 The Round One projects delivered have helped to realise some strong and tangible benefits. Some learning from Round One delivery has already been reflected in preparations for Round Two. It is anticipated that the full suite of learning and recommendations in this evaluation report will be built into Education Scotland's approach to assessing projects for Round Three delivery, and for any subsequent rounds.

6.21 The next stage of the evaluation will focus on Round Two delivery of funded projects and some aspects of programme management and delivery. The ekosgen team will work with the Education Scotland team to refine the evaluation approach to maximise the learning that can be gained from the next round of delivery.

Appendices

Appendix 1: STEM Grants Programme: Projects Summary

Organisation	Org. type	Brief description of project and delivery	Geography	Delivery mode	Target group	Outputs
Aberdeen Science Centre	Science Centre	Aberdeen Science Centre (ASC) proposes to deliver engaging CLPL sessions on a variety of STEM topics to increase the knowledge, skills and confidence of Early Years practitioners and Primary school teachers in local clusters and across Scotland.	Aberdeen City and Shire	Professional learning sessions	ELC Practitioners	240 practitioners
Dynamic Earth	Science Centre	This project will increase access to innovative CLPL in STEM by adapting successful elements of Dynamic Earth's face-to-face programme for online training. Three modules will be delivered that will inspire creative STEM teaching across Scotland.	National	Online	Primary, ASN, CLD	120 teachers attending events; 300 practitioners completing Creative Science online; 200 practitioners completing modules by March 2020; 500 practitioners completing modules by March 2020
Institute of Physics	Institute	The IOP sets up three hubs, each consisting of six to eight partner school clusters and a lead school. The hubs will enable high-quality bespoke CLPL to strengthen pedagogical and subject knowledge for physics teachers and be the basis of a strong partnership and support function between schools.	Rural	Professional learning hubs	Primary and Secondary	6-8 schools per hub, up to 24 schools
Royal Society of Chemistry	Institute	The RSC will create CLPL opportunities for practitioners to meet, learn together and share expertise. This will enhance the subject knowledge, skills and confidence of educational practitioners, who will deliver chemistry lessons across Scotland.	National	Professional learning support; mentoring	Primary-secondary transition, early career mentoring, secondary teachers	P-ST: 9 secondary teachers, 21 primary, 4.5 day meetings ECM: 40-60 mentors & mentees ST: surveys & 10 phone interviews

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Organisation	Org. type	Brief description of project and delivery	Geography	Delivery mode	Target group	Outputs
Scottish Childminding Association	Prof. body	SCMA and SSERC aim to develop and deliver a range of CPL courses and workshops, supported by additional resource packs, to promote and increase involvement with STEM learning for childminders across Scotland. These will be available nationally, covering early years to primary school age children.	National	Courses and workshops; online resource	Childminders (and parents)	3 courses
Scottish Technicians' Advisory Council	Prof. body	A professional learning course for school technicians will be developed which will specifically link to the use of various data collection, equipment interphases and programs which have become available over the past 10 year with the introductions of technology items such as 3D Printing and Laser Cutting.	National	Professional learning courses	Science Technician Practitioners	2 courses
Youth Scotland	Charity	This programme will upskill primary teachers, CLD practitioners, parents and volunteers in the use of Youth Scotland's Hi-5 STEM activity toolkit. This toolkit contains 50 fun challenges to inspire young people age 5+ to engage in STEM activities and achieve an SCQF level 2 Hi-5 Award to recognise their achievements.	National	Practical workshops	Primary, CLD, parents, volunteers	10 workshops, 200 practitioners
Aberdeenshire Council	Local Authority	A partnership approach to strengthen the understanding and skills of those who work in CLD settings where STEM is relevant to practice through delivery of a learning and development programme, the publishing of case studies relating to STEM activity in the area and an investment in research skills.	Aberdeen City and Shire	Professional learning, focus groups, learning and development programme	CLD practitioners	90+ practitioners

Organisation	Org. type	Brief description of project and delivery	Geography	Delivery mode	Target group	Outputs
East Ayrshire Council	Local Authority	The #WomenInWellies project will support practitioners to encourage girls to consider STEM subjects and careers. Working with partners from STEM and rural sectors, the project will consist of a networking event, online engagement and face to face CLPL.	East Ayrshire	Professional Learning Programme	ELC, Primary, Secondary	Networking event for S3-6 pupils and teachers from two secondary schools, as well as employers and professionals
East Ayrshire Council	Local Authority	The 'SEEDS' programme will inspire practitioners, building their confidence, skills and knowledge in STEM subjects, to create equitable, engaging learning environments for Scotland's children and young people. The programme comprises of networking events, online support and face to face professional learning.	East Ayrshire	Professional Learning Programme	ELC, Primary, Secondary	7 primary, 4 secondary, 5 ELC staff, plus networking event involving local businesses, schools and leaders, and practitioners
Glasgow City Council	Local Authority	STEM Glasgow, at regional level, will expand the Primary STEM Leaders programme to deliver experiential CLPL which builds leadership capacity at school/cluster. In addition, delivery of STEM in a Context sessions for the region will enable practitioners to deliver tailored CLPL at school.	Glasgow City Region	Professional Learning Programme	Primary	35 practitioners
Highland Council	Local Authority	The delivery of STEM CLPL by means of virtual delivery using G Suite with a body of trained STEM Mentors. Sessions would be run at various times, but particularly in the twilight session time when travel for staff in Highland is a barrier to participation in CLPL activities.	Highlands	Online	ELC, Primary, Secondary	350 practitioners
Midlothian Council	Local Authority	Our STEM CLPL programme will work to equip 60 CLD practitioners, third sector staff and volunteers (across Midlothian, East Lothian & Edinburgh region) with the	Midlothian, East Lothian, Edinburgh	Professional Learning Programme	CLD practitioners	60 practitioners

Organisation	Org. type	Brief description of project and delivery	Geography	Delivery mode	Target group	Outputs
		knowledge and confidence to deliver STEM programmes within their settings.				
North Ayrshire Council	Local Authority	A STEM Hub will be implemented in North Ayrshire Council. It will be an inspirational learning space for our educators and STEM Ambassadors to meet, learn and share their expertise. Once implemented, we intend to open our learning events to other local authorities.	North Ayrshire	Mobile STEM Hub	STEM practitioners	30 practitioners
South Lanarkshire Council	Local Authority	Staff will be equipped with the confidence and knowledge of STEM activities through peer and continuous professional learning, and how to maximise opportunities to inspire learners across communities, build their skill sets, and develop new ones, whilst closing the equality gap and growing the learning culture within CLD.	South Lanarkshire	Targeted professional learning & development	CLD practitioners	19 practitioners
Stirling Council	Local Authority	Stirling Council will take a cluster approach to building a strong network of STEM practitioners across all Stirling schools and nurseries. Staff will be supported to involve pupils in an exciting STEM challenge. There will then follow a showcase event to allow staff to share good practice and expand their expertise.	Stirling	Expansion of STEM network	ELC and Primary	80 practitioners
West Dunbartonshire Council	Local Authority	This project aims to increase practitioner confidence in teaching numeracy and mathematics through different STEM contexts. A variety of resources will be developed and a professional learning package for practitioners delivered to support this aim.	West Dunbartonshire	Online learning resources	Primary, Secondary	Professional learning sessions and online resources

Organisation	Org. type	Brief description of project and delivery	Geography	Delivery mode	Target group	Outputs
		Practical resources can also be shared using an online STEM platform.				
College Development Network	FE/HE	A pilot project bringing together a range of partners to deliver STEM CLPL to primary, secondary and college practitioners around the practical application of Internet of Things (IoT) technology; the project covers an introduction to IoT, workplace examples/local issues, and live classroom activities backed by reusable materials and resources.	Aberdeen	Learning and teaching resources, half-day workshops	Primary, Secondary, College	9 workshops
Forth Valley College	FE/HE	Forth Valley College is aiming to create a "community of STEM practice" which will enhance STEM CLPL across the Forth Valley region. This will involve developing new on-line learning materials; facilitating knowledge-exchange events and promoting opportunities for collaborative working between practitioners across business, public and third sector.	Clacks, Falkirk, Stirling	Piloting STEM support materials, KE Events, 3-day course (targeted)	ELC, Primary, Secondary	138 practitioners
Glasgow Clyde College	FE/HE	In Phase I it will develop pedagogical knowledge and skills of CLD and family learning practitioners around delivery of STEM learning in a community context. In Phase 2, building on this, it develops a new credited rated course looking at supporting parents to support children through STEM.	National	One-day workshops	CLD practitioners	3 workshops, 20-25 practitioners in each
New College Lanarkshire	FE/HE	Adopting a multi-agency, collaborative approach this project will support the delivery of a cohesive pipeline of STEM activities from early years to	Lanarkshire	Practitioner engagement (research)	ELC, Primary, Secondary	Telephone and face-to-face consultation, online surveys, school cluster focus groups, workshops and discussion groups

Organisation	Org. type	Brief description of project and delivery	Geography	Delivery mode	Target group	Outputs
		SCQF level 6/7 in the Lanarkshire region by undertaking a scoping exercise and subsequent development of a bank of innovative professional learning aligned to the needs of practitioners.				
University of Aberdeen	FE/HE	This project will investigate the skills and knowledge gaps in STEM education to identify, create and deliver new innovative online career long professional learning (CLPL).	National	Practitioner engagement (research)	All	Discussion sessions, focus groups and short surveys with a range of practitioners
University of Dundee	FE/HE	The Funds of Knowledge STEM programme engages children, families, and communities to develop science capital and promote STEM careers via enhanced STEM.	Tay Cities	Practitioner study groups	Primary, CLD	30-50 practitioners
West College Scotland	FE/HE	A lecturer and Microsoft Innovative Educator Expert Amanda Ford will create a coding CLPL programme. This will develop online resources that teachers can use to run Game Jam events for pupils in upper primary school, and deliver a series of related face-to-face and online training sessions.	Renfrewshire, national	Professional Learning Programme, digital resources, training sessions	Primary	75 practitioners

Appendix 2: Education and attainment in STEM

Overview

This appendix presents and analyses data regarding education and enrolment in STEM. Where possible, data is analysed by gender, Scottish Index of Multiple Deprivation, ethnicity, care experienced, disability and the Scottish Government's Rural and Environment Science and Analytical Services (RESAS) classification (as far as possible as data will allow). As such, it provides an overview of STEM education and skills provision in Scotland, using definitions consistent with those contained within the STEM Education and Training Strategy and its supporting Evidence Base (the latter was prepared by ekosgen in 2017, and refreshed in 2019). It considers current levels of provision in key areas of school and college provision, apprenticeships and university provision.

The analysis set out in this appendix draws on data from the Scottish Qualifications Authority (SQA), Scottish Funding Council (SFC), Higher Education Statistics Agency (HESA) and Skills Development Scotland (SDS) regarding provision, as well as desk research into the range of qualifications available.

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

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

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

Education overview

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

National, Higher, and Advanced Higher level qualifications

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

Scottish Vocational Qualifications (SVQs)

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

SVQs are available at SCQF levels 4 to 11 (SVQ 1-5), meaning they are suitable for learners in a variety of job roles within STEM industries. The qualifications and their content are split by the purpose of the qualification and the needs of the learners, ranging from 'users' to 'professionals'. SVQs are designed to be undertaken by people working or seeking to work in STEM occupations.

National Qualification Group Awards (NQGAs)

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

Higher National Qualifications (HNQs)

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

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

Apprenticeships

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

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

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

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

Professional Development Awards (PDAs)

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

Reflecting the wide range of STEM occupations, a large number of PDAs are available, providing specialist skills in a number of areas and supporting continuous professional development and improved professional practice. PDAs are available at SQCF levels 6-12, with credit values ranging from 16-64 credits, reflecting the level of content in each PDA and the number of learning hours required to complete them.

Degrees

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

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

Schools

Entries and passes

Table A2.1 sets out STEM entries and qualifications for Scottish school pupils from 2016 to 2019.[43] In 2019, there were 144,000 passes at SCQF Levels 3 to 5 (National level), 46,000 at SCQF Level 6 (Higher) and 9,000 at SCQF Level 7 (Advanced Higher). Between 2016 and 2019, there has been a decline in the number of passes at National level (particularly for SCQF Levels 3 to 5) and the pass rate has also declined. In 2018, Scotland's scores in the PISA assessments were similar to the OECD average in science and maths, but above the OECD average in reading.[44]

At National level (SCQF Level 3-5), changes to subject choices, qualifications and examinations implemented through Curriculum for Excellence have meant that, while there is a greater focus on blended and interdisciplinary learning, pupils are taking a more focused number of subjects[45] (generally one fewer). As learners are being entered for less subjects in S4 overall this is likely to have had an impact on the numbers taking and attaining qualifications in STEM-related subjects at National level, though will of course not wholly explain the change in the STEM cohort. It should be noted that some schools are moving to National 5 and Highers over two years for some learners. The latter may involve a bypass of National 5 completely, for some learners. Additionally, there has been a historic trend of declining secondary school pupil population (c.1-2% per annum), though latest data indicates a modest increase in 2018 and 2019.[46] Comparing a single year (2019) with a previous single year (e.g. 2016) is not necessarily that helpful and will be increasingly inappropriate in years to come. Some schools are

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

[44] Scottish Government (2019) *Programme for International Student Assessment (PISA) 2018: Highlights from Scotland's Results*

[45] On average, this is just above six subjects, although some schools still offer seven or eight subjects at National level.

[46] Scottish Government (2018) Pupils in Scotland, 2018; also Scottish Government (2019) Summary statistics for schools in Scotland no. 10: 2019 edition

offering students the opportunity to undertaken non-traditional awards and courses, such as Skills for Work, NPAs and Foundations Apprenticeships, a positive in terms of increasing variety and achievement – albeit not counted in traditional STEM National Qualification pathways.

However, the impact at Higher and Advanced Higher level appears to be less pronounced. The number and proportion of passes and entries in STEM-related subjects at Advanced Higher level remained fairly steady between 2016 and 2019. At Higher level, the number of passes has fallen overall since 2016, and at a greater rate than the decrease in the size of the STEM Higher cohort (Table A2.1).

The pass rates at both Higher and Advanced Higher level fell from 2016 to 2019. For Higher the subjects contributing to the increase in entries were primarily Human Biology and Biology, where entries increased by 4.5% and 2.6% respectively. For Advanced Higher the largest increases in entries took place in Computing Science (27%) and Mathematics (12%).

Table A2.1: STEM entries and qualifications for Scottish school pupils, 2016-2019

	2016	2017	2018	2019	% or p.p.[47] change 2016-2019
SCQF 3-5					
Entries	203,394	198,802	184,456	186,425	-8.3%
Passes	162,525	158,682	143,394	144,036	-11.4%
Pass rate	79.9%	79.8%	77.7%	77.2%	-2.7pp
SCQF 6[48]					
Entries	69,623	69,455	67,492	63,598	-8.7%
Passes	50,559	51,123	49,922	45,667	-9.7%
Pass rate	72.6%	73.6%	74.0%	71.8%	-0.8pp
SCQF 7					
Entries	11,987	12,065	12,328	11,883	-0.9%
Passes	9,286	9,187	9,438	9,051	-2.5%
Pass rate	77.5%	76.1%	76.6%	76.2%	-0.7pp

Source: SQA, 2019

Table A2.2 shows the change in entries and attainment across non-traditional STEM subjects at SCQF Levels 3 to 5. Over the time period, 16% more pupils undertook STEM-related Skills for Work courses, with 21% more pupils completing NPAs in STEM subjects. STEM-related National Certificate attainment fell by almost half over the period (-48%), however overall entries/attainment in non-traditional STEM qualifications grew 4% between 2016 and 2019. Although there has been a decline in entries and attainment in National, Higher and Advanced Higher qualifications across the period, the 4% increase in entries and attainment across non-traditional STEM qualifications subjects suggests a proportion of pupils are still studying STEM subjects. A full list of non-traditional STEM subjects and qualifications can be found in Appendix 4.

[47] Percentage point

[48] Human biology only available at SCQF level 6.

Table A2.2: Non-traditional STEM entries and attainment for Scottish school pupils, 2016-2019

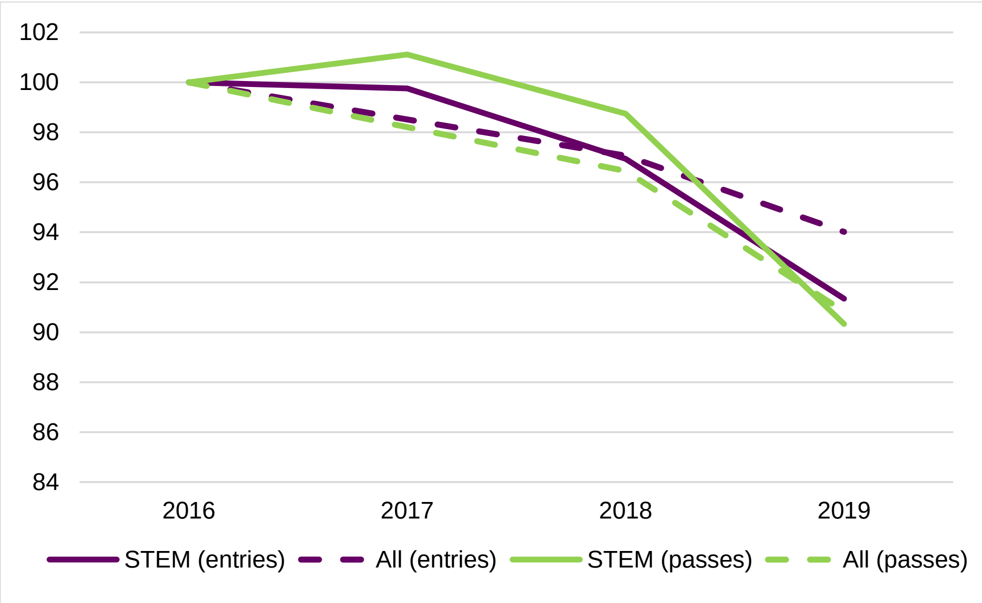
Qualification Type	2016	2017	2018	2019	% Change 2016-19
Skills for Work[49]	3,262	3,179	3,430	3,777	16%
NPAs[50]	2,351	2,519	2,740	2,852	21%
Awards	1	0	4	47	4,600%
National Certificates	1,583	1,067	950	831	-48%
Total	**7,197**	**6,765**	**7,124**	**7,507**	**4%**

Source: SQA, 2019

STEM's relative performance

In line with the overall SCQF Level 6 entry and pass trends in Scotland over the period from 2016, the decline of STEM Higher entries and passes have followed a similar, but more pronounced trend, as shown at Figure A2.1. STEM entries at Higher level fell by 9%, over a period when the number of all Higher entries has fallen by 6%. There is less difference in the trends in terms of the passes, falling about 10% for STEM subjects, and 9% for all subjects.

Figure A2.1: Index of total and STEM entries and passes for Highers, 2016-2019



Source: SQA, 2019

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

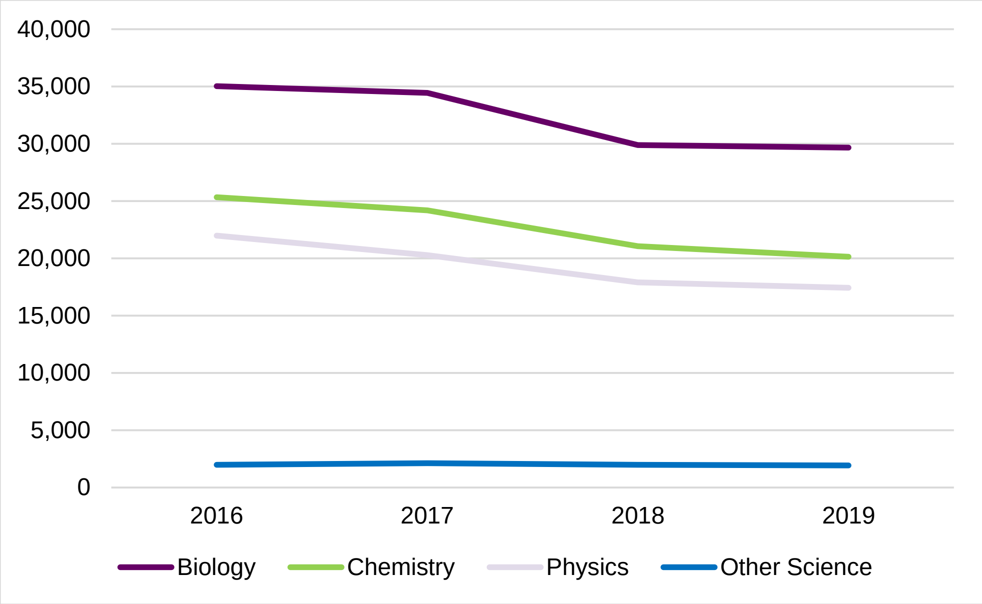
One of the most significant contributing factors to the 11% decline in STEM passes at National level between 2016 and 2019 has been the 23% decline in passes in Computing, with a 16% decline in Physics and Chemistry over this period.

In terms of Science subjects, as shown in Figure A2.2, there has been a 16% decline in passes for *Physics* and *Chemistry* over this period, contributed to by a decline in entries, and a smaller fall in the number of *Biology* passes.

[49] Skills for Work entries are shown.

[50] NPA, Award and National Certificate attainment is shown.

Figure A2.2: STEM passes for Science subjects at National level, 2016-2019[51]



Source: SQA, 2019

It is more difficult to draw specific trends from National level passes in Technology subjects as there have been a number of curriculum changes, including the withdrawal of some subjects and others being newly introduced. However, the overall trend is a decrease in the number of passes in Technology subjects between 2016 and 2019 of around 14% (24,500 to 22,000). This is in the context of a decline in entries over the period of around 7% (30,000 to 28,000).

There has been a notable decline in *Computing Science*[52] passes at National level from 2016 to 2019, over 2,200 in absolute terms and 23% proportionally.

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

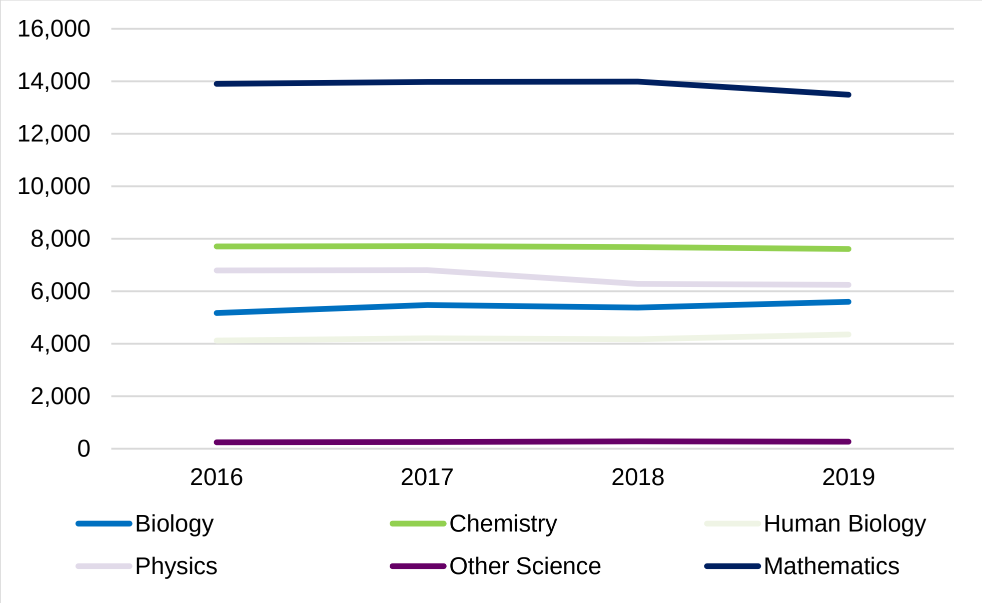
Contributors to change – SCQF Level 6 (Higher level)

A closer look at the data for Science and Mathematics Higher level subjects suggests that there has not been a great deal of change over this period, with small fluctuations for all subjects (Figure A2.3). There has been a slight increase in passes for Other Science (+13% percentage change), Biology (+8%) and Human Biology (+5%), while there has been a small decline in Physics (-8%), Mathematics (-3%) and Chemistry (-1%).

[51] It should be noted that Human Biology is not offered at National level.

[52] This includes Computing, Computing Science, Computing Studies and Information Systems.

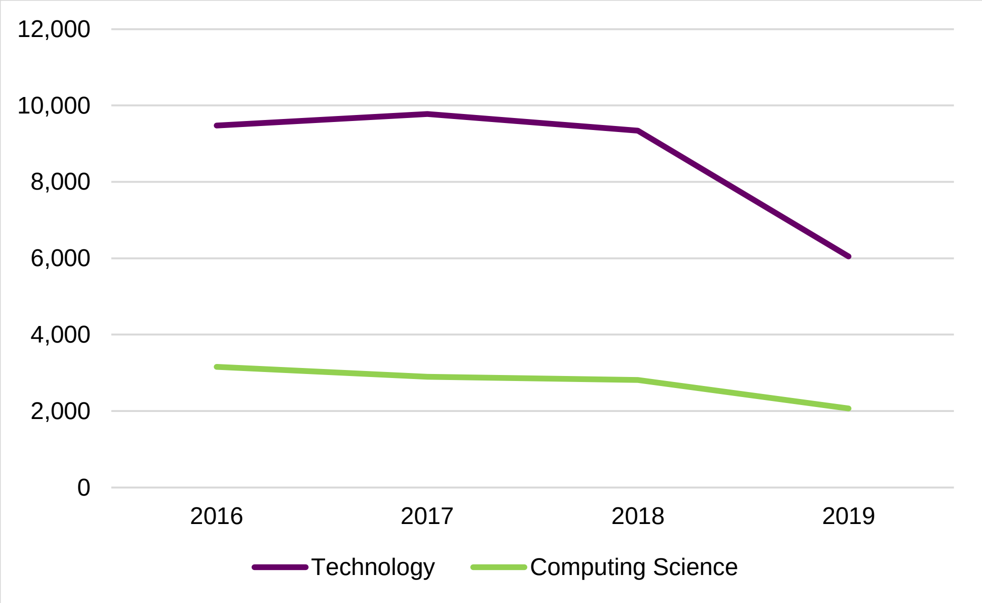
Figure A2.3: STEM passes for Science and Mathematics subjects at Higher level, 2012-2018



Source: SQA, 2019

As with National Level, it is more difficult to draw out subject level trends with Higher *Technology* passes due to changes in subject provision. Figure A2.4 shows that passes for both *Technology* and *Computing Science* have declined over this period (36% and 34% respectively), with a particularly stark decline for Technology between 2018 and 2019 (from 9,300 to 6,000).

Figure A2.4: STEM passes for Technology subjects at Higher level, 2016-2019

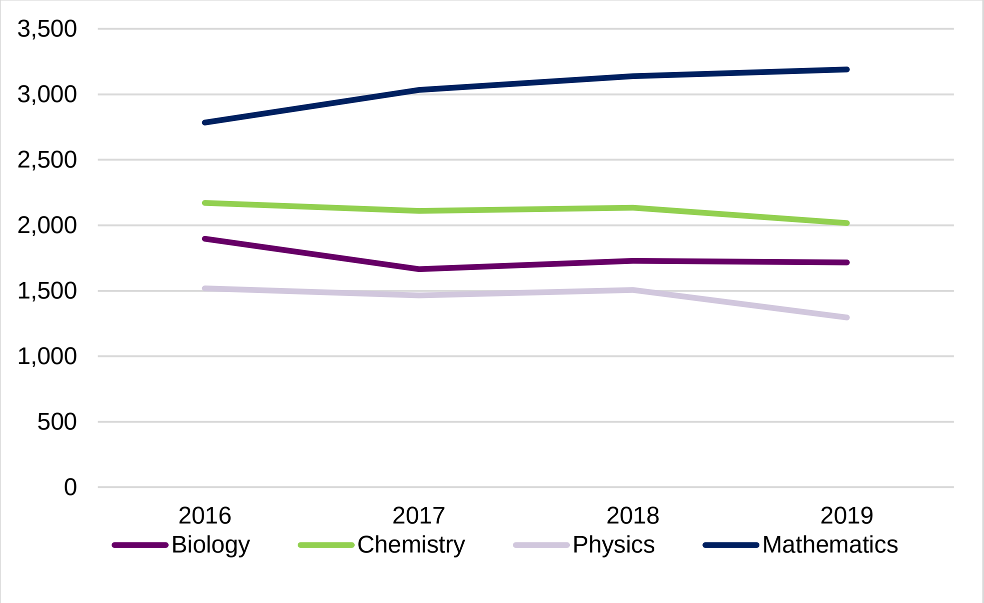


Source: SQA, 2019

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

As shown in Figure A2.5, there has been an increase in passes for *Mathematics* at Advanced Higher level over the period 2016 to 2019 (a 15% increase, or 407) respectively. However, over this period, there were slight reductions in Advanced Higher passes for all other science subjects, particularly so for *Physics* (-15%).

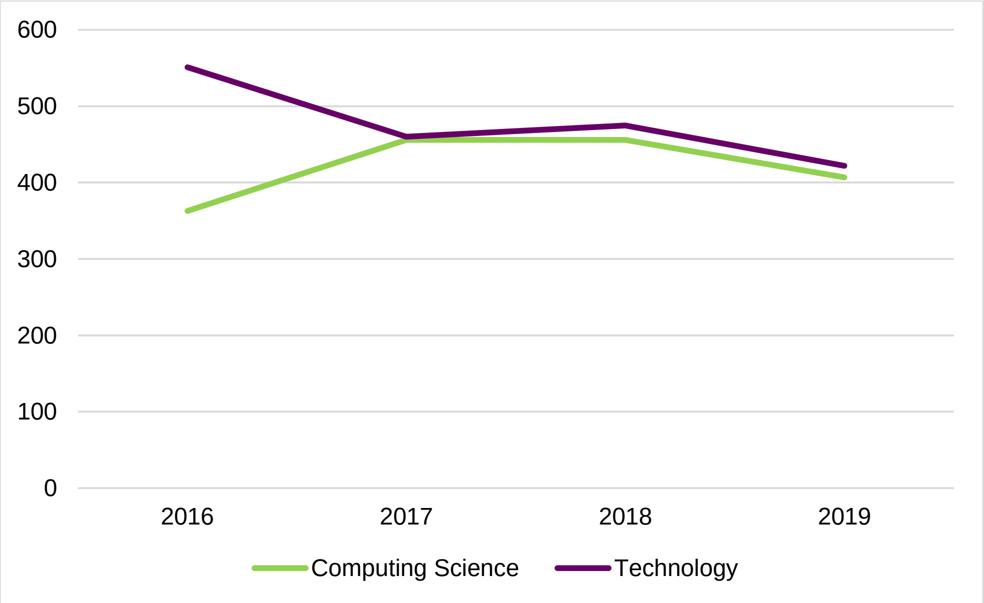
Figure A2.5: STEM passes for Science and Mathematics subjects at Advanced Higher level, 2012-2018



Source: SQA, 2019

As shown in Figure A2.6, there have historically been fewer passes in Technology subjects than Science subjects at Advanced Higher. There has been a notable decline in passes in *Technology*, by 23%, partly due to entries declining by nearly a third. In contrast, the number of *Computing Science* passes grew by 12% between 2016 and 2019.

Figure A2.6: STEM passes for Technology subjects at Advanced Higher level, 2016-2019



Source: SQA, 2019

Profile of learners

Table A2.3 shows that females continue to be under-represented in STEM-related subjects at school. In 2019, 44.9% of STEM entrants were female at National level, 47.3% were female at Higher level, and 45.4% were female at Advanced Higher level. This is lower in comparison to the female entry share for all school subjects at these levels, where female entrants were 51.5%, 56.0% and 56.2%, respectively.

Where females engage in STEM-related subjects, data suggests that they secure a higher success rate than males. Females make up a higher percentage of STEM passes than STEM entrants. This reflects their higher pass rate across all levels, with the difference in pass rate being highest at Advanced Higher level. It may also reflect the likelihood that only females who are confident and committed to STEM subjects will choose to undertake them. In 2019, the female pass rate in STEM-related subjects at Advanced Higher level was 4.1 percentage points higher than that for males, it was 3.2 percentage points higher at Higher level and 0.5 percentage points higher at National level. The breakdown of STEM entries, passes and pass rate by gender and over time is given at **Appendix 3**.

Table A2.3: STEM school entries and passes, by gender, 2019

Level	STEM entries		STEM passes	
	Female share	Male share	Female share	Male share
SCQF 3-5	44.9%	55.1%	45.0%	55.0%
SCQF 6	47.3%	52.7%	48.2%	51.8%
SCQF 7	45.4%	54.6%	46.6%	53.4%

Source: SQA, 2019

The differences in gender representation between subjects are also notable. For example, females made up 65% of *Biology* passes at National level in 2019. This compares with females accounting for just 20% of passes in *Computing Science,* 26% in *Technology* and 28% in *Physics*. At the National level, there is a fairly even gender split in *Chemistry* and *Mathematics*. These trends are similar to the data for 2018.

This pattern largely persists through Higher and Advanced Higher entries and passes, for example males account for over 70% of *Physics* passes and 80% of *Computing Science* passes at Higher and Advanced Higher. The exception is *Mathematics*. Although the gender split in *Mathematics* is very equal at National and Higher levels, males make up 60% of both entries and passes at Advanced Higher. These trends match those in 2018.

STEM qualified school leavers by local authority

Data on sub-national school STEM attainment is available for school leavers only, rather than all current school pupils. The most recent data available online is for the 2017/18 academic year. Table A2.4 shows the attainment of secondary school leavers by their highest level achieved in a STEM-related subject, by Scottish RESAS definition. However, it should be noted that local authorities are not like-for-like comparisons because the offers across authorities differ. Almost four in 10 (38%) school leavers in Scotland had a STEM pass at SCQF 6 or above in 2018 while fewer than one in 10 (9%) had a pass at SCQF 7 and above. There has been little change since 2017 at the national level, with 37% having a STEM pass at SCQF 6 or above, and 9% having a pass at SCQF 7 or above.

At the sub-national level, East Dunbartonshire, Falkirk and Shetland have the highest leaver attainment levels for SCQF 3-5 and above; and East Renfrewshire and East Dunbartonshire for both SCQF 6 and above and SCQF 7 and above. It is notable that some of the local authorities reporting the highest levels of STEM attainment are suburban areas such as East Renfrewshire and East Dunbartonshire. The more rural areas of Aberdeenshire, Argyll and Bute, Scottish Borders and Orkney are also amongst those with greater STEM attainment at Higher level than nationally. For cities, whilst City of Edinburgh and Aberdeen City have high attainment at Advanced Higher level, Dundee City and Glasgow City, both of whom face significant challenges in terms of deprivation, have relatively low attainment at both Higher and Advanced Higher levels.

Table A2.4: School leaver STEM attainment by level and local authority (2017-2018)

	% of all leavers with a STEM subject pass at SCQF level (2017)			% of all leavers with a STEM subject pass at SCQF level (2018)			Percentage point change 2017-2018		
	SCQF 3 or better	SCQF 6 or better	SCQF 7 and above	SCQF 3 or better	SCQF 6 or better	SCQF 7 and above	SCQF 3 or better	SCQF 6 or better	SCQF 7 and above
The Northern Alliance									
Aberdeen City	94.2	34.2	9.0	93.8	35.1	9.8	-0.4	+0.9	+0.8
Aberdeenshire	97.1	36.3	9.3	95.8	41.5	10.1	-1.3	+5.2	+0.8
Argyll & Bute	96.2	37.6	6.7	94.4	40.3	8.4	-1.8	+2.7	+1.7
Orkney Islands	94.6	48.5	10.3	93.4	39.3	7.1	-1.2	-9.2	-3.2
Na h-Eileanan Siar	96.6	46.6	6.7	96.7	34.9	7.7	+0.1	-11.7	+1.0
Shetland Islands	97.4	45.8	10.0	98.8	37.3	10.4	+1.4	-8.5	+0.4
Highland	94.2	36.7	8.8	94.2	37.1	9	0.0	+0.4	+0.2
Moray	92.9	33.6	6.6	93	35.7	9.8	+0.1	+2.1	+3.2
The Tayside Collaborative									
Dundee City	93.2	33.1	6.7	93.1	26.5	4.3	-0.1	-6.6	-2.4
Angus	96.4	39.7	8.1	95.2	37.2	7.6	-1.2	-2.5	-0.5
Perth & Kinross	95.5	37.7	11.2	96.1	39.6	11.6	+0.6	+1.9	+0.4
The West Partnership									
Glasgow City	93.9	27.8	5.9	96.6	30.6	5.4	+2.7	+2.8	-0.5
East Dunbartonshire	98.7	58.7	16.1	100	59.6	15.5	+1.3	+0.9	-0.6
West Dunbartonshire	94.9	36.2	7.8	94.4	34.4	6.5	-0.5	-1.8	-1.3
East Renfrewshire	98.6	61.1	21.1	98.3	61.2	21.4	-0.3	+0.1	+0.3
Renfrewshire	95.6	39.6	8.4	96.9	42.7	9.1	+1.3	+3.1	+0.7
South Lanarkshire	96.0	38.6	8.8	96.6	37.6	8.2	+0.6	-1.0	-0.6
North Lanarkshire	95.0	35.0	6.0	95.6	35.3	5.6	+0.6	+0.3	-0.4
Inverclyde	97.1	35.9	8.2	98.3	42.1	9	+1.2	+6.2	+0.8
Forth Valley and West Lothian Collaborative									
Stirling	97.1	39.9	12.2	97.4	45.1	12.5	+0.3	+5.2	0.3
Falkirk	97.5	39.1	7.5	99.5	43.1	8.3	+2.0	+4.0	+0.8
West Lothian	98.4	37.4	8.9	98.2	38.2	9.2	-0.2	+0.8	0.3
Clackmannanshire	93.5	26.1	3.4	93.4	26.9	5.5	-0.1	+0.8	2.1
South East Collaborative									
Edinburgh, City of	95.2	35.7	9.2	96.3	38.1	11.1	+1.1	+2.4	+1.9
Fife	95.0	31.9	6.4	94.5	35.5	8.6	-0.5	+3.6	+2.2
Midlothian	98.6	33.6	6.2	98.4	37.2	5	-0.2	+3.6	-1.2
East Lothian	96.0	38.4	9.5	95.9	37.6	9.3	-0.1	-0.8	-0.2
Scottish Borders	94.3	40.0	9.3	94.8	39.6	8.8	+0.5	-0.4	-0.5
South West Collaborative									
East Ayrshire	95.6	37.4	5.9	95.1	39.3	6.4	-0.5	+1.9	+0.5
North Ayrshire	96.7	37.6	6.1	95.9	37.4	6.5	-0.8	-0.2	+0.4
South Ayrshire	98.7	42.2	9.9	97.6	41.5	9.6	-1.1	-0.7	-0.3
Dumfries & Galloway	96.3	37.2	8.2	95.4	34.7	8.1	-0.9	-2.5	-0.1
Scotland	**95.8**	**37.1**	**8.5**	**96.1**	**38.4**	**8.8**	**-0.3**	**-1.3**	**-0.3**

Source: SQA, 2020. Please note local authority data for 2019 is not yet available.

In terms of the number of leavers, reflecting concentrations of population, Glasgow City (2,876), North Lanarkshire (2,129) and Fife (2,083) have the greatest number of school leavers with a SCQF 3-5 or above STEM pass. At SCQF 6 or above, STEM leavers are greatest in Glasgow City (1,099) and North Lanarkshire (1,051), while for the SCQF 7 or above level, STEM leavers are highest in City of Edinburgh (357) and Fife (304).

Across all STEM-related subjects, female school leavers have a greater attainment than males at SCQF 6 or better, while a slightly higher proportion of male school leavers have STEM passes at SCQF 3 or better and SCQF 7 or better. These trends have been consistent since 2016. Table A2.5 gives a gender breakdown of school leaver STEM attainment in Scotland. Again, 2018 data is the most recent data available.

Table A2.5: School leaver STEM attainment by gender, 2018

Level	Female	Male
SCQF 3 or better	95.8	96.4
SCQF 6 or better	40.8	36.1
SCQF 7 or better	8.5	9.2

Source: SQA, 2019

Again, across all STEM-related subjects, Asian (Chinese) and Asian (Indian) school leavers have the greatest attainment levels at Higher and Advanced Higher, as shown at Table A2.6. This trend has continued year-on-year from 2016, and the attainment levels of both ethnicity groups have increased since 2017.

Also consistent with historic trends, White (Scottish) school leavers have the lowest STEM attainment rates at Higher and Advanced Higher levels. However, these rates have grown slightly since 2017, from 36.3% to 37.3% for Higher and from 7.8% to 8.0% for Advanced Higher.

Table A2.6: School leaver STEM attainment by ethnicity, 2018

Ethnicity	SCQF 3 or better	SCQF 6 or better	SCQF 7 or better
White (Scottish)	96.3	37.3	8.0
White (non-Scottish)	94.2	41.5	11.8
Mixed or multiple ethnic groups	97.1	44.4	16.9
Asian (Indian)	98.8	63.6	27.6
Asian (Pakistani)	98.9	49.6	15.2
Asian (Chinese)	98.4	80.6	35.1
Asian (other)	95.9	54.1	16.9
African/Black/Caribbean	96.2	44.5	11.4
All other categories	89.4	43.6	12.5

Source: SQA, 2017

School leavers by SIMD quintile

Data on pupil attainment according to SIMD[53] quintile is only available for all school leavers, and not by subject area. The most recent data available is for the 2017/18 academic year. As shown in Table A2.7, there remain significant differences in STEM attainment for pupils from difference SIMD quintiles, with rates typically higher for those residents in the least deprived parts of the country.

[53] Scottish Index of Multiple Deprivation, 2016 classification, which ranks all of the datazones in Scotland in terms of different deprivation domains. 1 is the most deprived quintile, and 5 is the least deprived quintile.

Table A2.7: School leaver STEM attainment by SIMD, 2018

Level	0-20%	20-40%	40-60%	60-80%	80-100%	Gap
SCQF 3 or better	93.6	95.3	96.0	97.1	98.4	4.8pp
SCQF 6 or better	21.6	28.9	38.7	45.9	58.2	36.6pp
SCQF 7 or better	2.9	5.1	8.5	10.9	17.2	14.3pp

Source: SQA, 2019

This data emphasises the prevalence of the attainment gap within STEM-related subjects. As a point of comparison, 22% of school leavers from the most deprived quintile achieved a STEM Higher pass or better, while the equivalent was 58% for leavers from the least deprived quintile. Despite falling longer term, this 36.6 percentage point gap has increased slightly from 35.6 in 2017.

The gap for STEM attainment at Advanced Higher or better has also widened slightly from 13.6 percentage points in 2017 to 14.3 in 2018. However, the STEM attainment gap at SCQF 3 or better has narrowed, from 5.6 percentage points in 2017 to 4.8 in 2018.

Colleges and further education

Colleges in Scotland deliver a wide range of education provision relevant to STEM employers and occupations. This section provides an analysis of the College provision in Scotland according to the FE College definition detailed in **Appendix 4**.[54]

Overall college provision in STEM

STEM enrolments at Scottish colleges have grown significantly in recent years. Table A2.8 below shows the total number of enrolments on STEM-related qualifications as a proportion of total provision in Scottish colleges in from 2015/16 to 2018/19.

Table A2.8: College enrolments in STEM-related subjects (2015/16-2018/19)

	2015/16	2016/17	2017/18	2018/19
STEM enrolments	63,759	73,383	77,824	84,938
STEM share of all enrolments	23%	25%	26%	26%

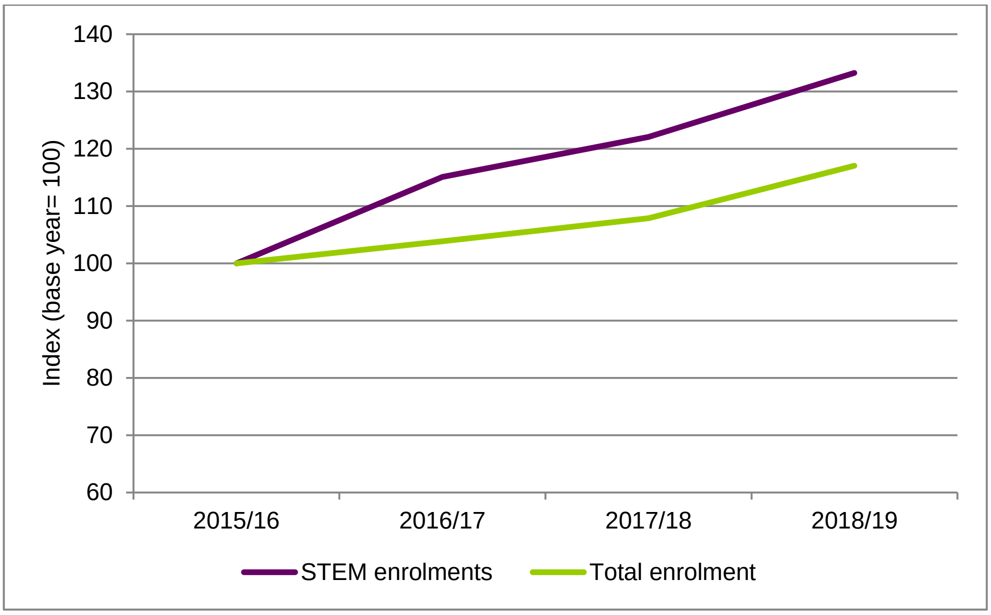
Source: SFC, 2020

STEM-related subjects contribute a significant proportion of college enrolments in Scotland, accounting for 26% of the total in 2018/19, with almost 85,000 enrolments. As shown at Table A2.7, this has risen year-on-year from almost 64,000 enrolments in 2015/16.

As shown in Figure A2.7, this growth in STEM college enrolments is greater than overall college enrolments over the period between 2015/16 and 2018/19 (33% growth, compared to 17% growth).

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

Figure A2.7: College enrolments in STEM-related subjects (2015/16-2018/19)



Source: SFC, 2020

Provision by region

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

Whilst STEM-related courses are delivered in all 13 college regions (plus by Scotland's Rural College (SRUC), it is geographically concentrated (Table A2.8). In 2018/19, provision was greatest in the Fife region (Fife local authority) with over 21,000 enrolments, 56% of the total in Fife, followed by the Glasgow region (East Dunbartonshire, East Renfrewshire and Glasgow City local authorities) with almost 17,000 enrolments, 24% of the total in Glasgow. This was followed by provision in the Aberdeen and Aberdeenshire, Edinburgh and the Lothians and Forth Valley regions, each having over 6,000 enrolments on STEM-related courses. These geographical concentrations of STEM provision have changed since 2015/16, when Glasgow had by far the highest STEM enrolments, followed by Fife, Aberdeen and Aberdeenshire, the Highlands and Islands and the West region. This is in part driven by variations in subject choices by college. Some colleges in Scotland have more limited STEM offerings than others, and this should be borne in mind.

In comparison with overall enrolments, the high number of STEM enrolments in Glasgow region reflects the region's large number of overall enrolments – around 71,000, almost double the number of any other region. However, the prevalence of STEM enrolments in Fife and Aberdeen and Aberdeenshire reflects the higher share of STEM enrolments at these institutions. The top four college regions[55] for number of overall enrolments are: Glasgow (71,000), Fife (37,000), Highlands and Islands (32,000) and Edinburgh and the Lothians (30,000). Enrolments in Fife are particularly high in the *Engineering* subject grouping, while Glasgow has a particular concentration of enrolments in *Computing and ICT* and Edinburgh and the Lothians in *Science and Mathematics.*

As shown in Table A2.9, regions that have amongst the largest number of STEM enrolments are not necessarily amongst the regions with the highest share of STEM as a proportion of all enrolments. For example, although Fife has the highest number of STEM enrolments and by far the highest STEM share of all enrolments, at 56%, Aberdeen and Aberdeenshire and Forth Valley also have high proportions of its enrolments being in STEM subjects, at 39% and 35% respectively. Around one quarter of all enrolments in Glasgow, Edinburgh and the Lothians and Ayrshire are in STEM-related subjects.

[55] It should be noted that Glasgow and the Highlands and Islands are multi-college regions.

Similarly, although it has a fairly high number of STEM enrolments, the West region has a relatively low STEM share of all enrolments, at just under one fifth (18%).

Table A2.9: College enrolments in STEM-related subjects by college region (2015/16-2018/19)

College region	2015/16	2016/17	2017/18	2018/19	STEM % of all enrolments (2018/19)
Fife	8,864	19,332	20,232	21,096	56%
Glasgow	16,769	17,204	17,922	16,852	24%
Aberdeen and Aberdeenshire	6,041	5,624	5,219	9,814	39%
Edinburgh and Lothians	3,679	4,047	6,423	8,064	27%
Forth Valley	4,685	4,945	5,071	6,276	35%
West	5,095	5,392	5,649	4,875	18%
Highlands and Islands	5,883	5,019	4,813	4,802	15%
Ayrshire	2,949	2,563	3,423	3,909	23%
Lanarkshire	3,897	3,741	3,530	3,803	18%
Dundee and Angus	2,676	2,567	2,694	2,734	13%
Dumfries and Galloway	1,615	1,391	1,214	1,076	18%
West Lothian	1,016	1,022	1,050	1,052	13%
Borders	469	416	506	498	11%
Landbased (SRUC)	121	120	78	87	1%
Total	**63,759**	**73,383**	**77,824**	**84,938**	**26%**

Source: SFC, 2020

Please note, this data is from the INFACT database and so differs slightly to data presented elsewhere in this section. Please note, this data includes HE provision in colleges

Full-time/part-time split

In 2018/19, approximately 17% of enrolments in STEM-related subjects were full-time, whilst the remainder of enrolments were studying STEM-related subjects part-time (part-time day release/day course or other part-time modes). This is lower than the full-time rate for all enrolments at college in the same year, which was 23%.

Since 2015/16, there has been a fall in the proportion of enrolments in STEM-related subjects which are full-time, falling eight percentage point from 25% to 17%. This is similar to the overall trend at college level, where full-time study fell five percentage points from 28% to 23%.

Enrolments by subject

College programme data shows provision according to its general subject grouping. There are a wide range of college superclasses (individual subjects) included in our definition of STEM-related subjects (see **Appendix 4** for details). Table A2.10 presents the subject groupings with the number of STEM enrolments within each for 2018/19.

Table A2.10: College enrolments by STEM subjects, 2018/19

Subject	No.	% of total	Change from 2015/16
Engineering	46,790	42%	+48%
Computing and ICT	23,881	27%	-2%
Science and mathematics	14,267	16%	+33%
Total	**84,938**	**100%**	**+33%**

Source: SFC, 2020

Engineering has the highest STEM enrolments of the subject groupings, accounting for 42% of enrolments (c.47,000) in 2018/19.

Comparing the 2018/19 enrolments to 2015/16, the STEM subject groupings were in the same order by number of enrolments, although there have been significant changes in the number of enrolments. Changes to note include a strong growth in enrolments in *Engineering*, from c.32,000 to c.47,000, a 48% rise. There has also been strong growth in *Science and Mathematics* enrolments over the period, from c.8,000 to c.14,000, an increase of 33%. However, the number of enrolments in *Computing and ICT* fell slightly during this time, from c.24,300 to c.23,900, a decline of 2%.

FE/HE split

Table A2.11 shows that the majority of college enrolments are at Further Education level, accounting for 87% of student enrolments in STEM-related subjects compared to 13% for Higher Education. This is broadly consistent with all college enrolments in Scotland (85% v 15%).

Table A2.11: College enrolments on STEM qualifications by FE/HE split (2018/19)

Level	Enrolments	
	No.	% of total
Further Education	73,967	87%
Higher Education	10,971	13%
Total	**84,938**	**100%**

Source: SFC, 2020

Between 2015/16 and 2018/19, the trend of Further Education dominating STEM college provision increased from 81% to 87%. This is set in the context of the proportion of Further Education provision across all college enrolments also rising slightly from 82% to 85% over the period.

Profile of learners

The age profile of the STEM student cohort is varied and has become younger over the last four years. The STEM student cohort is, on average, younger than the overall college student cohort, with over half of the STEM cohort aged 19 or under, compared to 41% for all college enrolments, as shown at Table A2.12. In 2018/19, 34% of enrolments on STEM-related qualifications were aged under 16 and 21% were aged 16-19 years old. Older learners continue to account for a significant proportion of enrolments, with one third (31%) of enrolments in STEM-related subjects by learners aged 25 or over, although this is significantly below 44% for all college enrolments.

Table A2.12: College enrolments on STEM qualifications by age (2018/19)

Age group	% of STEM total	% of total enrolments
Under 16	34%	17%
16-19	21%	24%
20-24	14%	14%
25 and over	31%	44%
Total	**100%**	**100%**

Source: SFC, 2020

Males are much more likely to study STEM-related subjects at college. Table A2.13 shows that males accounted for two thirds (67%) of college enrolments on STEM qualifications in 2018/19, despite only accounting for 49% of all college enrolments in that year. However, the STEM gender gap has narrowed slightly over the last four years, with female enrolments in STEM-related subjects rising from 29% in 2015/16 to 33% in 2018/19 (an overall rise of over 9,000 enrolments).

Table A2.13: College enrolments on STEM qualifications by gender (2018/19)

Subject	Gender		
	Female	Male	Other
Engineering	22%	77%	>1%
Computing and ICT	41%	59%	>1%
Science and mathematics	55%	45%	>1%
Total	**33%**	**67%**	**>1%**

Source: SFC, 2020

As expected, the gender variation differs significantly by subject grouping. For example, in 2018/19, female enrolments were more common in *Science and Mathematics* (55%) subjects, which was the most gender balanced subject grouping. However, male enrolments were much more prevalent in *Engineering* (77%) and also more common in *Computing and ICT* subjects (59%).

Apprenticeships

Foundation Apprenticeships

Total starts

Foundation Apprenticeships (FAs) are two year programmes developed during an early pathfinder design and development stage from 2014-17. The early pathfinders for the period 2014-16 and 2015-17 engaged a range of lead partners in the design and development of FA frameworks and pathfinder delivery models to capture insight and learning to inform future design, development and delivery. The period 2016-18 is the first time that FA starts and cohorts participated in the fully designed and certified FA frameworks[56]. Data is reported on here starting from 2016/18 given the timing of the publication of the Scottish STEM strategy in 2017.

Table A2.14 shows STEM FA starts under the second pathfinder and the subsequent full programme cohorts. There has been an increase of starts to over 900 in the 2018-20 cohort. Mirroring the trend in

[56] Frameworks falling under the STEM definition are outlined in **Appendix 5.**

STEM college enrolments, there is a clear gender imbalance, with males accounting for almost two thirds of FA starts.

Table A2.14: STEM Foundation Apprenticeship starts (2016/18-2018/20)

Academic Year	Starts			Currently in Training	Early Leavers	Completers
	Total	Female	Male			
2016/18	251	37%	63%	201	50	n/a
2017/19	657	25%	75%	378	n/a	n/a
2018/20	912	36%	64%	912	n/a	n/a

Source: SDS, 2020

Starts by framework

As Table A2.15 shows, the *Social Services and Healthcare* framework accounted for the largest proportion of starts in 2016/18 (35%), but this has since reduced to 16% in 2017/19 and 21% in 2018/.20 – still a sizeable proportion. In 2017/19 and 2018/20, the *Engineering* framework accounted for the largest proportion of STEM starts (35% and 33%). *Creative and Digital Media* (15%) and IT: Software Development (12%) both accounted for a notable number of starts in 2018/20.

Table A2.15: STEM Foundation Apprenticeship starts by framework (2016/18-2018/20)

Framework	2016/18		2017/19		2018/20	
	No.	%	No.	%	No.	%
Civil Engineering	47	19%	87	13%	93	10%
Creative and Digital Media	-	-	43	7%	135	15%
Engineering	71	29%	232	35%	305	33%
Food and Drink Technologies	-	-	-	-	10	1%
IT: Hardware Systems Support	13	5%	40	6%	35	4%
IT: Software Development	30	12%	130	20%	105	12%
Scientific Technologies	-	-	20	3%	39	4%
Social Services and Healthcare	85	35%	105	16%	190	21%
Total	**346**	**100%**	**1,244**	**100%**	**912**	**100%**

*Source: SDS, 2020 * denotes disclosure data. Percentage is as a percentage of starts on STEM frameworks, rather than overall*

As Table A2.16 shows, gender imbalance is apparent across most of the frameworks, with four skewed towards male starts of between 64% (*Creative and Digital Media*) and 87% (*Engineering* and *IT: Software Development*) in 2018/20, while the imbalance is reversed for *Social Services and Healthcare*, where females account for 90% of starts. This reflects traditional gender patterns evident in the economy.

Nevertheless, there has been a slight improvement over time. In 2016/18, the skew was even greater for these male-dominated frameworks, ranging from 87% (*Civil Engineering*) to 97% (*IT: Software Development*). Likewise, 93% of *Social Services and Healthcare* starts were female at this time.

Table A2.16: STEM Foundation Apprenticeship starts by framework (2016/18-2018/20)

Framework	2016/18		2017/19		2018/20	
	%M	%F	%M	%F	%M	%F
Civil Engineering	87	13	88	12	84	16
Creative and Digital Media	-	-	44	56	64	36
Engineering	93	7	93	7	87	13
Food and Drink Technologies	-	-	-	-	46	54
IT: Hardware Systems Support	92	8	100	0	-	-
IT: Software Development	97	3	90	10	87	13
Scientific Technologies	-	-	50	50	46	54
Social Services and Healthcare	7	93	10	90	10	90

*Source: SDS, 2020 * denotes disclosure data*

Provision by geography

Table A2.17 shows provision by local authority, grouped under the Scottish Government's RESAS definition. This shows the provision under each STEM framework has either grown or stayed the same over the three years. For the current 2018-20 cohort, STEM FAs are being delivered in 30 of Scotland's 32 local authorities, with Scottish Borders and Shetland being the only exceptions.

In 2018/20, as well as having the greatest uptake in starts, the *Engineering* framework is also the most geographically widespread, being delivered in 22 local authorities. Creative and Digital Media is being delivered in 20 local authorities, while the *Social Services and Healthcare* framework is being delivered in 19. *Food and Drink Technologies* is the newest STEM FA framework, and as such, is being delivered in four local authorities.

Table A2.17: STEM Foundation Apprenticeship provision by local authority (2016/18-2018/20)

Local authority	Civil Engineering			Creative and Digital Media			Engineering			Food and Drink Technologies			Hardware and Systems Support			Scientific Technologies			Social Services and Healthcare			Software Development		
Cohort	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Larger cities																								
Aberdeen City					X	X	X	X	X					X	X				X	X				
Dundee City			X			X													X		X			
Edinburgh, City of		X			X	X		X	X						X						X		X	X
Glasgow City	X	X	X		X	X	X	X	X			X		X				X	X	X	X	X	X	X
Urban with substantial rural areas																								
East Dunbartonshire	X	X			X		X	X	X					X				X	X	X	X	X	X	X
East Renfrewshire	X	X	X		X	X		X	X									X		X	X	X	X	X
Falkirk			X			X	X	X	X										X	X	X			
Fife	X	X	X					X	X			X			X		X				X	X	X	X
Inverclyde	X	X	X						X						X			X	X	X			X	X
Midlothian						X		X															X	
North Ayrshire			X				X	X	X														X	
North Lanarkshire	X	X			X	X	X	X	X			X		X	X						X	X		X
Renfrewshire	X	X						X						X					X	X			X	
South Lanarkshire		X			X			X						X						X			X	
Stirling																			X					
West Dunbartonshire		X			X			X												X		X	X	
West Lothian	X	X						X												X		X	X	
Mainly rural																								
Aberdeenshire					X	X	X	X	X					X	X				X	X			X	
Angus		X	X			X		X											X	X	X		X	
Clackmannanshire			X				X		X										X	X	X			
Dumfries and Galloway								X	X						X									
East Ayrshire			X					X	X														X	
East Lothian						X			X						X			X						X
Highland	X	X	X		X	X							X	X	X		X	X	X	X	X	X	X	X
Moray						X														X	X			
Perth & Kinross		X					X	X																
Scottish Borders																								
South Ayrshire							X	X															X	
Islands and remote																								
Argyll and Bute						X	X	X																
Na h-Eileanan Siar						X													X	X	X			
Orkney Islands																				X				
Shetland Islands							X	X											X	X				
Total	**9**	**14**	**18**	**0**	**10**	**20**	**12**	**22**	**22**	**0**	**0**	**4**	**1**	**8**	**12**	**0**	**2**	**9**	**14**	**18**	**19**	**8**	**18**	**12**

Source: SDS, 2020

Modern Apprenticeships

The number of starts on SDS-funded Modern Apprenticeships in STEM-related subjects in Scotland increased slightly from 2016/17 to 2017/18 (9,619 to 10,325), before declining very slightly to 10,038 in 2018/19. The numbers of both achievements and leavers has increased over time, with the achievement rate[57] averaging at 78%, with minor fluctuations (see Table A2.18).

During 2018/19, there were 10,038 starts on SDS-funded Modern Apprenticeships in STEM-related subjects in Scotland[58]. In the same year, there were 8,427 achievements against 10,754 leavers, equating to an achievement rate of 78%, greater than the overall MA achievement rate of 76%.

Table A2.18: Starts, achievements, leavers and success rate for MAs in STEM-related subjects 2016/17 to 2018/19[59]

Year	Starts	Achievements	Leavers	Achievement rate
2016/17	9,619	6,076	8,033	76%
2017/18	10,325	7,473	9,487	79%
2018/19	10,038	8,427	10,754	78%
Total	**29,982**	**21,976**	**28,274**	**78%**

Source: SDS, 2020

The vast majority of STEM starts from 2016/17 to 2018/19 have been males, although there has been a slight improvement in terms of the balance over this time (95% in 2016/17 and 2017/18, declining to 91% in 2018/19. However, this compared to 59%-62% of males starts across all MA provision during this period.

Modern Apprenticeships by framework

STEM-related Modern Apprenticeships (MAs) are provided across 39 different frameworks in Scotland (see **Appendix 4** for the definition applied). As presented in Table A2.19 below, *Construction: Building* was the most popular MA in 2018/19, with over 1,600 starts. This is followed by *Construction: Civil Engineering*, *Automotive* (1,200 starts each), *Construction: Technical* (1,100 starts) and *Engineering* (1,000 starts)

The top 10 frameworks by starts have not shifted greatly from 2016/17 to 2018/19 (the most recent data available). In all three years, *Construction: Building* was the most popular MA, followed by *Construction: Civil Engineering*, *Automotive*, *Construction: Technical*, *Engineering* and *IT and Telecommunications*, albeit with slightly shifting rankings.

In line with the overall profile of STEM apprenticeship provision, the majority of framework areas are dominated by males, which is in line with the overall STEM workforce, and contrasting with university enrolments – in part due to the lack of availability of Apprenticeships in Medicine, and conversely degree-level Construction courses. However, there are a small number of frameworks (not shown in Table A2.19 due to relatively low numbers), in which females make up the majority of starts, including *Dental Nursing* and *Equine*, and some which are fairly gender-balanced, including *Creative and Digital Media* and *Life Sciences*.

[57] Note: achievers can occasionally relate to prior years' leavers.

[58] 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.

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

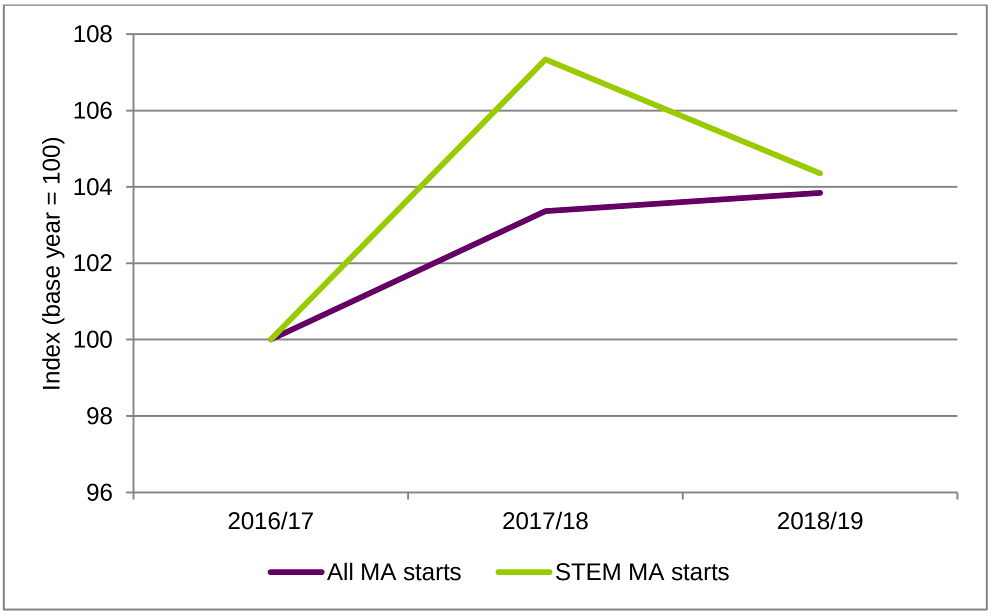
Table A2.19: Top 10 MA frameworks in STEM-related subjects (2016/17-2018/19)

Framework	2016/17			2017/18			2018/19		
	No.	%F	%M	No.	% F	% M	No.	% F	% M
Construction: Building	1,527	2%	98%	1,608	1%	99%	1,620	2%	98%
Construction: Civil Engineering	997	2%	98%	1,125	-	-	1,242	-	-
Automotive	1,099			1,035	4%	96%	1,151	2%	98%
Construction: Technical	905	4%	96%	1,145	3%	97%	1,115	4%	96%
Engineering	864	16%	84%	924	5%	95%	1,039	5%	95%
IT and Telecommunications	900	5%	95%	1,052	13%	87%	923	16%	84%
Electrical Installation	743	1%	99%	763	-	-	739	1%	99%
Construction: Technical Apprenticeship	597	2%	98%	557	1%	99%	522	3%	97%
Plumbing	398	-	-	^	-	-	^	-	-
Construction: Specialist	257	0%	100%	^	-	-	^	-	-
Dental Nursing	^	-	-	^	-	-	251	-	-
Horticulture	^	-	-	213	-	-	210	6%	94%
Digital Applications	^	-	-	512	62%	38%	^	-	-
All other STEM frameworks	1,332	13%	87%	1,391	24%	76%	1,226	12%	88%
Total	**9,619**	**5%**	**95%**	**10,325**	**11%**	**91%**	**10,038**	**5%**	**95%**

Source: SDS, 2020. ^ These figures are included in 'All other STEM frameworks' in these years as they were not in the top 10

STEM MA provision has grown between 2016/17 and 2018/19, as more STEM-related frameworks have come on stream. Starts have grown by 4.4% over this period, from 9,600 (across 34 frameworks) in 2016/17 to 10,000 (across 39 frameworks) in 2018/19. As shown at Figure A2.8, this is a faster rate of growth than overall apprenticeship provision, which grew by 3.8% over the period.

Figure A2.8: All and STEM MA starts (2016/17-2018/19)



Source: SDS, 2020

Apprenticeships by geography

MAs for learners in STEM-related subjects are provided across Scotland, although to varying extent, as shown at Table A2.20. Scotland's urban areas (the larger cities and urban with substantial rural areas) accounted for nearly seven in 10 (69%) MA STEM starts in 2017/18. This is driven by particularly high provision in Glasgow City and North and South Lanarkshire local authorities, which together account for 28% of all STEM MA starts. Provision of STEM MAs in more rural areas is low.

Table A2.20: Provision of MAs in STEM-related subjects by RESAS geography (2017/18)

RESAS geography	No.	% of total
Larger cities	1,931	20%
Urban with substantial rural areas	4,755	49%
Mainly rural	2,749	28%
Islands and remote	246	3%
Total	**9,681**	**100%**

Source: SDS, 2020. Please note, MA data by local authority is only currently available for 2017/18.

Graduate Apprenticeships

Despite still being in the early stages of development, Graduate Apprenticeships (GAs) are beginning to expand and roll out across Scotland, and volumes are expected to continue to grow in future years. Since 2018/19, GA starts are included in the apprenticeship total and contribute towards the Scottish Government commitment[60].

During 2018/19, a total of 921 learners started Graduate Apprenticeships (GAs)[61]. This is a significant increase from 278 starts in 2017/18, 13 in 2016/17 and 14 in 2015/16. As follows, nearly all of the 14 current GA frameworks are related to STEM subjects:

- Accounting (currently a pilot, SCQF Level 10/11)
- Business Management (SCQF Level 10)
- Business Management: Financial Services (SCQF Level 10)
- Civil Engineering (SCQF Levels 8 and 10)
- Construction and the Built Environment (SCQF Level 10)
- Cyber Security (SCQF Levels 10 and 11)
- Data Science (SCQF Level 10)
- Early Learning and Childcare (currently a pilot, SCQF Level 9)
- Engineering: Design and Manufacture (SCQF Level 10)
- Engineering: Instrumentation, Measurement and Control (SCQF Level 10)
- IT: Management for Business (SCQF Level 10)
- IT: Software Development (SCQF Level 10)

[60] https://www.skillsdevelopmentscotland.co.uk/media/44711/modern-apprenticeship-statistics-quarter-4-2017-18.pdf

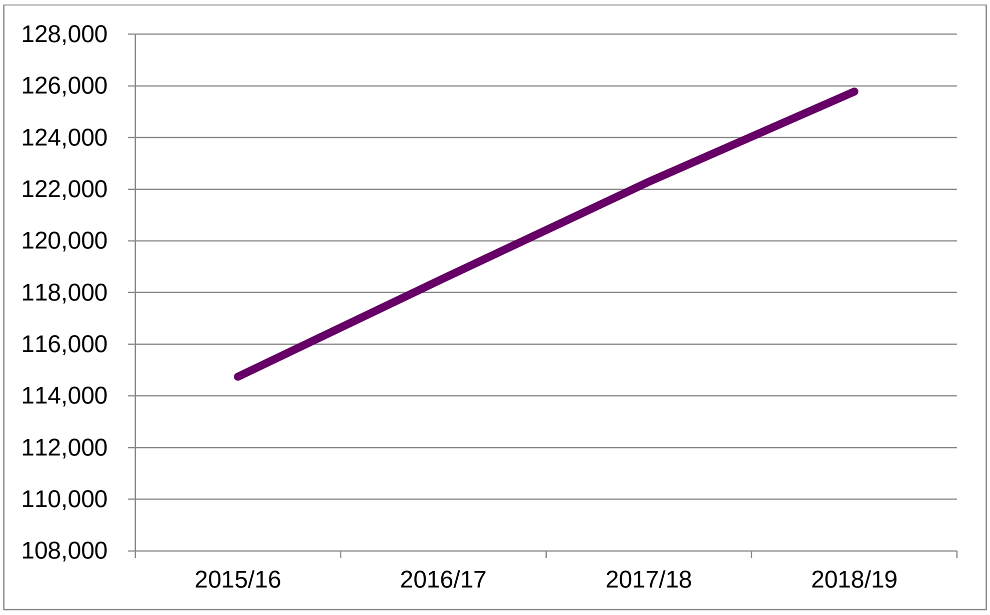
[61] https://www.skillsdevelopmentscotland.co.uk/media/45882/ga-report-2019.pdf

University and higher education[62]

Overall university provision in STEM

During the 2018/19 academic year there were a total of 125,775 enrolments across full-time and part-time undergraduate and postgraduate courses in STEM-related subjects (see **Appendix 4** for the definition) at Scottish universities, accounting for 50% of total enrolments. Between 2015/16 and 2018/19 total enrolments in STEM-related subjects at Scottish universities increased by 10% (+11,035 enrolments), as shown at Figure A2.9. This was accompanied by an increased STEM share of total enrolments from 49% in 2015/16 to 50% in 2018/19, shown at Figure A2.10. The growing level of STEM enrolments reflects the recognised importance of STEM-related subjects and the prevalence of initiatives encouraging the study of STEM-related subjects. It is worth noting that this is within the wider context of an increase in enrolments at Scottish universities (8% since 2015/16).[63]

Figure A2.9: University enrolments in STEM-related subjects (2015/16-2018/19)

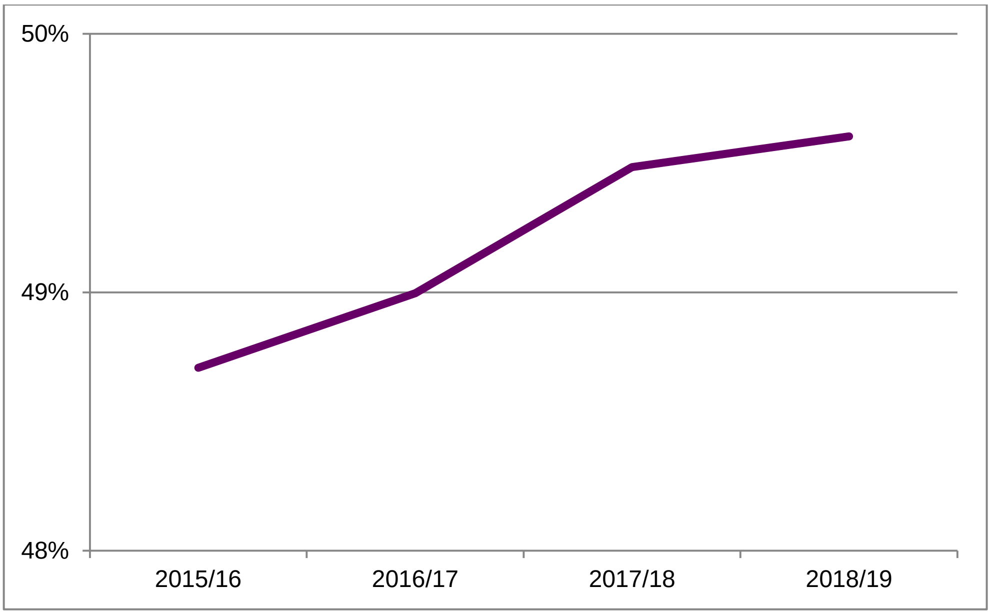


Source: HESA/SFC, 2020

[62] Please see https://www.hesa.ac.uk/data-and-analysis for the data used in this section.

[63] http://www.sfc.ac.uk/communications/Statisticalpublications/2017/SFCST062017.aspx

Figure A2.10: University enrolments in STEM-related subjects as a share of total enrolments (2015/16-2018/19)



Source: HESA/SFC, 2020

Provision by subject

As shown in Table A2.21, *Subjects allied to Medicine* accounted for the highest number (31,175) and share (25%) of STEM enrolments at Scottish universities in 2018/19. This is followed by *Biological Sciences* with a total of 24,765 enrolments and 20% share and *Engineering & Technology* which had 20,855 enrolments and a 17% share of total STEM enrolments. In comparison with 2015/16, the popularity of STEM-related subjects has stayed fairly stable with the order of preference remaining the same, with the exception of *Computer Science* enrolments slightly overtaking *Physical Sciences* enrolments.

Table A2.21: University enrolments by STEM-related subject (2015/16 and 2018/19)

Subject	2015/16		2018/19		Change in enrolments	
	Count	Share %	Count	Share %	Count	%
Subjects allied to medicine	29,130	25%	31,175	25%	2,045	7%
Biological sciences	21,850	19%	24,765	20%	2,915	13%
Engineering & technology	20,250	18%	20,855	17%	605	3%
Computer science	10,690	9%	13,960	11%	3,270	31%
Physical sciences	11,665	10%	11,810	9%	145	1%
Medicine & dentistry	7,655	7%	7,795	6%	140	2%
Architecture, building & planning	5,600	5%	6,380	5%	780	14%
Mathematical sciences	4,405	4%	5,040	4%	635	14%
Agriculture & related subjects	1,975	2%	2,370	2%	395	20%
Veterinary science	1,520	1%	1,630	1%	110	7%
Total	**114,740**	**100%**	**125,775**	**100%**	**11,035**	**10%**

Source: HESA/SFC, 2020

Points to note include:

- There were no declines in enrolments in any STEM subjects between 2015/16 and 2018/19.
- The biggest absolute increase in enrolments was recorded against *Computer Science*, which saw a total increase of 3,270 and a growth in share from 9% to 11%.
- The largest proportional increase in enrolments between 2012/13 and 2017/18 also took place in *Computer Science* at 31%. *Agriculture and Related Subjects* also saw a large proportional increase, at 20%, although this was starting from a small base and only represented an absolute increase of 395 enrolments.

Full-time/part-time split

In 2018/19, 80% of enrolments in STEM-related subjects at Scottish universities were for full-time programmes and 20% were part-time. The STEM full-time enrolment rate was slightly higher than that across all subjects which stood at 77%. From 2015/16 there has been no change in the proportion of full-time enrolments in STEM-related subjects. Reflecting the length of the course and its vocational nature, the full-time enrolment rate was highest in *Veterinary Science* at 94%. Part-time enrolments were most common for *Subjects allied to Medicine* where the share of part-time enrolments was 33%.

Provision by level

In 2018/19, 76% of enrolments in STEM-related subjects at Scottish universities were for undergraduate programmes and 24% were for postgraduate programmes. The share of postgraduate enrolments for STEM-related subjects was slightly lower than that across all subjects where postgraduate enrolments accounted for 25% of total enrolments. The share of postgraduate enrolments for STEM-related subjects increased slightly from 2015/16 to 2018/19 (23% to 24%). *Veterinary Science* had the lowest rate of postgraduate enrolments at just 14%. Again, this likely reflects the length and vocational nature of the course. The share of postgraduate enrolments was highest for *Agriculture and Related Subjects* at 36% and *Architecture, Building and Planning* at 30%.

Provision by institution

As shown in Table A2.22, in 2018/19 STEM enrolment was highest at the University of Edinburgh with 16,400 enrolments. This was followed by the University of Glasgow with 14,285. This is to be expected as these are the two largest HEIs in Scotland.

The STEM share of total enrolments was highest at Scotland's Rural College where STEM-related subjects accounted for 80% of enrolments, reflecting the specialist nature of this institution. Glasgow Caledonian University (69%), Queen Margaret University (63%) and Heriot-Watt University (63%) had the next highest shares of STEM enrolments. Again this likely reflects the focus these institutions have on scientific and technical subjects.

From 2015/16 to 2018/19 the biggest absolute increase in STEM enrolments was seen at the University of Edinburgh (2,285), University of Glasgow (1,580) and the Open University (1,375). Again this reflects the size and reach of these institutions and, at the University of Edinburgh, strong overall growth in enrolments. The largest proportional increase was at the Open University (28%), with high proportional growth also at the University of the Highlands and Islands (23%), University of Abertay (22%) and Scotland's Rural College (19%), the latter reflecting the strong growth in *Agriculture and Related Subjects*.

The smallest enrolments in STEM at Scottish universities in 2017/18 were at Glasgow School of Art (590) and Scotland's Rural College (1,415). This can be attributed to the small size of these institutions. In terms of STEM share of total enrolments, this was smallest at Glasgow School of Art (26%), which is to be expected due to the specialism of this institution. The Open University, University of the Highland Islands and University of St Andrews also reported low STEM shares, at 37%, 39% and 40% respectively. It should be noted that this still reflects a growth in STEM's share of overall enrolments at these institutions.

Whilst overall there has been absolute and proportionate growth for STEM-related subjects from 2015/16 to 2018/19, this has not been reflected across all institutions. The University of Dundee saw a fall in STEM enrolments of 190 (2%) during this time. Similarly, the University of Stirling saw very little change in STEM enrolments over this time period of 65 (1%). STEM enrolments in both institutions fell at a disproportionately high rate over this period.

Table A2.22: University enrolment in STEM-related subjects by institution (2015/16 and 2018/19)

Institution	2015/16		2018/19		Change in Enrolments		Change in STEM share of total enrolments
	STEM enrolment	STEM share	STEM enrolment	STEM share	Count	%	
The University of Edinburgh	14,115	46%	16,400	48%	2,285	16%	+2pp
The University of Glasgow	12,705	47%	14,285	46%	1,580	12%	-1pp
Glasgow Caledonian University	10,470	63%	11,690	69%	1,220	12%	+6pp
The University of Strathclyde	10,315	48%	10,800	48%	485	5%	No change
The University of the West of Scotland	7,725	50%	8,620	51%	895	12%	+1pp
The University of Dundee	8,770	59%	8,580	54%	-190	-2%	-5pp
Edinburgh Napier University	7,000	56%	7,760	57%	760	11%	+1pp
The University of Aberdeen	6,665	48%	7,035	48%	370	6%	No change
Heriot-Watt University	6,630	63%	6,870	63%	240	4%	No change
The Robert Gordon University	6,165	48%	6,305	51%	140	2%	+3pp
The Open University	4,910	33%	6,285	37%	1,375	28%	+4pp
The University of Stirling	5,210	44%	5,275	42%	65	1%	-2pp
The University of St Andrews	4,035	38%	4,185	40%	150	4%	+2pp
University of the Highlands and Islands	3,015	36%	3,705	39%	690	23%	+3pp
Queen Margaret University, Edinburgh	3,145	60%	3,290	63%	145	5%	+3pp
University of Abertay Dundee	2,195	55%	2,685	62%	490	22%	+7pp
SRUC	1,185	75%	1,415	80%	230	19%	+5pp
Glasgow School of Art	505	25%	590	26%	85	17%	+1pp
Total	**114,740**	**49%**	**125,780**	**50%**	**11,040**	**10%**	**+1pp**

Source: HESA/SFC, 2020

Profile of learners

In 2018/19, 53% of students enrolled in STEM-related subjects at Scottish HEIs were female. This is significantly lower than the 59% across all subjects; however it is high relative to trends in other provision considered earlier in this chapter (for example Apprenticeships; though it should be noted that considers enrolment data only, and does not take into account applications to study). The gender split grew slightly from 52:48 to 53:47 between 2015/16 and 2018/19.

There were, however, significant differences in the gender gap between different subjects, which impacts on the overall gender balance of enrolments, as shown at Table A2.23. For example, in 2018/19, 82% of enrolments in *Subjects Allied with Medicines* and *Veterinary Science* were female.

This compared with just 19% in *Engineering and Technology* and 20% in *Computer Science*. This subject split appears to reflect traditional gender norms with women more represented in subjects associated with caring and less so in areas seen to be more technical. The limited number of females studying engineering and computing is particularly significant as they are projected to experience significant growth. For the most part, the gender split within subjects remained broadly stable from 2015/16 and 2018/19. The only significant changes were:

- In *Veterinary Science* where the share of female enrolments increased from 78% to 82%, becoming less gender balanced; and
- In *Physical Sciences* where the share of female enrolments grew from 43% to 46%, becoming more gender balanced.

Table A2.23: University enrolment in STEM-related subjects by gender (2015/16 and 2018/19)

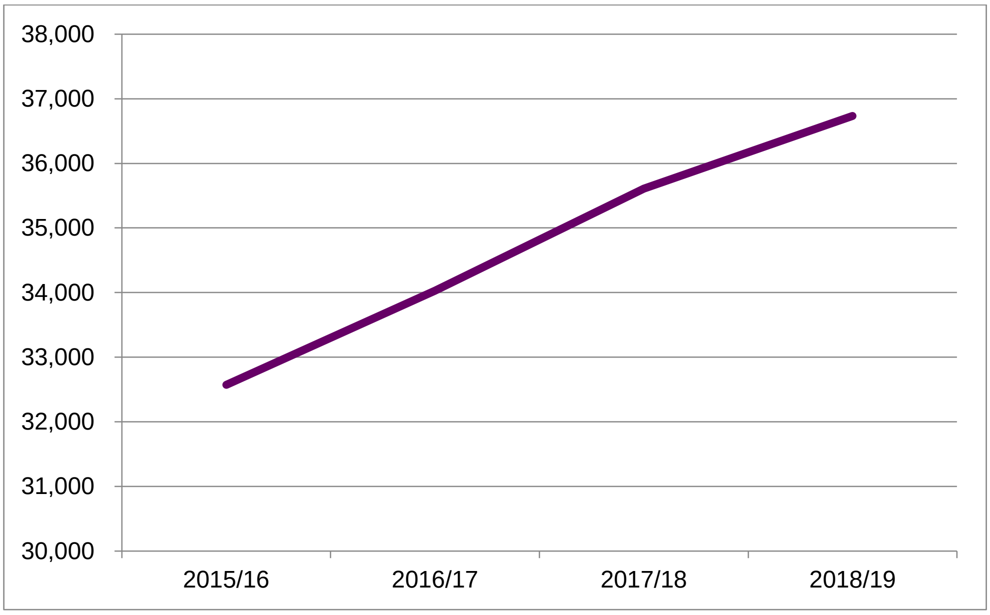
Subject	2015/16		2018/19	
	Female % enrolments	Male % enrolments	Female % enrolments	Male % enrolments
Medicine & dentistry	59%	41%	61%	39%
Subjects allied to medicine	81%	19%	82%	18%
Biological sciences	65%	35%	67%	33%
Veterinary science	78%	22%	82%	18%
Agriculture & related subjects	63%	37%	62%	38%
Physical sciences	43%	57%	46%	54%
Mathematical sciences	43%	57%	41%	59%
Computer science	20%	80%	21%	79%
Engineering & technology	19%	81%	20%	80%
Architecture, building & planning	42%	58%	41%	59%
Total	**52%**	**48%**	**53%**	**47%**

Source: HESA/SFC, 2020

Graduates profile

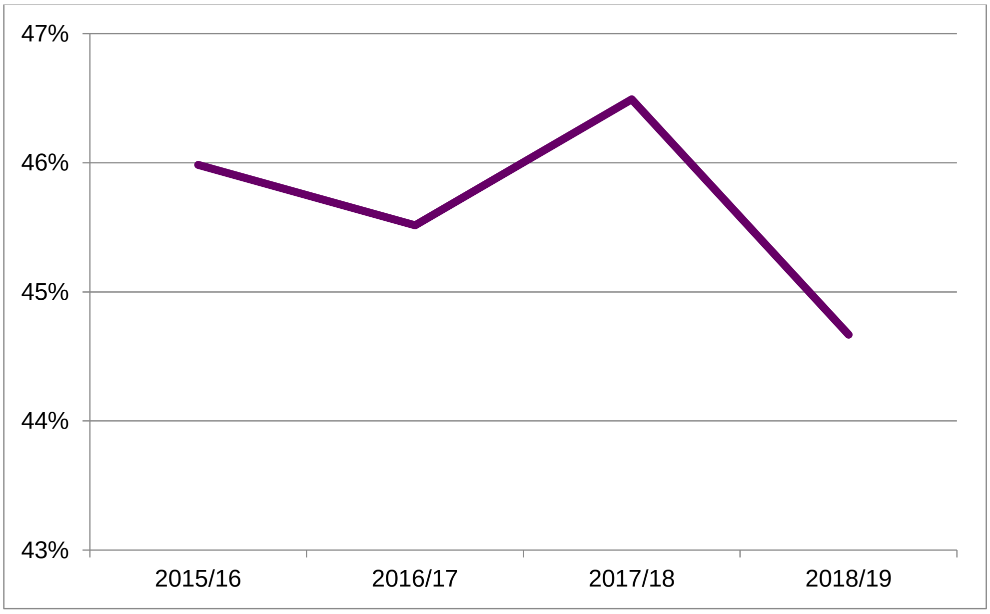
In total, 36,735 students qualified from Scottish universities in STEM-related subjects in 2018/19 – 45% of the total – following strong growth in recent years (+4,165, or 13% since 2015/16). The STEM share of qualifiers has fallen slightly from the 2015/16 level after dropping from above 46% in 2017/18, as shown at Figures A2.11 and A2.12.

Figure A2.11: STEM qualifications at Scottish universities (2015/16-2018/19)



Source: HESA/SFC, 2020

Figure A2.12: STEM qualifications as a share of total qualifications (2015/16-2018/19)



Source: HESA/SFC, 2020

In terms of subject coverage of qualifiers, as shown in Table A2.24:

Subjects Allied to Medicine had the highest number of qualifiers from Scottish universities in 2018/19 at 8,395, or 23% of total STEM qualifiers reflecting strong enrolments in this subject area. This was followed by *Biological Sciences* with 7,260 qualifiers, or 20%.

- The biggest absolute growth in qualifiers between 2015/16 and 2018/19 was in *Biological Sciences* at +1,190 (+20%), whilst the biggest proportional growth was in *Agriculture and Related Studies* at +55%, although from a much lower base.
- There was a small decrease in the number of *Medicine and Dentistry* qualifiers over the period, of 40 or -2%, the only STEM subject that saw a decline.

- *Engineering and Technology* saw the biggest decline in share of total STEM qualifiers from 2015/16 to 2018/19, contracting by 2 percentage points.

Table A2.24: STEM qualifiers at Scottish universities by subject (2015/16 and 2018/19)

Subject	2015/16		2018/19		Change	
	Count	Share %	Count	Share %	Count	%
Subjects allied to medicine	7,405	23%	8,395	23%	990	13%
Biological sciences	6,070	19%	7,260	20%	1,190	20%
Engineering & technology	6,050	19%	6,390	17%	340	6%
Computer science	3,450	11%	4,160	11%	710	21%
Physical sciences	3,140	10%	3,390	9%	250	8%
Architecture, building & planning	2,095	6%	2,265	6%	170	8%
Medicine & Dentistry	2,180	7%	2,140	6%	-40	-2%
Mathematical sciences	1,165	4%	1,290	4%	125	11%
Agriculture & related subjects	715	2%	1,105	3%	390	55%
Veterinary science	300	1%	340	1%	40	13%
Total	**32,570**	**100%**	**36,735**	**100%**	**4,165**	**13%**

Source: HESA/SFC, 2020

In 2018/19, 52% of STEM qualifiers from Scottish universities were female and 48% were male. Table A2.25 gives a breakdown of qualifiers by gender and subject. The percentage of STEM female qualifiers is significantly lower than that across all subjects where it is 59%. The gender split has been fairly stable since 2015/16, having been 50:50 at the start of this period and rising to 52% female in 2017/18. As with enrolments, there are significant differences in the gender balance across subjects with points of note including:

- *Subjects Allied to Medicine* and *Veterinary Science* had the highest percentage of female qualifiers in 2018/19, at 81% and 76% respectively.
- *Engineering and Technology* and *Computer Science* had the lowest percentage of female qualifiers, at 21% and 23% respectively.
- The biggest increases in the female share of qualifiers were in *Engineering and Technology* and *Architecture, Building and Planning,* which both grew by 3 percentage points over the period, making them more gender balanced.

Table A2.25: STEM qualifiers at Scottish universities by gender (2015/16 and 2018/19)

Subject	2015/16		2018/19	
	Female % qualifiers	Male % qualifiers	Female % qualifiers	Male % qualifiers
Medicine & dentistry	58%	42%	60%	40%
Subjects allied to medicine	81%	19%	81%	19%
Biological sciences	64%	36%	65%	35%
Veterinary science	77%	23%	78%	22%
Agriculture & related subjects	60%	40%	62%	38%
Physical sciences	44%	56%	46%	54%
Mathematical sciences	45%	55%	44%	56%
Computer science	22%	78%	23%	77%
Engineering & technology	18%	82%	21%	79%
Architecture, building & planning	42%	58%	45%	55%
Total	**50%**	**50%**	**52%**	**48%**

Source: SFC, 2020

Appendix 3: School entries and passes by gender

Table A3.1: STEM entries and qualifications for Scottish school pupils by gender (2016-2019)

	2016		2017		2018		2019		% or p.p. change 2016-19	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
SCQF 3-5										
Entries	90,040	113,354	89,405	109,397	82,806	101,650	82,626	101,520	**-8%**	**-10%**
Passes	71,962	90,557	71,021	87,660	64,892	78,502	72,093	88,102	**-0.18%**	**-3%**
Pass rate	79.9%	79.9%	79.4%	80.1%	78.4%	77.2%	87.3%	86.8%	**+7.4 p.p.**	**+6.8 p.p.**
SCQF 6										
Entries	32,313	37,310	31,922	37,533	32,034	35,458	30,078	33,517	**-7%**	**-10%**
Passes[64]	24,196	26,363	24,146	26,977	24,620	25,302	27,034	29,055	**-12%**	**+10%**
Pass rate	74.9%	70.7%	75.6%	71.9%	76.9%	71.4%	89.9%	86.7%	**+14.9 p.p.**	**+16 p.p.**
SCQF 7										
Entries	5,045	6,942	5,130	6,935	5,367	6,961	5,392	6,489	**7%**	**-7%**
Passes	4,095	5,187	4,062	5,117	4,307	5,130	4,697	5,384	**15%**	**+3.8%**
Pass rate	74.9%	70.7%	75.6%	71.9%	76.9%	71.4%	87.1%	83.0%	**+12.2 p.p.**	**+12.3 p.p.**

Source: SQA, 2020

[64] Grade D was widened in 2019. As a consequence, Grade D passes for 2018 and previous years are not directly comparable.

Appendix 4: STEM education definitions

School subjects (covering SCQF Levels 3-5, 6, 7)

Biology
Chemistry
Human Biology
Physics
Other Science
Computing Science
Mathematics
Technology

Source: SQA

Skills for Work courses (covering SCQF Levels 3-5)

Automotive Skills	Energy
Building Services Engineering	Engineering Skills
Construction Crafts	Food and Drink Manufacturing Industry
Creative Digital Media	Laboratory Science
Creative Industries	Practical Experiences: Construction and Engineering

Source: SQA

National Progression Awards (covering SCQF Levels 3-5)

Administration: Information and Technology Audio	Digital Media Editing
Art and Design: Digital Media	Digital Passport
Building Services Engineering	Internet Technology
Business with Information Technology	Mobile Technology
Computer Games Development	PC Passport
Computer Networks and Systems	PC Passport: Beginner
Computer Refurbishment	PC Passport: Intermediate
Computers and Digital Photography	Practical Science
Cosmetology	Science and Health
Creative Industries	Science and Technology
Cyber Security	Social Software
Digital Literacy	Software Development
Digital Media	Television Production
Digital Media Animation	Web Design
Digital Media Basics	Web Design Fundamentals

Source: SQA

Awards (covering SCQF Levels 3-5)

Cyber Security Fundamentals
Internet Safety

Source: SQA

National Certificates (covering SCQF Levels 3-5)

Applied Sciences	Engineering Practice
Computer Arts and Animation	Engineering Systems
Computer Games Development	Fabrication and Welding Engineering
Computing with Digital Media	Land-based Engineering: An Introduction

Computing: Technical Support	Manufacturing Engineering
Creative Industries	Mechanical Maintenance Engineering
Digital Media Computing	Mobile Technology
Electrical/Electronic Engineering	Social Sciences

Source: SQA

Foundation Apprenticeships frameworks

Civil Engineering
Creative and Digital Media
Engineering
Food and Drink Technologies
IT: Hardware Systems Support
IT: Software Development
Scientific Technologies
Social Services and Healthcare

Source: SDS

Modern Apprenticeship 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) (no longer exists)
Construction: Technical	Pharmacy Services (no longer exists)
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 (no longer exists)
Gas Heating & Energy Efficiency	Wind Turbine Installation and Commissioning (no longer exists)
Gas Industry	Wind Turbine Operations and Maintenance

Source: SDS

Graduate Apprenticeship frameworks

Civil Engineering
Creative and Digital Media
Engineering
Food and Drink Technologies
IT: Hardware Systems Support
IT: Software Development
Scientific Technologies
Social Services and Healthcare

Source: SDS

College superclasses

C: Information Technology and Information
Computer Technology

IT: Computer Science / Programming / Systems
IT: Computer Use
Information Systems / Management
Text / Graphics / Multimedia Presentation Software
Software for Specific Applications / Industries
Information Work / Information Use
Information Systems / Management
Libraries / Librarianship
R: Science and Mathematics
Science and Technology (general)
Mathematics
Physics
Chemistry
Astronomy
Earth Sciences
Land and Sea Surveying / Cartography
Life Sciences
X: Engineering
Engineering / Technology
Metals working / Finishing
Welding / Joinery
Tools / Machining
Mechanical Engineering
Electrical Engineering
Power / Energy Engineering
Electronic Engineering
Telecommunications
Electrical / Electronic Servicing
Aerospace / Defence Engineering
Ship and Boat Building / Marine / Offshore Engineering
Road Vehicle Engineering
Vehicle Maintenance / Repair
Rail Vehicle Engineering

Source: SFC

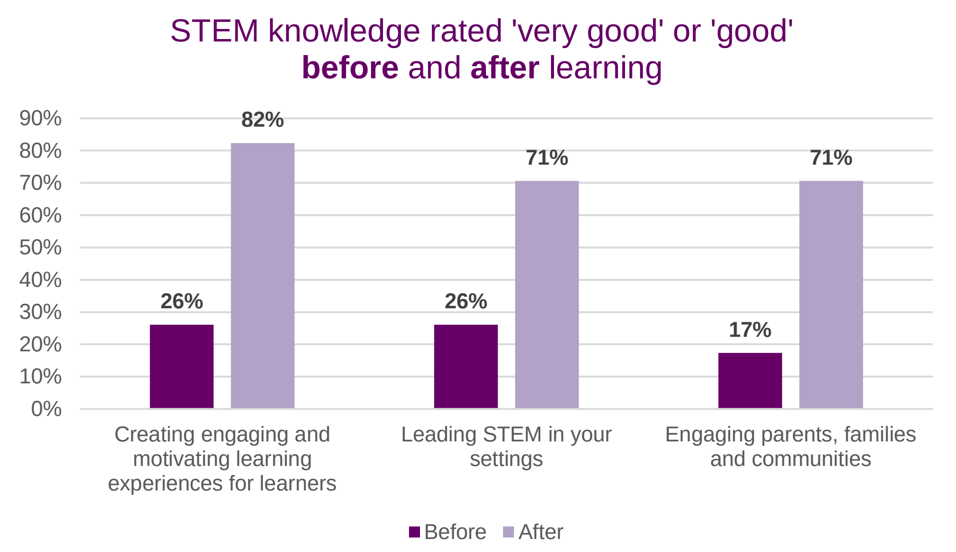
University subjects

Subjects allied to medicine
Biological sciences
Engineering & technology
Physical sciences
Computer science
Medicine & dentistry
Architecture, building & planning
Mathematical sciences
Agriculture & related subjects
Veterinary science

Source: HESA

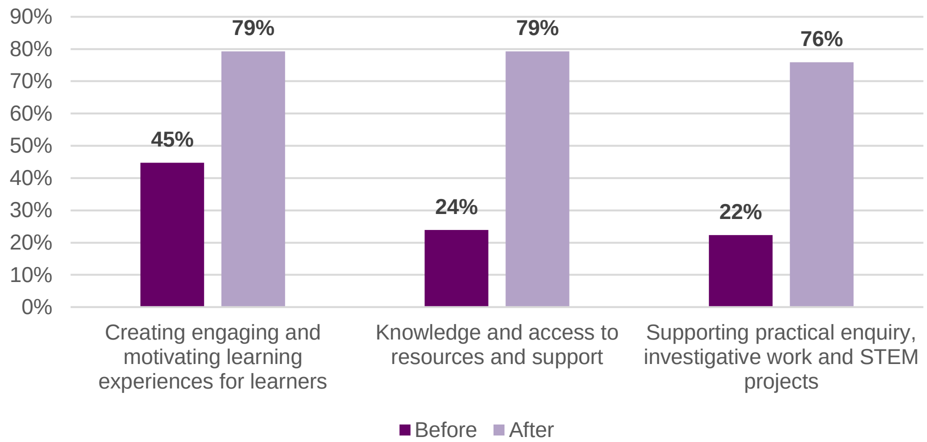
Appendix 5: STEM practitioner survey summary

Early Learning and Childcare			
Total responses	**34**	**Main project(s) undertaken by ELC practitioners**	Scottish Childminding Association ➢ **88%**
Main method(s) of delivery for learning received by ELC practitioners	1. Face-to-face workshop (**50%**) 2. Online learning (**45%**)	**Main activities undertaken by ELC practitioners**	1. Practical activities (**57%**) 2. Group work (**43%**)
Ease of access to STEM learning before the STEM Grants programme	Very difficult or fairly difficult ➢ **33%**	**Main barrier prior to currently learning, highlighted as a significant or moderate issue**	Lack of funding to pay for training ➢ **30%**
Skills related to STEM rated 'very good' or 'good' following learning	1. Problem-solving (**83%**) 2. Communication (**78%**) 3. Confidence (**72%**)	**Awareness of equity and equality issue in STEM before and after learning**	Before: **65%** After: **78%**
Capabilities in STEM after the STEM Grants programme	Significantly or moderately improved ➢ **72%**	**Whether learning met ELC practitioners' expectations**	Met most, all or exceeded expectations ➢ **89%**

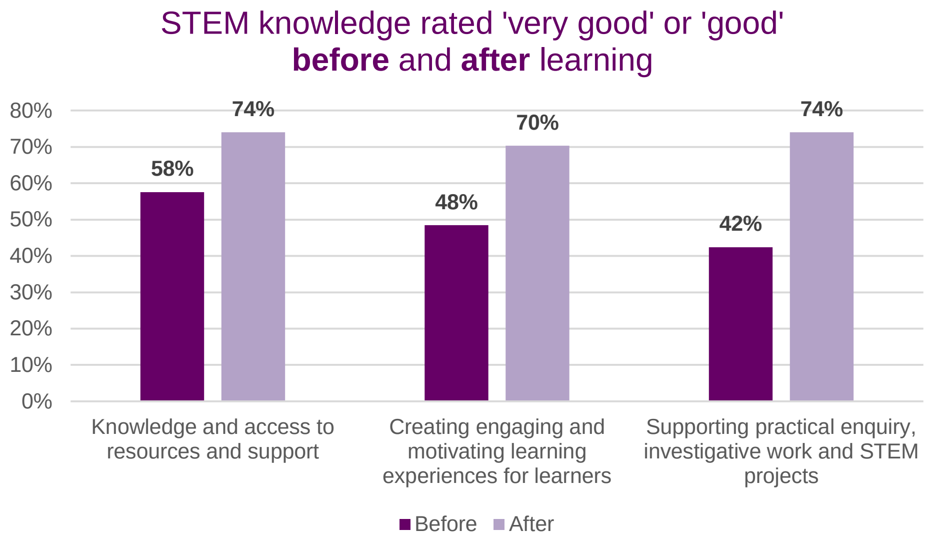


Primary			
Total responses	**77**	**Main project(s) undertaken by primary practitioners**	1. Glasgow City Council (**38%**) 2. Forth Valley College (**25%**) 3. Highland Council (**19%**)
Main method(s) of delivery for learning received by primary practitioners	1. Face-to-face workshop (**38%**) 2. Face-to-face course (**25%**)	**Main activities undertaken by primary practitioners**	1. Practical activities (**92%**) 2. Networking (**65%**) 3. Group work (**58%**)
Ease of access to STEM learning before the STEM Grants programme	Very difficult or fairly difficult ➢ **46%**	**Main barrier prior to currently learning, highlighted as a significant or moderate issue**	Difficulty finding staff cover ➢ **59%**
Skills related to STEM rated 'very good' or 'good' following learning	1. Confidence (**85%**) 2. Communication (**81%**) 3. Leadership (**78%**)	**Awareness of equity and equality issue in STEM before and after learning**	Before: **78%** After: **95%**
Capabilities in STEM after the STEM Grants programme	Significantly or moderately improved ➢ **90%**	**Whether learning met primary practitioners' expectations**	Met most, all or exceeded expectations ➢ **89%**

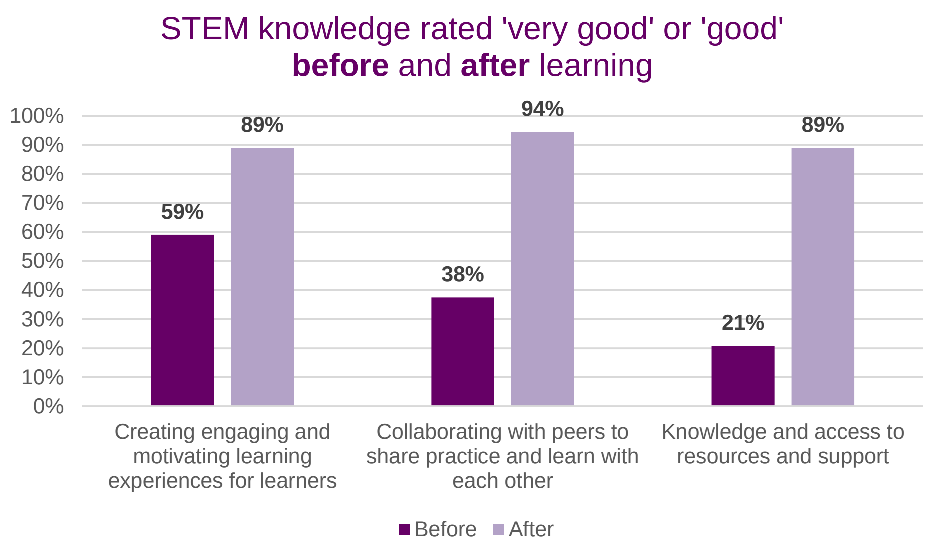
STEM knowledge rated 'very good' or 'good' **before** and **after** learning



Secondary			
Total responses	**47**	**Main project(s) undertaken by secondary practitioners**	1. Royal Society of Chemistry (**65%**) 2. Institute of Physics (**28%**)
Main method(s) of delivery for learning received by secondary practitioners	1. Face-to-face workshop (**55%**) 2. Face-to-face course (**23%**)	**Main activities undertaken by secondary practitioners**	1. Practical activities (**84%**) 2. Group work (**74%**) 3. Networking (**61%**)
Ease of access to STEM learning before the STEM Grants programme	Very difficult or fairly difficult ➢ **40%**	**Main barrier prior to currently learning, highlighted as a significant or moderate issue**	Difficulty finding staff cover ➢ **59%**
Skills related to STEM rated 'very good' or 'good' following learning	1. Confidence (**83%**) 2. Communication (**72%**) 3. Team working (**72%**)	**Awareness of equity and equality issue in STEM before and after learning**	Before: **86%** After: **96%**
Capabilities in STEM after the STEM Grants programme	Significantly or moderately improved ➢ **90%**	**Whether learning met secondary practitioners' expectations**	Met most, all or exceeded expectations ➢ **83%**



Community Learning and Development			
Total responses	**33**	**Main project(s) undertaken by CLD practitioners**	1. Aberdeenshire Council (**48%**) 2. Aberdeen Science Centre (4**2%**)
Main method(s) of delivery for learning received by CLD practitioners	Face-to-face workshop ➢ **87%**	**Main activities undertaken by CLD practitioners**	1. Practical activities (**100%**) 2. Group work (**65%**) 3. Networking (**65%**)
Ease of access to STEM learning before the STEM Grants programme	Very difficult or fairly difficult ➢ **37%**	**Main barrier prior to currently learning, highlighted as a significant or moderate issue**	Lack of funding for training, transport and accommodation ➢ **50%**
Skills related to STEM rated 'very good' or 'good' following learning	1. Communication (**90%**) 2. Creativity (**90%**) 3. Team working (**81%**)	**Awareness of equity and equality issue in STEM before and after learning**	Before: **79%** After: **95%**
Capabilities in STEM after the STEM Grants programme	Significantly or moderately improved ➢ **86%**	**Whether learning met CLD practitioners' expectations**	Met most, all or exceeded expectations ➢ **86%**



Appendix 6: STEM End Beneficiary survey summary

School pupils and college students			
Total responses	**81**	**Main way(s) pupils or students have been involvement in STEM**	1. School: Teaching (**75%**) 2. School: Practical activities (**63%**) 3. STEM event (**32%**)
Reasons for studying or choosing to study STEM	1. Important for job/future career (**67%**) 2. Enjoy subjects (**54%**) 3. Important for future studies (**47%**)	**What pupils or students enjoy most about STEM learning**	1. Learning new things (**66%**) 2. Building knowledge and skills for job/future career (**55%**) 3. Practical activities (**55%**)
Things pupils or students find most difficult or challenging in STEM learning	1. Learning new skills they were previously unware of (**30%**) 2. Not as good at STEM subjects (**20%**) 3. Group working (**12%**)	**Full understanding of STEM jobs/careers**	Science (**57%**) Technology (**49%**) Engineering (**42%**) Mathematics (**52%**) Digital (**30%**)
Likelihood of choosing a job/career in a STEM area in future following STEM learning	Yes – likely ➢ **53%** No – unlikely ➢ **19%**	**Reason for choosing a job/career in STEM area in future**	1. Find it interesting or enjoy (93%) 2. Many jobs in STEM (**59%**) 3. Good at STEM subjects (**52%**)

Adult or older learner			
Total responses	**24**	**Main way(s) adults or older learners have been involvement in STEM**	1. Attending a STEM event (**65%**) 2. Online learning (**47%**) 3. Workplace Visits (**41%**)
How adults or older learners became aware of additional training or learning in STEM	1. STEM event (**25%**) 2. Social media (**25%**) 3. Word of mouth (**19%**)	**Main reasons for undertaking learning in STEM**	1. Increase knowledge and skills in STEM (**100%**) 2. Enjoy or find it interesting (**44%**) 3. Inspired by STEM company/visit (**38%**)
What adults or older learners enjoy most about STEM learning	1. Undertaking practical activities (**63%**) 2. Specific subjects (**50%**) 3. Building skills for job/future career (**44%**)	**Aspects of STEM learning described as 'very helpful' or 'helpful'**	Content of learning (**100%**) Skills learnt (**100%**) Relevance of learning to future studies/career (**87%**) Teaching methods (**81%**) Frequency of learning (**69%**)
Likelihood of choosing a job/career in a STEM area in future following STEM learning	More likely ➢ **50%** No change ➢ **50%**		

Parents			
Total responses	**8**	**Phase of child or children's education**	1. Early years (**46%**) 2. Primary school (**46%**) **3.** Secondary School (**8%**)
Parents understanding of STEM themes, rated 'fully understood' or 'a lot of understanding' before STEM learning	Science (**17%**) Technology (**33%**) Mathematics (**50%**) Digital (**17%**)	**How parents become aware of additional training or learning in STEM**	1. STEM event (**33%**) 2. Personal research online (**17%**) 3. Social media (**17%**)
Parents' main reasons for learning in STEM	1. To advise/guide child's future (**50%**) 2. Increase STEM knowledge in everyday work/life (**33%**) 3. Enjoy or find it interesting (**17%**)	**What parents enjoy most about STEM learning**	1. Building knowledge to advise children (**30%**) 2. Wider appreciation of STEM in work and life (**20%**) **3.** Learning new things (**20%**)
Parents' understanding of STEM jobs/careers, rating 'fully understood' or 'a lot of understanding' since STEM learning	Science (**33%**) Technology (**60%**) Engineering (**20%**) Mathematics (**60%**) Digital (**40%**)	**Since undertaking STEM learning, how informed do parents feel around about education, jobs and careers in STEM**	More informed ➢ **83%**