The Scottish Parliament
Pàrlamaid na h-Alba

Education and Skills Committee
Comataidh Foghlam is Sgilean

Report on STEM in early years education

Contents

Education and Skills Committee

To consider and report on matters falling within the responsibility of the Cabinet Secretary for Education and Skills.

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Summary of recommendations

1.   The Committee believes the Scottish Government needs to be able to demonstrate, through clear measures, progress towards:

-improving access to training to increase teacher and early years practitioner confidence, especially in technology and engineering, and

-improving access to adequate internet connectivity and other resources to support STEM learning experiences, including in remote and rural areas.

2.   The Committee also believes that gender discrimination and compounded disadvantage from living in deprivation are issues that require systemic change. The Committee is therefore recommending more of a focus on long-term interventions in school and early learning settings when the Scottish Government is measuring progress towards the STEM strategy's aims.

Teacher and early years practitioner confidence

3.   The Committee recommends that teacher and early years practitioner confidence levels should only be expressed in Scottish Government progress reports as four separate percentages for the four disciplines of Science, Technology, Engineering and Mathematics. Presenting one overall confidence level for STEM as a whole can mask the low levels of confidence in teaching engineering and technology.

4.   Given the evidence on very low confidence levels in technology and engineering, the Committee recommends that Education Scotland ensures, in balancing the allocation of future Enhancing Professional Learning grants, that there is sufficient emphasis on improving confidence in technology and engineering.

Initial Teacher Education (ITE)

5.   The Committee recommends that Education Scotland publishes a detailed breakdown of work it has undertaken since 2016 to assess the delivery of primary teacher initial teacher education. This should include all work to assess whether there has been a sufficient focus on STEM in one year courses.

6.   At present, the GTCS accredits course content and Education Scotland assesses its delivery. The Committee considers that the evidence received to this inquiry on initial teacher education supports its previous recommendation from its *Teacher Workforce Planning for Scotland's Schools* inquiry. The Committee recommended that there would be merit in having the same organisation accrediting courses and assessing their delivery. The Committee invites the Scottish Government to re-consider this recommendation.

Early years practitioners

7.   Private and third sector providers are key to the delivery of funded childcare including the expansion to 1,140 hours for all children over the age of three by August 2020. The Committee welcomes the Minister for Further Education, Higher Education and Science's commitment to consider the extent to which sufficient training on STEM, including from the Scottish Schools Education Research Centre,

is accessible to those in private and third sector early learning settings. The Committee requests a detailed update on this work in the Scottish Government's response to this report.

Continuing Professional Development (CPD)

8.   The Committee welcomes the commitment from the Minister to produce a new measure to understand "how the whole country is benefitting" [1] from STEM training opportunities. The Committee recommends that such a measure should provide an indication of the extent to which teachers and early years practitioners face barriers to accessing training. The Committee recognises the existing pressures on practitioners and therefore recommends that Education Scotland should be responsible for the work required to collate this new data.

Knowledge sharing opportunities

9.   The Committee recommends that an existing initiative, such as the regional hubs or the national e-portfolio, should be expanded to include an online platform that enables connections between those keen to share expertise and practitioners seeking experience. The Committee has no desire to recommend additional initiatives when so many already exist in relation to STEM, many of which are in their early stages.

Collaboration between schools - working in clusters

10.   The Committee recommends that Regional Improvement Collaboratives should map cluster working across their regions. This work could help establish where cluster working between schools is well established and where there are gaps in support for cluster working.

11.   The Committee recommends that this work should include mapping cluster work between early learning and childcare settings and primary schools, as well as mapping collaborative work between primary and secondary schools.

STEM's place in the curriculum

12.   The Committee recommends that the Scottish Government considers the extent of the focus in the education system on literacy, numeracy, health and wellbeing. This includes in: the National Improvement Framework; Education Scotland guidance; school improvement plans, and the inspection regime. The extent of the focus on literacy and numeracy and the practice of teaching them as stand-alone topics in large blocks of primary school timetables, limits the opportunity for interdisciplinary learning.

13.   The Committee recommends that the Scottish Government and its agencies, and by extension the leadership within schools, ensure a sufficient emphasis on interdisciplinary learning in early education. The Committee highlights to the Scottish Government the positive evidence received on the potential of interdisciplinary learning. This includes how it reflects the ethos of Curriculum for Excellence and how it can contribute towards curricular priorities including literacy and numeracy.

Quality of internet connectivity in schools

14.   Given the evidence received, the Committee recommends that the Scottish Government, in conjunction with local authorities, explore the extent to which STEM learning experiences are being limited by the standard of the internet connection in schools across Scotland.

Deprivation

15.   The Committee is concerned at anecdotal evidence that some school staff are paying for resources and also that parents are often called upon to fund and support activities. The Committee recommends that Education Scotland works with the Learned Societies Group to repeat the 2014 study which found that "98% of [primary school] respondents drew on additional funding for practical activities, with parental sources the most common for extra-curriculum activity."[i] [2]

16.   The Committee recommended in its inquiry into Attainment and Achievement of School Aged Children Experiencing Poverty that the Scottish Government assess the extent to which there is charging for access to school education. The Committee seeks an update on this work, including in relation to STEM learning experiences.[ii]

17.   The Committee also recommends that the inspection regime ensures that the fabric of a school, including required apparatus and technology to deliver STEM learning experiences, is a sufficient focus of the inspection process.

18.   The Committee recommends that the Scottish Government develops a means of measuring targeted long-term interventions within early learning and primary settings in deprived areas. The Committee has heard in evidence that closing the deprivation 'equity gap' in relation to STEM has been a long held policy ambition and that long-term interventions are key to making progress.

Remote and rural areas

19.   The Committee recommends that the Scottish Government reviews its approach to publicly funded large STEM related initiatives to ensure the approach taken by such initiatives focuses sufficiently on remote and rural areas. Such a review should take into account the need to counteract the urban bias and 'self-selection' bias of numerous smaller projects.

20.   In relation to the Raising Aspirations in Science Education programme, the Committee welcomes the decision to roll out the programme to all interested local authorities as a result of the positive outcomes generated by the initial pilots. However, the Committee would be concerned if the continuity of such a valuable

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[i] The Committee notes the Learned Societies Group needs the support of Education Scotland to expand its sample size to include more primary schools.

[ii] Relevant recommendations of *What Support Works: Attainment and Achievement of School Aged Children Experiencing Poverty:* "The starting point to address this issue of charging for access to school education is to assess the extent of this practice. The Committee recommends that the Scottish Government surveys all education authorities to establish which authorities sanction charging for in-school activities and the level of these charges. The Committee also recommends that the Scottish Government undertake a review of which elements of the experiences offered by schools may attract a charge and the cumulative impact of these charges."

programme was lost where the pilot has already run in remote and rural areas. The Committee requests an update on the sustainability of all pilots in the Government response to this report. Progress in mainstreaming STEM is being pursued through various initiatives and it is important that large scale publicly funded initiatives with the potential for long-term positive impact are sustained.

Gender

21. The Committee recommends that the Improving Gender Balance and Equalities programme should specifically monitor whether the new Education Scotland IGBE team has the staff numbers and the capacity to provide support that can reach schools and early learning settings across Scotland in a meaningful way.

22. The Committee recommends that the Scottish Government, in its work measuring progress against the aims of its STEM strategy, develops a means of measuring tangible progress in schools and early years settings in relation to gender balance. The Committee considers there is a need to be able to assess progress, including where the Minister suggests that some work may deliver "long-term impacts" [3] .

Introduction

23.	The Scottish Government published its Science, Technology, Engineering and Mathematics (STEM) strategy on 26 October 2017. The strategy, which runs from 2017 to 2022, states:

> The Strategy aims to build Scotland's capacity to deliver excellent STEM learning, and to close equity gaps in participation and attainment in STEM. It also aims to inspire young people and adults to study STEM, and to provide a better connection between STEM education and training and the needs of the labour market in Scotland.

24.	The Committee's inquiry has looked at progress towards these aims since 2017, including scrutinising the first annual progress report on the strategy which was published in February 2019. The Committee is aware that a number of the issues the strategy seeks to address are systemic, such as in relation to gender balance. There were a number of substantial pieces of work undertaken in advance of the strategy being published, which looked at the same issues and made recommendations seeking to address similar aims. Professor Ian Wall highlighted two examples to the Committee:

> I have chaired two committees: first, the science and engineering education advisory group and, subsequently, STEMEC, both of which wrote long and detailed reports for the Scottish Government that were fully evidenced. The STEMEC report was said to be the basis of the science strategy for learning and teaching, although a good chunk of what was in it did not really appear. [4]

25.	Professor Wall also highlighted the key to making progress in relation to systemic issues, such as gender discrimination:

> Evidence indicates that clear leads from the top, identification of practical programmes with clear targets and consistent engagement by senior management are essential if change is to be made in schools and other institutions. [5]

26.	Given this context, the Committee's inquiry has sought to focus on what work makes a real impact on systemic issues and the evidence of the progress the Scottish Government is making towards addressing these issues.

27.	The Committee's initial work for this inquiry heard that children's perceptions of what type of people can perform different job roles can be defined as early as the age of seven. This can become the basis for perpetual cycles where stereotypes learned at an early age limit aspirations and eventually inform career choices in later life. The Committee's STEM inquiry has therefore focussed on STEM learning experiences of three to seven-year-olds in early learning and childcare and primary school settings.

28.	The inquiry has explored the extent to which STEM subjects are included in the learning experiences of those aged three to seven and the impact that this has on young people including broadening their horizons, developing an interest in particular STEM disciplines and eventually leading to future careers. This focus is in

part because the Committee appreciates the value of STEM disciplines in the workforce required for the fourth industrial revolution. It also appreciates the value of interdisciplinary learning involving STEM subjects, including to ensure the workforce of the future has transferable skills and can move between disciplines, possibly numerous times, as the economy evolves.

29. The Committee is also aware that tackling 'equity gaps' is vitally important from an individual learner level up to societal level, including to ensure inclusive economic growth. Given this, the Committee has focussed on equity gaps in learning experiences, namely:

    - gender: including the need to tackle conscious and unconscious bias;

    - deprivation: including the need to provide long-term sustained interventions, and

    - rurality: including the need to understand distinct challenges for accessing teacher training and other resources in remote and rural areas.

30. The Committee explored whether teachers and early learning practitioners have the skills, confidence and resources to teach STEM subjects alongside many other areas in the curriculum. In addition, it looked at the success of a wide variety of positive STEM initiatives, including those supported by schools, further and higher education, businesses, science centres, science festivals and the third sector. The Committee has heard about the barriers to success for these initiatives and also explored how best practice can be shared.

31. The Committee held an evidence session on 27 March 2019 to discuss the possible focus of a STEM inquiry. The Committee's inquiry then involved a call for written views; four evidence sessions in formal committee meetings; a visit to the Primary Science Education Conference and Children's Conference on 7 June, and a workshop with teachers and others at the Scottish Learning Festival on 25 September.[iii] The Committee also wrote to the Minister for Further Education, Higher Education and Science for details of the funding streams supporting the implementation of STEM policy as set out in the Scottish Government's STEM Strategy (running from 2017 to 2022). These two documents provided useful context for the Committee's work. The evidence received by the Committee and its associated recommendations to the Scottish Government and others are all available in full on the Committee's webpage and are analysed in the remainder of this report.

32. **The Committee wants to begin by acknowledging the amount of innovation occurring across Scotland in relation to STEM, some of which is at an early stage. As highlighted in this report, the focus must be on ensuring efforts are channelled into sustainable co-ordinated work that can be scaled up and embedded in learning approaches across Scotland. The Committee believes STEM learning experiences should be available to all children in early learning and primary school and is mindful of the need to ensure STEM learning is perceived as core to the curriculum and mainstreamed in practice.**

[iii] The Committee's membership changed a number of times during the course of the inquiry. On 3 September 2019 Gail Ross was appointed to the Committee replacing Gordon MacDonald. On 10 September 2019: Beatrice Wishart replaced Tavish Scott; Daniel Johnson replaced Johann Lamont; and Alison Harris replaced Oliver Mundell.

Within this, the Committee has also heard how effective interdisciplinary learning can be, including in developing literacy and numeracy skills in young children.

33. **At the outset the Committee wants to say how inspiring it found hearing from early years practitioners and teachers in person who are passionate about STEM disciplines, including self-confessed 'STEM converts'. Their motivation and determination to share their experiences with other practitioners and to inspire children was so tangible when they spoke of their work. The Committee wants to thank them and all others who contributed to this inquiry.**

34. **The Committee believes the Scottish Government needs to be able to demonstrate, through clear measures, progress towards:**

    -improving access to training to increase teacher and early years practitioner confidence, especially in technology and engineering, and

    -improving access to adequate internet connectivity and other resources to support STEM learning experiences, including in remote and rural areas.

35. **The Committee also believes that gender discrimination and compounded disadvantage from living in deprivation are issues that require systemic change. The Committee is therefore recommending more of a focus on long-term interventions in school and early learning settings when the Scottish Government is measuring progress towards the STEM strategy's aims.**

Teacher and early years practitioner confidence

36.   A number of submissions to this inquiry highlighted a lack of confidence in pursuing STEM focused activities with children in early learning and primary school settings. Elisabeth Kelly, a principal teacher, noted that early years professionals "can lack understanding in STEM disciplines. This lack of understanding leads to a lack of confidence. Practitioners can become daunted by STEM, when in reality it is occurring naturally all day and in everyday experiences and activities." [6] Education Scotland further noted that practitioners working in early learning and primary settings "may not recognise the learning they are leading as being science or STEM related". Lorna Hay, a primary school teacher, emphasised the importance of ensuring that teacher confidence in STEM is considered in its constituent parts. She commented on the content of the first annual report from the Scottish Government which is intended to measure progress against the aims of the Scottish Government's STEM Strategy:

> I was quite surprised that the report of the first year of the strategy said that 63 per cent of teachers said that they either agreed or strongly agreed that they were confident in teaching STEM subjects. I feel that that figure is rather high, so I wondered about it. When I asked the staff in my school about this, I made a point of separating the subjects. We are talking about science, technology, engineering and maths, so we have to be very cautious about bundling the four together and asking teachers whether they are confident about teaching STEM. You will find that probably the majority are very confident about teaching maths and, possibly, about science and basic information and communication technology, but they are not confident at all about teaching computer science and engineering. [7]

37.   The perspective that engineering and technology are the areas where teachers feel least confident was reflected in numerous pieces of evidence to the Committee. Dr Kirsty Ross, a public engagement lead at the University of Strathclyde, noted from service evaluations of her STEM training session: "Most were OK when it came to science and maths but struggled with technology and engineering" [8] Susan Boyd, a primary teacher, made a submission that included a staff survey from Breadalbane Academy, the findings of which include: "Very few primary practitioners had a higher level of learning in Technology and Engineering with Engineering receiving 7 "not confident" votes." [9]

38.   At the Scottish Learning Festival workshop teachers and early years practitioners were asked to vote on confidence levels broken down by STEM discipline. Attendees were asked: "Which element of STEM do you feel most confident in?" – 45% said science, 2% technology, 3% engineering, 50% maths. Attendees were then asked: "Which element of STEM do you feel least confident in?" – 5% said science, 27% technology, 62% engineering, 5% maths." [10]

39.   Education Scotland concurred with the findings on technology and engineering:

> Our experience, from both the [Education Scotland] survey results and inspections, shows very clearly that the technology side needs more support, especially engineering, but that we also still have work to do in terms of mathematics and numeracy. That is why the second round of the grants programme, which we launched last week, continues to have an extremely strong focus on mathematics and numeracy. [11]

40. The grants programme referred to was also highlighted by Richard Lochhead, Minister for Further Education, Higher Education and Science:

> Recently, Education Scotland awarded nearly £1.4 million of STEM professional learning grants for teachers, technicians and early and community learning practitioners. A total of 140 new bids will be supported, which will benefit an estimated 722 establishments across the country and nearly 14,000 practitioners this year alone. [12]

41. The Minister added in relation to practitioner confidence levels: "Many of the experts whom I have spoken to and heard from see [teacher and early year practitioner confidence] as key." [13] Evidence to this inquiry clearly reflects very low levels of confidence in technology and engineering for many teachers and early years practitioners who require the support and time to develop more knowledge.

42. The Education Scotland survey cited in the Scottish Government's first annual report on the STEM strategy states '63.4% [of teachers and early years practitioners] agreed or strongly agreed with the statement "I am confident in delivering STEM learning in my practice".''

43. **The Committee recommends that teacher and early years practitioner confidence levels should only be expressed in Scottish Government progress reports as four separate percentages for the four disciplines of Science, Technology, Engineering and Mathematics. Presenting one overall confidence level for STEM as a whole can mask the low levels of confidence in teaching engineering and technology.**

44. **Given the evidence on very low confidence levels in technology and engineering, the Committee recommends that Education Scotland ensures, in balancing the allocation of future Enhancing Professional Learning grants, that there is sufficient emphasis on improving confidence in technology and engineering.**

Initial Teacher Education (ITE)

45. The Committee heard a number of proposals for improving teacher confidence based around: the qualifications required to train as a primary teacher; the content of initial teacher education (ITE), and the ability to access continuing professional development (CPD) (also referred to as career-long professional learning (CPL)).

46. On qualifications, the absence of any requirement for those aspiring to be a primary teacher to have any formal science qualification was raised by the Learned Societies Group which recommended that: "ITE applicants should be expected to

achieve at least one SCQF level 5 qualification in a science as a minimum requirement." [14]

47. The Science, Technology, Engineering and Mathematics Education Committee (STEMEC) 2016 report recommended: "The qualification requirements for applications from students wishing to study to become primary school teachers should be raised to an SCQF Level 5 in a science and after a further five years the requirements should be increased to Level 6 in mathematics and a science." [5] Professor Ian Wall, who chaired STEMEC, explained in evidence to the Committee that this gradual process of increasing the requirements of applications was partly intended to ensure the change in requirements did not act as a deterrent and lead to any drop off in applications.

48. The General Teaching Council for Scotland (GTCS) undertook a consultation in late 2018 on proposals to revise the Memorandum of Entry Requirements for courses to train as a primary teacher. Ken Muir, Chief Executive, commented on the outcome of this work: "The feeling was that our approach of requiring Higher English and a national 5 in maths and recommending a science and/or a modern language is consistent with the evidence that we got through the consultation on the entry memorandum." [15]

49. He and others cautioned against increasing qualification requirements at a time of teacher shortages. "At a time when we are short of teachers in Scotland, we would be likely to dissuade a number of folk who do not meet the requirement from coming into the teaching profession." [16] Toni Scullion, a secondary computing teacher, teachers at the Scottish Learning Festival, and finally the Minister all cautioned about dissuading possible applicants.

50. The GTCS also highlighted that the profile of people applying to become teachers is changing, meaning they may have valuable experience from their previous career in addition to any school or college based qualifications. [17]

51. The Committee also discussed the potential to gain relevant qualifications during ITE or having primary teacher ITE courses with more in depth specialist pathways in STEM. Professor Fiona McNeill, Learned Societies Group, suggested one approach would be "We could accept primary school teachers [into ITE] who do not have any science qualifications and then help them to gain those qualifications as they train, so that when they go into a school they have a solid science foundation." [18]

52. The GTCS reflected recent reaccreditations of courses where specialist pathways are now available. Charliane Simpson from GTCS stated:

> We have reaccredited the University of Strathclyde programme, which has personalisation and choice that allows students to choose a STEM pathway among other pathways. The bachelor of arts course at the University of Stirling also has a STEM focus and students can come out with an enhanced science qualification. At the Dumfries campus of the University of Glasgow, there are pathways in environmental science and mathematics...There are options should students choose to come out with a specialism in science. [19]

53. The delivery of course content in practice was highlighted by a number of teachers who reflected the intense nature of ITE, especially when undertaken in a year long course where a dense course content is covered in a short space of time. This can reflect on the quality of learning and the level of teacher confidence when someone initially qualifies. Two contributions from the Committee's workshop are reproduced below to illustrate this point:

> One teacher responded that...no science qualification was needed to become a primary teacher and ITE covered relevant content in a "handful" of sessions. She surmised that it was an "unreasonable expectation" for primary teachers to be knowledgeable in all of these areas.
>
> A primary teacher who recently completed ITE reflected on her experience suggesting that she had been shown how to do a number of experiments during her training but that the time available for training in this area was limited due to the amount of course content to work through in teacher training. For example she had not been taught how to 'range up' or 'range down' for different age groups and felt she did not have a depth of understanding and therefore would struggle to embed learning in the classroom. [10]

54. The Learned Societies Group has recommended that "the Scottish Government and the GTCS should review the provision of science and mathematics within ITE Primary Education programmes. This should cover both the disciplinary content and pedagogy of science and mathematics." It argues that: "… 'Teaching Scotland's Future' was clear on the need for science and mathematics to feature prominently in ITE programmes for primary teachers. While the Scottish Government has reviewed the number of hours dedicated to literacy, numeracy, health and wellbeing, equality and data literacy in ITE programmes, this did not consider science. In our response to the GTCS, the Learned Societies Group recommended that the Scottish Government and GTCS should review the provision of science and mathematics within ITE Primary Education programmes. The review should cover both the disciplinary content and pedagogy of science and mathematics." [2]

55. The Committee's inquiry into *Teacher Workforce Planning for Scotland's Schools* was the catalyst for the review of ITE content on literacy and numeracy referred to by the Learned Societies Group above.

56. When asked about course content and its delivery in relation to science the GTCS responded:

> The difficulty, or the tension, is about how much can be embedded within an initial teacher education programme, particularly the one-year postgraduate programme. We have had lots of representation from various parties who would like to see more within that programme. Although we talk about it being a postgraduate year, in fact it is 36 weeks, 18 of which are spent in a university and 18 of which are spent on placement. [15]
>
> In initial teacher education, we accredit the programmes as presented to us. We do not have a formal role [evaluating delivery of ITE programmes]. That formal role sits with Education Scotland and HMIE, which, at the request of the committee and the ministers, undertake reviews of aspects of teacher education. GTC Scotland plays no role in that, although I know from discussions with Gayle Gorman, the chief executive, that she, like me, has recognised an inconsistency in having an organisation that accredits the programmes but then has no role in monitoring the implementation of them. Gayle Gorman has given an undertaking that GTC Scotland will be represented in any initial teacher education review that the committee or ministers call for in future. [20]

57. The Committee's inquiry report *Teacher Workforce Planning for Scotland's Schools* stated: "The Committee recommends that the cycle of revisiting existing courses to renew accreditation should be shorter to ensure course content is responsive to the changing needs of Scottish education." It also recommended that "the Scottish Government considers the benefits of making one organisation responsible for the accreditation of ITE courses and the assessment of the delivery of these courses."

58. The Committee appreciates that it is challenging for initial teacher education to cover every aspect of a primary teacher's role in detail. At a time of teacher shortages there has been an increase in those undertaking shorter initial teacher education courses to increase the number of teachers in schools across Scotland. Evidence suggests that intense courses provided over short periods of time can sometimes come at a cost in terms of the depth of the learning experience and the associated levels of confidence when teachers graduate.

59. **The Committee recommends that Education Scotland publishes a detailed breakdown of work it has undertaken since 2016 to assess the delivery of primary teacher initial teacher education. This should include all work to assess whether there has been a sufficient focus on STEM in one year courses.**

60. **At present the GTCS accredits course content and Education Scotland assesses its delivery. The Committee considers that the evidence received to this inquiry on initial teacher education supports its previous recommendation from its *Teacher Workforce Planning for Scotland's Schools* inquiry. The Committee recommended that there would be merit in having the same organisation accrediting courses and assessing their delivery. The Committee invites the Scottish Government to re-consider this recommendation.**

Early years practitioners

61.   The Committee has sought to ensure in evidence taking that there has been sufficient emphasis on the distinct challenges faced by early years practitioners. The Committee is very aware of the often high level of staff turnover experienced in the early years sector, the reduction in the number of teachers in the sector and the distinct training routes followed by staff. Elisabeth Kelly, a principal teacher, explained in evidence to the Committee:

> Most of the practitioners that we work with in early learning and childcare do not go through the initial teacher education programme; they come from many other avenues, because they are not teachers. Few authorities still have teachers in early learning and childcare. There are some, but, even in those authorities, a majority of the staff in early learning and childcare settings are early learning practitioners. They may have higher national certificates, higher national diplomas or a bachelor of arts degree in childhood practice, if they are at graduate level. Some have level 3 Scottish vocational qualifications. A wide range of courses are presented within that structure but, from the research that I have done—which has been largely anecdotal, from asking people—there is very limited STEM input to those courses. [21]

62.   Susan Boyd, a primary teacher, highlighted the challenging role of an early years practitioner:

> Early years practitioners, who are not teachers, are being asked to teach children to the same level as teachers would. On top of that, they have all the care standards to meet. They have a lot on their plates. [22]

63.   The availability of opportunities for CPD for early years practitioners was explored with the Scottish Government in evidence. Niamh O'Connor, Head of Early Learning and Childcare Quality Unit, detailed opportunities for CPD, including in light of the increased workforce required to deliver 1,140 hours funded childcare from August 2020:

> The Education Scotland STEM grants are accessible by private, voluntary and independent providers of funded ELC... as the minister said, "Early Learning and Childcare National Induction Resource"...includes a directory of the CPL opportunities that are available to all staff, no matter the sector that they work in—local authority, private, voluntary or independent. That document is available on the Care Inspectorate's website. It has a section on STEM resources that practitioners can use. [23]

64.   The Scottish Schools Education Research Centre (SSERC), the main training provider for primary teachers for STEM learning, highlighted a recent shift in its focus towards the provision of training to early years practitioners. Alastair MacGregor, Chief Executive Officer of SSERC stated:

> ...I have been in post for just over a year and a half. During that time, the organisation has been through a significant amount of organisational change and some diversification. Part of the diversification is intended to broaden our offering to include early years practitioners and, now, childminders. [24]

> 〃 Yes. There is a massive appetite [from private or third sector early years practitioners] for doing it. However, the funding of our organisation comes, in many circumstances, from the public purse either through the Scottish Government or through local authorities that are members of our organisation, so our focus has been primarily on working with the state sector. [25]

65. The Minister was asked about the potential for an imbalance in access to STEM training for early years practitioners between those in the state sector and those in the private and independent sectors. The context for this is the vital role these sectors are required to play in the expansion of funded childcare to 1,140 hours per child over the age of 3 by August 2020. As set out above there are a number of learning opportunities available to all sectors. The question was specifically focussed on provision through SSERC. The Minister responded:

> 〃 There is clearly an issue, in that local authority nurseries have, in relation to early years provision, more access to support in some areas. I am keen to look at that and am doing so at the moment...However, there is a lot happening for private providers, as well as for local authority providers. As part of the expansion, there is an induction programme that takes into account STEM learning, which is open to private providers and local authority providers...Education Scotland has also set up online portals for STEM activities and advice, which are available to private providers as well as to local authority providers. [26]

66. The Minister also stated in relation to SSERC that as it is funded by local authorities it is there primarily for training of local authority staff. [27] The Committee notes that SSERC is jointly funded by local authorities and the Scottish Government. The Minister's letter on funding streams for STEM activity states that Scottish Government funding for SSERC for 2019-20 will be £870k.

67. To summarise, SSERC training, whilst being only one of a number of forms of training available to the private and third sectors, has been particularly praised in evidence to the Committee, including the provision of twilight sessions and online 'cookalongs'. SSERC suggested in evidence that there is a massive untapped appetite from private and third sector providers for continuing professional development. Local authority funding for SSERC is understandably allocated to the training of state sector schools and early years settings. The funding streams for private and independent sector support from SSERC are much more limited in that SSERC can provide support to private and third sector providers of early learning and childcare only when it is successful in bidding for grants for such work from Education Scotland.

68. **Private and third sector providers are key to the delivery of funded childcare including the expansion to 1,140 hours for all children over the age of three by August 2020. The Committee welcomes the Minister's commitment to consider the extent to which sufficient training on STEM, including from the Scottish Schools Education Research Centre, is accessible to those in private and third sector early learning settings. The Committee requests a detailed update on this work in the Scottish Government's response to this report.**

Continuing Professional Development (CPD)

69.   The STEM strategy includes a series of measures intended to enable the Scottish Government to assess whether the objectives of the strategy are being achieved. In relation to continuing professional learning the Key Performance Indicator in the Scottish Government's first annual progress report is to: "Increase the cumulative hours of STEM professional learning accessed by early years, schools, college and CLD practitioners annually."

70.   The first annual report states in relation to this indicator:

> Education Scotland introduced new data gathering measures in 2017-18 to track provision of professional learning in STEM. Responses from 44 organisations showed that they collectively provided 109,969 cumulative hours of STEM professional learning between 1 August 2017 and 31 July 2018. At the same time, early learning and childcare and school practitioners were surveyed. Responses from 876 practitioners showed they accessed an average of 21.3 hours of STEM professional learning between 1 August 2017 and 31 July 2018.

71.   A theme of evidence from teachers, early years practitioners and others has been barriers to the ability to access CPD. The NASUWT submission states:

> It remains the case that teachers continue to report that their experiences of Professional Learning are mixed, with nearly a quarter of respondents in the NASUWT Big Question Survey 2019 feeling unable to access Continuing Professional Development (CPD) in the last 12 months. While this statistic could, in part, be due to the reduced resources available to local authorities, it does also raise a question as to whether the Professional Update and local authority Professional Review and Development (PRD) processes are operating as they should at school level. [28]

72.   Nicola Dasgupta, a primary teacher, described an "overload of work for teachers" [29] Lorna Hay, a primary teacher, and Alastair MacGregor, CEO of SSERC, discussed the challenge of finding staff cover in schools:

> Money is not an issue; the issue is actually the bodies. My headteacher has said that it is not a problem to find the money to provide cover for me but that they cannot physically get a supply teacher. [30]

> ...there continues to be that issue that our practitioners have talked about, which is about getting the opportunity to be released to attend these types of intervention. As an organisation, we have to think about how we respond to that issue. We offer a lot of practical activities and practical professional learning within our organisation in Dunfermline, but we now go out to do more local interventions as well, because we realise that there are issues with releasing staff. [31]

73.   The level of class contact time was also cited as a limitation on a teacher's ability to be freed up for CPD, for example as noted by an attendee of the Committee's workshop: "The root of many of the issues is class contact time. If you want

teachers to engage with the CPD necessary to deliver high quality STEM education you have to give them time. Cut class contact time!" [10]

74. The Committee also heard positive feedback for initiatives to help people access training, this included SSERC twilight sessions through an online platform:

> We will broadcast live from our broadcast studios in Dunfermline out to, potentially, 45 to 50 schools where there are a variety of types of practitioners. We send out boxes of resources in advance, and we basically do a cook-along. We say, "Here are the resources and here are the activities. We will show you what you can do with these resources and we will also share the underpinning knowledge—the scientific or STEM basis and the concepts and principles." That seems to work because it is a short intervention of usually an hour to an hour and a half maximum. [25] (Alastair MacGregor, SSERC CEO)

> Although it is miles from Dunfermline, Highland Council has been able to access the SSERC remote delivery, which has had a positive impact on teacher confidence. [32] (Kathryn Thomas, RAiSE Officer, Highland region)

75. Matching the needs of the individual with the opportunities available and also knowing where to find out about these opportunities have both been highlighted as issues. Ian Menzies from Education Scotland stated:

> Another big issue is general knowledge of what is available and resources. In initial teacher education, there is quite limited time to provide that support and learning to teachers who are coming into the system. Connecting them to the fabulous support from the science centres, festivals and other STEM partners is an important part of the support that they can be given. [33]

76. The lack of a sustained approach to training was also raised, such as a lack of support in the longer term following initial training:

> Teacher confidence is a big issue in STEM, and I agree that the approach has been variable in different authorities, with teachers having different experiences. Unfortunately, there is no real mentoring approach where I am. We have had training, but it has been of variable quality. There was a big push on STEM a couple of years ago in my local authority and a lot of time was given to it. However, the approach involved not small groups in which people could have professional dialogue, but a big room with 100 people being talked at by various people who told them how to take forward a certain initiative. There was no real follow-up, so teachers who were not particularly sure or confident had no one to ask. Teachers were all at the same sort of level and were trying to find their way through the training without being sure how. Perhaps a more consistent approach is needed, both to STEM and to CPD more generally. [29]

77. Some evidence from Matt Lancashire, SCDI, also highlighted a lack of co-ordination between initiatives impacting on the long-term effectiveness of the CPD provided:

> The consistent feedback that we have had from the teacher training sessions that we run at YESC is that many teachers acknowledge that they lack confidence in moving the programme forward. Once the kits are out and the outcomes have been delivered, they appreciate them. CPD seems to be lacking in that area. That could be about the mentoring approach or because we need further contact between YESC, the regional co-ordinators and the STEM ambassadors. It seems as though we get to a point at which we have done the training, the kits are there and the kids are ready to go, but then the handholding goes. No further support is there. [34]

78.   The need to 'scale up' positive work to match the scale of the need for development was also emphasised by Dr Gage, Director, Edinburgh Science:

> The STEM strategy is welcome. It has some black-and-white figures in it. The figure that I remember is the 85,000 or 83,000 practitioners—early years, primary or secondary—who require more help in teaching STEM subjects. Although there are great examples around of CLPL programmes, the problem is that their capacity is of the wrong order of magnitude. They are delivering to a few hundred or maybe a couple of thousand a year, which does not stack up well against that 85,000. For me, the frustration is the scale at which things are delivered. There are great examples of things that can be done; we have heard of a few here. However, somehow, as a nation, we are doing it with the wrong number of zeros at the end. We need to find a mechanism that scales up. [35]
>
> I have watched the discussion for 30 years in Scotland. Although the STEM strategy is extremely welcome, it feels like a rerun of things that have gone before. [36]

79.   The Committee sought to get a sense of the reach of some of the positive programmes currently available that support training and associated confidence levels. At the Committee workshop around a third of attendees indicated they had had involvement with STEM ambassadors. Six people from over 50 attendees had had any involvement with SSERC (It should be noted not all attendees were teachers). [10]

80.   The availability of forms of support and training was also highlighted as an issue in evidence with some areas of Scotland better served than others. For example in relation to STEM ambassadors two distinct experiences were conveyed by Kathryn Thomas, a RAiSE development officer and then by Nicola Connor, a primary teacher:

> We suffered from the fact that the STEM ambassador network is based at Aberdeen Science Centre but covers seven local authorities. I think that 300 STEM ambassadors are signed up for the Highland region, but their commitment is to one visit a year and they are spread out, so we have not had much success in using the STEM ambassador network. Somebody suggested that the commitment should be raised from one industry school visit a year to six visits a year. [37]

> I have had a different experience with the STEM ambassadors. STEM East has been fantastic about coming to schools across West Lothian and it has organised and taken part in teach meets to share what it does with all the schools in West Lothian. We have had various engineers and scientists coming into the school. [38]

81. The STEM annual report suggests Education Scotland has established baseline data in relation to CPD and intends to undertake further work in this area. The information appears to be based in large part upon responses from 44 organisations providing learning opportunities. The number of learning opportunities should not be conflated with the number of teachers and early years practitioners undertaking STEM CPD as evidence suggests motivated individuals might undertake numerous training opportunities if they are developing a specialism. Ken Muir, Chief Executive, GTCS was asked whether the forms of CPD being undertaken by teachers is recorded and collated, for example for the purpose of assessing the proportion of primary teachers accessing STEM specific training:

> We do not record the areas in which teachers undertake their professional learning—that is the responsibility of teachers aligned with whoever their reviewer in the school is. [39]

> We have a research hub on our website and, over the past few years, Charlaine Simpson has been responsible for trying to encourage teachers to engage in meaningful but small-scale research... Overall, although we do not measure it in a hard, quantitative way, the qualitative evidence suggests that the incidence of professional learning in STEM is increasing. [39]

82. Where time for training is limited, STEM can lack priority as other curriculum subjects which are prioritised. A deputy headteacher of a primary school spoke on this issue at the Committee's workshop:

> The first comment echoed by a number of others during the discussion was "the issue is workload". The deputy headteacher of a primary school highlighted the number of priorities in the curriculum – literacy, numeracy and wellbeing, the need to train colleagues on the play-based approach. The Deputy Headteacher suggested they were seeking to balance ensuring there is training on STEM with the need to ensure staff are not overloaded with work. [10]

83. The Minister was asked whether there was scope to create an accurate measure of how much STEM related CPD has been undertaken by primary teachers and early years practitioners. The Minister responded:

> There is an appetite out there for career development. It would be helpful to have a better picture, because as well as what the Government is doing there are local initiatives in each local authority area and initiatives that take place through the college hubs. The science centres reach out to pupils and to staff. There is a bit of work to be done; that is a fair point. We need a better picture. [12]

84. The Minister was then asked whether, in a year's time, the Scottish Government will be in a position to accurately report to the Committee how much CPD has been

undertaken in specific STEM areas by primary teachers and early years practitioners. The Minister responded "I hope that that will be the case, yes." [40] He later stated:

> ...there are so many different routes for CPD, so we must keep working on getting a complete picture for the country. There being so many ways in which practitioners can access CPD is a sign of success. We must just make sure that we are on top of it and that we understand how the whole of the country is benefiting. We monitor that and we have our own schemes. There is still a case for having a more complete picture. [41]

85.   There are clearly a wealth of positive opportunities available and under development for continuing professional learning including valuable online formats. There are also clear barriers to training resulting from workload, a difficulty sourcing staff cover and ensuring STEM receives CPD focus when competing with other priorities.

86.   **The Committee welcomes the commitment from the Minister to produce a new measure to understand 'how the whole country is benefitting' [1] from STEM training opportunities. The Committee recommends that such a measure should provide an indication of the extent to which teachers and early years practitioners face barriers to accessing training. The Committee recognises the existing pressures on practitioners and therefore recommends that Education Scotland should be responsible for the work required to collate this new data.**

Knowledge sharing opportunities

87.   The Minister stated in evidence to the Committee: "There should, through the many streams of CPD activity, be opportunities for all practitioners to benefit." [1] With numerous providers of CPD (44 contributed to the Education Scotland survey), in addition to opportunities for learning through collaboration such as informal cluster arrangements and knowledge exchange, the landscape for CPD on STEM is far from straightforward for teachers and early years practitioners seeking to develop. There are also barriers to teachers and early years practitioners being available to spend time sharing knowledge. For example, during the Committee's workshop at the Scottish Learning Festival in Glasgow, out of over 50 attendees no-one had travelled from outwith the Central Belt. At the same workshop one university lecturer contributed, highlighting an opportunity to share knowledge:

> A university lecturer suggested there was scope for university staff, especially those experiencing a drop off in student numbers for certain science courses, could undertake the role of science specialist for primary schools if they had a means of identifying where there was a need. [10]

88.   Some form of online platform where people could add in their availability to share expertise could be valuable. Two relevant strands of work that are at an early stage were highlighted in evidence by the GTCS and then the Minister:

> One of the pieces of work that [GTCS] are doing on behalf of the Scottish Government is creating a national e-portfolio, which is a portal through which teachers can record their professional learning. The added-value part of that is that it enables them to access professional learning opportunities. Things such as the work that Primary Engineer does would feature within that particular portal. [42]

> Colleges are developing 13 regional STEM Hubs to strengthen collaboration between partners including universities, science centres and employers and to facilitate more joint professional learning between schools and colleges. This will include primary and early learning settings from 2019. One of the aims of establishing the hubs is to ensure greater consistency in STEM engagement across different parts of the country. [43]

89.   **The Committee recommends that an existing initiative, such as the regional hubs or the national e-portfolio, should be expanded to include an online platform that enables connections between those keen to share expertise and practitioners seeking experience. The Committee has no desire to recommend additional initiatives when so many already exist in relation to STEM, many of which are in their early stages.**

Collaboration between schools - working in clusters

90.   Ian Menzies, Education Scotland, detailed the positive impact of cluster working that is underway, including the sharing of resources between primary and secondary schools. He suggested the Education Scotland grants programme has a strong focus on cluster working as a result [44] . He went on to detail positive outcomes from completed work:

> Practitioners have told us strongly that the opportunity to work with other practitioners in their schools and their clusters is really valuable and has a high impact on professional learning. For instance, 70 per cent of early learning and childcare practitioners said that working collegiately within their cluster has a high or very high impact and 81 per cent said that working collegiately within their setting has a high or very high impact. [45]

91.   The Committee heard from a number of practitioners, academics and delivery bodies that the preferred approach to building confidence was to cascade knowledge in order to build capacity. Professor Yellowlees from the Learned Societies Group stated: "cluster teaching is vital because we need to look for specialists who can help out" [46] . Larger scale STEM initiatives, such as SSERC's work, acknowledge the benefits of cluster working. The Minister highlighted that, "To date, SSERC's primary science cluster programmes have engaged with 99 school clusters across all 32 local authorities." [12]

92.   Nicola Connor, a primary school teacher, explained the lasting success of the SSERC cluster programme in her experience:

> We have been part of the SSERC cluster programme, the main aim of which is to raise teacher confidence within our cluster. There are six schools and one early years centre in our cluster and we have a science mentor in every school. We did the programme in 2016-17, but even though a couple of the mentors have left to go to promoted posts or different authorities, other mentors have taken over. Importantly, not only did the mentors ask someone to take on the role in their school, but they took the skills and everything that they learned through the SSERC and for themselves and disseminated it into other schools or authorities. [47]

93.   Given the importance of ensuring STEM learning is embedded in the earliest part of the curriculum, and to aid transitions to primary school, the Committee was also interested to learn of the SSERC cluster programme seeking to include early learning and childcare. The Chief Executive Officer of SSERC told the Committee: "...we are having a discussion with one local authority that wants to work in partnership with SSERC to put in place a primary cluster type programme, which focuses specifically on the transition between nursery and primary 1. I hope that we will work in partnership to see what that looks like." [48]

94.   The Learned Societies Group is also at an early stage of rolling out a cluster approach:

> We have taken something like a cluster approach and put experts in place throughout Scotland. Each area now has an expert in STEM, although it will take time for them to go around. It is like a pyramid—we have put in the people at the top and we have to cascade it down. We have started well and the new initiatives will help that to happen, but it will take time. [49]

95.   Cluster working supported by SSERC, Education Scotland, Learned Societies Group or other programmes such as those supported by local authorities require resource, including available specialist staff. The Committee heard of a number of initiatives that undertook positive work but despite being rolled out, had to end due to lack of funding. For example Susan Boyd told the Committee:

> I am really pleased to report that I have seen a lot of wonderful practice, particularly in early years. When I was in Highland, I had the opportunity to support a small cluster of nurseries and 33 principal teachers in a new programme that Highland rolled out and ran for five years until, sadly, budgetary cuts changed that perspective. [50]

96.   Another example was cited in a written comment received during the Committee's workshop:

> In the Council I work at, visiting STEM [secondary school] specialists were great because they had the knowledge and skill to teach the pupils. They were also available for teachers in school to go and ask for advice and guidance. Taking away the Visiting Specialists has made it harder to upskill current staff which has led to increasing teacher's workload. Can we get them back please? [10]

97.   The challenge of finding classroom cover to free up those keen to knowledge share, is more acute in times of staffing shortages, and this can limit the effectiveness of cluster working. This was raised with Education Scotland who confirmed that bids for new grants could be used to fund classroom cover. Specific funding that recognises the merits of encouraging cluster working is welcome, although the need to bid for funding acts as a barrier to a degree. Ian Menzies from Education Scotland stated:

> The new funding stream aims to give teachers the space and time locally to draw on their collective expertise and resources, to learn together and collaborate and to co-develop new approaches...Part of the money might be used for classroom cover [51]

98.   The comments at the Committee's workshop from teachers highlighted the value of cluster working, and there was clearly an appetite for more sustained work of this kind:

> Through running the primary cluster science transition, it is clear there is a space for a specialist PT role to work more consistently with cluster schools. [10]
>
> Another positive example was a secondary teacher working in a primary school cluster where the primary children visited secondary school for science experiment demonstrations. They found visiting high school and the experiments really exciting. Another secondary teacher later in the workshop emphasised the importance of inspiring young children and captivating their imagination during early years education. [10]

99. Although the inquiry has focussed on early learning and primary education, the Committee wishes to highlight that in respect of cluster working with secondary schools, such as the example highlighted above, the overall reduction in the number of school technicians impacts on the ability of secondary school teachers to demonstrate some STEM learning experiences. Figures provided by the Scottish Government show a 10.8% reduction in the number of technicians between 2012 and 2018 (from 1,120 to 999 across Scotland) with 23 of 32 local authorities experiencing a reduction in numbers since 2012. As highlighted in evidence from Scottish Government official Andrew Bruce: "The supply of technicians is a matter for local authorities, which can choose how to deploy their resource in education." [52]

100. Shortages of secondary school STEM specialists also impacts on the ability of secondary school specialist teachers to share knowledge. The availability of STEM bursaries for trainee secondary school teachers was highlighted by the Scottish Government as amongst the measures to increase intake onto ITE for STEM subjects.

101. Time constraints were also cited a number of times during discussions on cluster work. A need for more non-contact time was raised by a number of participants at the Committee's workshop as a means of freeing up teachers to undertake cluster work. In terms of the extent of cluster working, eight people of over 50 in attendance at the workshop indicated that they had taken part (it should be noted that not all present were teachers or early years practitioners).

102. Education Scotland highlighted, in terms of the reach of its work, that:

> Our big target is to reach every school cluster in Scotland in the next four years, which is challenging and ambitious. One of the key aspects of the work is the need to take a very strong cluster-based approach, because primary schools and early learning establishments cannot do the work on their own...We are excited by the sheer demand for time and engagement with our new team [STEM regional officers]" [53]

103. The value of STEM cluster working to teachers and early years practitioners was apparent throughout this inquiry. The Committee considers that the Regional Improvement Collaboratives should have more informed strategic oversight of cluster work.

104. **The Committee recommends that Regional Improvement Collaboratives should map cluster working across their regions. This work could help**

establish where cluster working between schools is well established and where there are gaps in support for cluster working.

105. **The Committee recommends that this work should include mapping cluster work between early learning and childcare settings and primary schools, as well as mapping collaborative work between primary and secondary schools.**

STEM's place in the curriculum

106. The Committee explored the extent to which STEM learning experiences receive sufficient focus in early learning and primary school settings. As highlighted elsewhere in this report it is important to guard against any mindset that STEM is an add-on learning experience. A number of contributions suggested STEM is not embedded in the delivery of the curriculum. There were a number of reasons suggested for this including that the system does not appear to recognise STEM as being core when set against the emphasis on literacy, numeracy and health and well-being. Examples of supporting evidence included:

> Priorities change—that is what is difficult in teaching. There is currently a huge focus on literacy and numeracy, so everything else shifts away a wee bit in people's heads. [54]

> One early year's practitioner highlighted the status and place of STEM in the curriculum suggesting "literacy and numeracy are embedded but STEM is not. [10]

> [the priorities are] literacy, numeracy and health and wellbeing, because that is what they are accountable for to their headteachers. [55]

> We are asked to focus on STEM but, as my colleague mentioned, literacy, numeracy and health and wellbeing are the subjects on everybody's school improvement plan. In addition, we are hit with other initiatives such as one-plus-two languages and outdoor learning. [56]

107. The Committee explored with Andrew Bruce from the Scottish Government the extent to which the policy framework ensures that STEM does not just feature, but is cited as a sufficient priority:

> As far as the systems and the policy framework are concerned, three out of the eight curricular areas are STEM related—mathematics, the sciences and technology are covered as part of the framework. [57]

> It is clear that STEM is not one of the priorities that are set out in the national improvement framework. [57]

108. Turning to the inspection element of the system, evidence reflected a focus on numeracy and literacy:

> I suppose that it is about the priority. Even if those things are coming down from the Government, in the heads of the teachers it is about literacy and numeracy, and health and wellbeing. Education Scotland's inspections often have that focus—they certainly have in recent times. [58] (Elisabeth Kelly)

> From what I have seen, the focus is mainly on health and wellbeing, literacy and numeracy, rather than other areas of the curriculum. [59] (Nicola Dasgupta)

> ...we had the Tayside regional improvement collaborative digifest in Dundee, which is a CPD event for primary school teachers...One of the teachers at that event stood up and said that she does not currently deliver to her class intended learning outcomes in computing science at all. She said that she thought that she could get away with that, because nobody will ever inspect those ILOs for computing science. That surprised me. She did not say that that was fine; she was there to learn how to do it, and she wanted to do it, but she had not delivered for a number of years, and she thought that nobody would ever pick up on that as an issue. I wonder how true that is throughout our schools. [60] (Dr Karen Petrie)

109. The need for guidance to sufficiently reflect STEM as a learning priority was also highlighted by Elisabeth Kelly:

> The profile of STEM education being raised in the policy and documentation that we have would help. In documents such as the new national standard that is coming out on expansion of early learning and childcare, and "How good is our early learning and childcare?", the curriculum is referred to and literacy and numeracy and health and wellbeing are mentioned a lot. Words such as "curiosity", "imagination" and "creativity" are used, but we need to help our practitioners to link those words to STEM. [61]

110. The Committee explored the extent to which an increased focus on interdisciplinary learning could better integrate STEM disciplines into core learning, including complementing the focus on literacy and numeracy:

> It is about bringing us back to how I feel curriculum for excellence was meant to be—that is, working together meaningfully with an interdisciplinary focus. For some reason—I am not blaming anyone—we seem to have become very literacy and numeracy focused, although each is dealt with separately. Of course those subjects are important—they are the foundations of everything—but we have lost sight of the rest, a wee bit. [62] (Elisabeth Kelly)

> When I speak about interdisciplinary learning, I mean that we need to start looking at literacy through being outside, through a gardening project or through an engineering project—we could be learning literacy while we are designing a new Mars or lunar landing. Then we move away from the idea of needing to spend blocks of time just on literacy, or the idea that I need to spend an hour teaching literacy before I can look at STEM. [63] (Elisabeth Kelly)

> There is always a perception that, if STEM does not appear in a school's improvement plan but literacy and numeracy do, the school cannot do STEM. We say that it can use STEM as a vehicle for taking forward that literacy and numeracy. [64] (Alastair MacGregor)

111. The GTCS highlighted in evidence an increased emphasis on training primary teachers to be generalists who use the method of interdisciplinary learning:

> In relation to early years up to the end of primary 4, through initial teacher education programmes in Scotland, we are trying to create primary teachers who can integrate the learning across a range of subject and curriculum areas...I make no apology for the fact that we expect teachers in the early stages of primary to be generalists who are skilled in making the links so that children understand. [65]

112. **The Committee recommends that the Scottish Government considers the extent of the focus in the education system on literacy, numeracy, health and wellbeing. This includes in: the National Improvement Framework; Education Scotland guidance; school improvement plans, and the inspection regime. The extent of the focus on literacy and numeracy and the practice of teaching them as stand-alone topics in large blocks of primary school timetables, limits the opportunity for interdisciplinary learning.**

113. **The Committee recommends that the Scottish Government and its agencies, and by extension the leadership within schools, ensure a sufficient emphasis on interdisciplinary learning in early education. The Committee highlights to the Scottish Government the positive evidence received on the potential of interdisciplinary learning. This includes how it reflects the ethos of Curriculum for Excellence and how it can contribute towards curricular priorities including literacy and numeracy.**

Quality of internet connectivity in schools

114. Dr Karen Petrie, a computing lecturer and associated dean for learning and teaching reflected the importance of a working internet connection, in teaching certain elements of STEM:

> ...I do quite a lot of work with primary schools both locally and throughout Scotland, particularly to help them to deliver the computing science and digital skills parts of the education remit...I asked a lot of the local schools that I work with, "What's the one thing you would like me to take to the inquiry?"...what has helped them the most to deliver the curriculum is a working internet connection....That surprised me, but four separate schools—and there were some tweets this morning—said that that is the biggest barrier and that, on any given day, they cannot trust the connection to be there. It is difficult to use a lot of digital skills and undertake the technology teaching...if there is no working internet connection. [66]

115. When asked whether this was an issue specific to rural schools Dr Petrie clarified that the local schools in question were not in rural areas. She went on to highlight in relation to rural schools: "The internet is genuinely an issue in a lot of our rural schools. One rural school said that it cannot have all the computers accessing the internet at once or it will crash, which is a major issue for teaching computing science." [67]

116. Attendees at the Committee's workshop were asked whether their school's internet connection was sufficient for STEM teaching. Over 50 attendees answered and the results were: yes 27%, no 58% and neither 15%. (This third option was intended to cover those who are not in a teaching role.) [10]

117. **Given the evidence received, the Committee recommends that the Scottish Government, in conjunction with local authorities, explore the extent to which STEM learning experiences are being limited by the standard of the internet connection in schools across Scotland.**

Deprivation

118.   The concept of access to 'STEM capital' was raised by the Learned Societies Group as including an individual's access to science capital such as science related knowledge, qualifications, attitudes, contacts, experiences and resources. The Learned Societies Group suggested that science capital is not evenly spread among different groups. Consequently, "students with low science capital who do not express STEM related aspirations by age 10 are unlikely to develop such aspirations as they get older. This demonstrates the need for early and sustained interventions to build STEM capital among learners and their families." [2]

119.   The RSE report Tapping All Our Talents makes similar points, highlighting that pupils are influenced by teachers, careers advisers, the media, peers and, often to the greatest extent, parents or carers. As such, "students from families with medium or high science capital are more likely to aspire to science and STEM-related careers and are more likely to plan to study science post-16" and "young people from the most deprived areas are less likely to choose to study a STEM subject than those from the least deprived areas".

120.   In relation to access to school and early learning based resources as part of 'STEM capital', STEM disciplines can be viewed as a resource intensive part of the curriculum. Examples in evidence include the cost of certain pieces of equipment and technology, the specialist knowledge of teachers and other specialists sharing knowledge, the staff time required to set up kit for different activities and also the number of staff required for activities where children undertake outdoors learning or visit STEM events. The Committee has explored in evidence, given the costs associated with some forms of STEM learning, the extent to which disadvantage is being compounded for children from deprived areas, and whether targeted work underway in response to this significant challenge is proving effective.

121.   In relation to access to STEM capital in the form of involvement from local communities, Talat Yaqoob from Equate Scotland explained the different levels of community involvement depending on the level of social deprivation:

> We see more role models from industry coming in or community-based learning in affluent areas, compared with socially deprived areas and rural communities. If we are going to do something about this, it has to be done Scotland-wide. There has to be a coherent strategy that is invested in across the board, rather than a focus on the lowest hanging fruit in areas where there is already access to opportunity and investment. Particularly in the early years and primary school, more parent and community engagement is happening in affluent areas. Any investigation needs to focus on how we do that in rural communities and areas of social deprivation. [68]

122.   Following on from this contribution, the barrier travel costs can represent for schools in areas with high levels of deprivation was also highlighted by Toni Scullion, a secondary school computing teacher:

> I want to pick up on two points from what Professor Wall and Talat Yaqoob said. I am at a Scottish attainment school in West Lothian, so we have high levels of deprivation. We do really well with girls, but we face barriers. For example, there are amazing initiatives such as the cyber security Christmas lectures but sometimes we cannot go because we do not have money for buses. We do not want to ask the kids because we know their backgrounds and they do not necessarily have the money, either. That is a simple thing that could easily be fixed if we could apply for some kind of budget. Having to beg for money is difficult—it works, but it is really hard and it definitely puts teachers off. [69]

123. The cost of classroom resources was also highlighted a number of times to the Committee:

> A lot of it is about basic resources. We are asked to build things, but we do not have the materials to build them with. [70] (Nicola Dasgupta)

> The concern is about how we fund all those things. As Alastair MacGregor said, there is nothing worse than going on courses and finding them brilliant and excellent, as I have done, then getting back to school and realising that we cannot do something because we do not have this or we do not have that. Sometimes I go to the shop and buy things out of my own pocket. However, I cannot fund resources for a whole class out of my own money...Or for a whole school. [71] (Lorna Hay)

> A lot of our teachers are buying resources. That point came out at the TRIC digifest, where a lot of people said that they had bought a Bee-Bot for their nursery because it did not have one. It is appalling that our teachers are paying for things for classes out of their own pockets. There cannot be just a one-off injection of funding, because the nature of science and—especially—technology means that things go out of date quickly, as a number of our schools have seen. [72] (Dr Karen Petrie)

124. The Committee did not explore in detail in this inquiry the impact of targeted funding such as Pupil Equity Funding on resources for STEM, although it is aware that some STEM posts are partly or entirely funded by PEF (for example Lorna Hay's post is part funded by PEF). The impact of PEF and the need for effective evaluation of this targeted funding was covered in detail in the Committee's inquiry into *Attainment and Achievement of School Aged Children Experiencing Poverty* . A theme of evidence for that inquiry was also the extent to which schools have the resources they require to teach the core curriculum. This theme of evidence was echoed in this inquiry, including Alastair MacGregor highlighting the role of inspections:

> If a lack of resources is having a detrimental effect on attainment, enjoyment and efficacy in relation to science, the inspection regime should look at that. [73]

125. When asked if Education Scotland looked at specific resourcing issues, Ian Menzies responded:

> Local authorities have lead responsibility for resourcing the curriculum and for resourcing their schools and settings. [74]

126. Research by the Learned Societies Group in this area was discussed with their witness, Professor Lesley Yellowlees. The research took place in primary schools in 2014 and found that "98% of respondents drew on additional funding for practical activities, with parental sources the most common for extra-curriculum activity." [2] Professor Yellowlees commented: "we should not underplay the contribution of parents who go in and help to teach subjects, either" [75]

127. Attendees at the Committee's workshop aimed at primary teachers were asked if the findings of the Learned Societies Group research relating to additional funding was also reflected in their experiences. Attendees answered: yes 61%, no 24% and neither 15%. (This third option was intended to cover those who are not in a teaching role). [10] The Committee is aware that, where resource and support in school are issues, asking parents and carers to address any gaps can reinforce disadvantage for some young children.

128. Professor Yellowlees highlighted that the Learned Societies Group had given recent consideration to revisiting some of the findings from the 2014 study:

> We received responses from only 39 primary schools, and we wished to engage with Education Scotland and other bodies to expand our sample size, but that offer was not taken up. Perhaps now would be a better time—sometimes we need to rely on timing—to find out whether there is an appetite to look at the matter further. [75]

129. The Committee explored the specific issue of support for parents and the local community when questioning witnesses from the Scottish Government and Education Scotland. Andrew Bruce, Scottish Government, highlighted the action in the STEM strategy to improve the level of resources available to parents through the parentzone website [76] . Ian Menzies, Education Scotland, set out the focus on community learning and development in Education Scotland's work:

> Parents are crucial. The STEM strategy was very influenced by the ASPIRES research, which showed the importance of building science and STEM capital within families and communities around Scotland. We take that very seriously. Engaging parents is part of the work that we have been doing through the RAiSE programme...Over the past few months, for instance, we have been doing a series of events around Scotland, bringing together community learning and development specialists with early learning specialists and primary and secondary school staff to look at the connections and how we can take STEM into the wider community and families. Our RAiSE team has been running a lot of parental engagement events: for example, we had the Angus STEM festival just last week and more than 400 people attended; we had the Leith family fun event, attended by more than 700 people over three days; and we also had a family stargazing event in Fife. [77]

130. The final aspect of STEM capital the Committee explored was the availability of support from parents and carers at home including access to their own technology

to support children. In this respect too, the Committee heard evidence of disadvantage being compounded for those from less affluent backgrounds:

> ...There are also issues with homework. We rely on children being able to access stuff online at home, but many children do not have such access. We also rely on parental involvement, but many parents cannot have such engagement for practical reasons—they might work shifts, so they might not have time to talk to their children about various bits of homework. A lot of the time, parents do not feel confident engaging with such subjects, because they did not have strengths in them when they were at school. Deprivation and inequity of access to science-based teaching are huge issues. [78] (Nicola Dasgupta)

> In West Lothian, we are very lucky in that we have support in place so that children can bring in their own digital appliances and use them in class, and they are able to use wi-fi...We have the support and resources in place just now. [79] (Nicola Connor)

131.   Children in deprived areas can experience compounded disadvantage where STEM learning experiences require resources such as: equipment or technology; outdoor learning or visits, and/or the support of people such as parents and carers or specialists from the local community (including input from businesses).

132.   As set out in the Committee's inquiry into *Attainment and Achievement of School Aged Children Experiencing Poverty* , an over-emphasis on online resources to inform parents and carers or for setting homework can compound disadvantage, creating a sense of digital exclusion as many households do not have online access or digital appliances.[iv] Conversely, community working and providing support at family level away from school and early learning settings can have a very positive impact. The Committee therefore welcomes the emphasis in the Raising Aspirations in Science Education programme on work in local communities.

133.   **The Committee is concerned at anecdotal evidence that some school staff are paying for resources and also that parents are often called upon to fund and support activities. The Committee recommends that Education Scotland works with the Learned Societies Group to repeat the 2014 study which found that "98% of [primary school] respondents drew on additional funding for practical activities, with parental sources the most common for extra-curriculum activity."[v]**

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iv Relevant conclusions of *What Support Works?: Attainment and Achievement of School Aged Children Experiencing Poverty:* "The Committee notes that certain trends in policy, such as the increased use of digital platforms can have a disproportionate negative impact on young people living in poverty.The Committee notes that since 2016, education authorities have had a legal duty to have regard to social disadvantage in new strategic decisions. However, this does not cover either existing policies such as the structure of the school year or more operational decisions such as the increasing use of digital platforms."

v **The Committee notes the Learned Societies Group needs the support of Education Scotland to expand its sample size to include more primary schools.**

134. **The Committee recommended in its inquiry into *Attainment and Achievement of School Aged Children Experiencing Poverty* that the Scottish Government assess the extent to which there is charging for access to school education. The Committee seeks an update on this work, including in relation to STEM learning experiences.** [vi]

135. **The Committee also recommends that the inspection regime ensures that the fabric of a school, including required apparatus and technology to deliver STEM learning experiences, is a sufficient focus of the inspection process.**

Science Centres and Festivals

136. One of the Scottish Government's aims in the STEM strategy is to achieve: "Significant reductions in the equity gaps in participation and achievement in STEM learning, engagement, study, courses and training across all sectors in relation to gender, deprivation, rurality, race, disability and for care leavers." Key Performance Indicators linked to this in relation to deprivation are:

> -Increase the proportion of schools from most deprived quintile that receive a quality STEM engagement experience from funded Science Centres.
>
> -Increase the number of members of community groups from the most deprived or rural areas participating in quality engagement with Science Centres and festivals to 10,000 by 2022.

137. The four sciences centres in Scotland are in: Edinburgh (Dynamic Earth), Aberdeen, Dundee and Glasgow. Each is pursuing outreach activities to draw in audiences from wider areas. For example, the Glasgow Science Centre has an outreach programme called Body Works on Tour that takes aspects of the science centre's work across schools in Scotland. Dundee Science Centre, through its outreach work, has provided schools with information on sources of funding to assist them with accessing science centre activities. The science centres also offer a range of CPD opportunities for early years practitioners or teachers.

138. Grant funding from the Scottish Government provided to Scottish science centres is based on the need to make provision to support engagement with a greater diversity of people; supporting pupils in rural and deprived areas to access science centres. There is also funding going to the three science centres (Aberdeen, Dundee and Glasgow) from the UK Association for Science and Discovery Centres and Science Museum Group to promote diversity. This is intended to provide these three centres with additional resources to enable children and adults from a more diverse range of backgrounds to participate in science-related experiences.

[vi] Relevant recommendations of *What Support Works: Attainment and Achievement of School Aged Children Experiencing Poverty: "*The starting point to address this issue of charging for access to school education is to assess the extent of this practice. The Committee recommends that the Scottish Government surveys all education authorities to establish which authorities sanction charging for in-school activities and the level of these charges. The Committee also recommends that the Scottish Government undertake a review of which elements of the experiences offered by schools may attract a charge and the cumulative impact of these charges."

139. The Committee took evidence from Glasgow Science Centre and Edinburgh Science (which runs the Edinburgh Science Festival). Examples of their work included projects aimed at improving accessibility for those from deprived areas:

> ...we try to encourage them to find STEM more interesting and exciting. We also run generation science, which tours the whole of Scotland, taking practical workshops and shows into primary schools. That involves about 55,000 to 60,000 primary school children in all 32 local authorities and interfaces with about 3,000 primary school teachers. [80] (Dr Simon Gage, Edinburgh Science)

> ...due to a £4.1 million investment from the Wellcome Trust, we are embarking on what we call the connect project. It is a large-scale organisational change for us to support and attract a more diverse audience. As part of that, we have been looking in depth at what the barriers are for those who wish to access us. At issue is whether those who partially see us as relevant to their lives are financially able to visit us and how we can make what we do relevant to them... The organisational change will take place over the next 10 years. [81] (Dr Emma Woodham, Glasgow Science Centre)

140. There was an emphasis in evidence on the need to balance visits and individual experiences from external providers with longer term interventions in early learning and primary school settings. The Committee heard a number of examples where, because of the number of large scale participation events or one-off workshops or other engagement opportunities, STEM education can be perceived solely as an add-on through external initiatives. Given the need for long-term interventions for those experiencing deprivation, this one-off initiative based approach to STEM education is particularly unhelpful to those children. Elisabeth Kelly stated:

> STEM needs to be embedded in everyday learning and teaching and not seen as a once a term or year initiative supported by a local business or science centre. Initiatives can be useful as a provocation or as a reflection tool but should not be a one–off STEM experience. [82]

> Every teacher must be able to deliver [STEM] at a really high quality, all the time, not just on one-off science visits. They are great as provocations, or as part of STEM, but some people in our profession do say, "Right. I've been to Dynamic Earth. Tick. I have done that bit of the curriculum." It cannot be like that. [82]

141. As set out earlier in this report, the Committee considers that STEM learning needs to be mainstreamed throughout the curriculum in practice, complemented by the valuable work of Science Centres and Science Festivals and other engagement opportunities and initiatives. The work of Science Centres and Festivals doubtless inspires and this can direct the career ambitions and choices of a young person from a very young age. This and other 'one-off' interventions need to be complemented by more frequent and sustained interventions for those experiencing deprivation (and to address other equity gaps).

142. The Committee has noted the emphasis on the role of science centres and festivals in the Key Performance Indicators for the STEM strategy relating to deprivation. There are numerous other pieces of work underway to target deprivation in addition to work linked to the Key Performance Indicators undertaken by science centres

and festivals. This includes targeted work as a result of substantial grants from Education Scotland as set out in the Minister's letter of 7 July.

143. The quality of baseline data therefore informs what can and cannot be used as a measurable key performance indicator. Presumably the number of participants in engagement experiences delivered by science centres and festivals is suitably measurable to base a Key Performance Indicator upon. Nevertheless the Committee is aware that where Key Performance Indicators are attached to certain strategy objectives, efforts can focus disproportionately on these measures. The Committee is of the view that, given the evidence about the potential for disadvantage to be compounded for children from deprived backgrounds, there should be more focus on the measurement of progress towards reducing the deprivation 'equity gap' through mainstream interventions in schools and early years settings.

144. The Committee acknowledges the increasing levels of targeted work being undertaken by science centres and festivals to ensure more equity of access for children from less affluent areas. It is really important that the implementation of the strategy has a sufficient emphasis on work within schools and early years settings, which science centres and festivals complement.

145. **The Committee recommends that the Scottish Government develops a means of measuring targeted long term interventions within early learning and primary settings in deprived areas. The Committee has heard in evidence that closing the deprivation 'equity gap' in relation to STEM has been a long held policy ambition and that long term interventions are key to making progress.**

Remote and rural areas

146. Connected to the question of whether there is a sufficient focus on STEM in the core curriculum, is the question of to what extent STEM activity should be delivered in school and early years settings by teachers and early years practitioners. Professor Lesley Yellowlees articulated the importance of initiatives sitting alongside, but not being a substitute for, sustainable work at individual school level.

   > ...the learned societies, as well as charities, have a huge part to play, and they try to play it. However, in my opinion, making such things sustainable and taking them forward requires resources at individual school level. [83]

147. The Committee has heard numerous examples of STEM work beginning with taking part in a programme and this becoming embedded in a school's practices, including from Nicola Connor:

   > We took part in the cluster programme in 2016-17, and we still have our cluster mentors even though the programme has finished. Outwith the sustain and extend programme that we are running just now, we continue to meet and look at plans for progression and for the transition of primary 7s into our high schools. The enthusiasm of the teachers meant that we continued that approach, which we do ourselves. [84]

148. The Scottish Government's intention is that in time, through knowledge sharing and continuing to develop existing initiatives, STEM will be more mainstreamed into the learning experiences of all children and young people. The progress and success of this complex process requires strategic oversight. The number and variety of pieces of work across Scotland to promote STEM learning from numerous providers makes it challenging to oversee. For example it is challenging to ensure all areas of Scotland are being effectively reached. The Committee explored the challenge of initiatives reaching remote and rural areas. One strand of related evidence reflected that smaller scale initiatives often focus on people living close by for logistical and financial reasons, and these initiatives are usually based in cities.

149. Dr Francesca Iezzi explained the challenges faced in this regard with her mathematics initiatives pointing out that the time and location of activities (which take place at the University of Edinburgh Maths Department on a Saturday afternoon) "prevents us from reaching a wider demographic, such as pupils from widening participation schools, or those whose parents are less likely to bring them to a University event." In relation to workshops she stated: "We prioritise the schools who actively ask for a visit and are situated in a low SIMD area. We are aware that prioritising the schools that actively get in contact with us can lead to self-selection bias, and schools located on the outskirts tend to be underrepresented." [85]

150. The project ReallySmallScience run by the University of Strathclyde mainly operates in Glasgow and the surrounding area. This has raised concerns for Sylvia Battcock who leads this project: "we have rarely delivered workshops outside of the central belt. Early years children in rural and underserved areas are missing out on

engaging STEM learning experiences. Unfortunately, we do not have the means to travel to nurseries and early years groups in these areas." [86]

151. The point was also made at the Committee's workshop by an attendee from the Institute of Physics that the issue can be remoteness from STEM capital as opposed to rurality. [10] For example, an early years practitioner in East Lothian is in a rural area but is not particularly remote from STEM resources in Edinburgh such as Dynamic Earth or the Edinburgh Science Festival. Similarly, while Glasgow Science Centre works to be accessible on a country wide basis, there are clear benefits for those living closer to the centre as Dr Emma Woodham set out:

> It is also extremely important for us to make and invest in partnerships with local education authorities, to ensure that the pupils who experience the highest levels of deprivation in those areas are able to access us. On that front, we have fruitful long-term partnerships with Glasgow City Council and West Dunbartonshire Council. We see the benefits of those partnerships, in that 43 per cent of Glasgow schools and 28 per cent of West Dunbartonshire schools visit us at least once a year. [87]

> Over the past three years, we have trained 240 teachers in the inspire and challenge approach, primarily in the West Dunbartonshire region. Prior to training, teachers rate their confidence in teaching STEM at 2.6 out of 5; after training, they rate it at 3.4 out of 5. [88]

152. This understandable selection process, where local children and staff can be prioritised by local initiatives, sits alongside a personality driven selection process by schools and early learning settings. Lorna Hay spoke about the results of her proactive work contacting and responding to different initiatives:

> To go back to the earlier conversation about equity, I point out that those people have been coming into the school because Laura Peden and I are driven to seek out such opportunities. If schools do not have people with the same kind of passion, such opportunities will pass them by. Those organisations publicise themselves, but their emails come into people's inboxes along with everything else, and I have had colleagues tell me that they just delete them. The reality is that their focus is probably on something else. [71]

> We have had 17 engineers sourced from the STEM ambassador network come into our school. That network needs to be tapped into; after all, if those people get an email from me, asking "Will you come to our school?", they will be able to meet their CPD requirements for the year. It is an absolutely fantastic resource. [71]

153. Given that smaller initiatives target local areas, including in some cases only where proactive staff with an interest in STEM approach them, the allocation of this valuable work is self-selecting either by those running the initiatives and/or by those approaching these initiatives for support. For example, Sylvia Battock, ReallySmallScience stated: "The school and nurseries that book ReallySmallScience workshops tend to already have a strong STEM presence. For example, a staff member committed to STEM engagement, a STEM focus week or a science club." [86]

154. The larger scale programmes receiving Scottish Government funding, should guard against 'self-selection bias' and be targeted according to need. The Committee explored this with one of the main delivery bodies, Education Scotland. The STEM grant awards programme was cited on a number of occasions by Education Scotland and the positive programmes that have been made possible by this funding stream:

> Another big piece of work that we have been doing is the grants programme that we launched in October, through which we have issued £187,000 to 24 organisations around Scotland. The focus of that programme was to extend provision to practitioners around Scotland to ensure equity of access, to develop new models and approaches and to find ways of scaling up existing provision that has proved to be successful. Last week was a big week for Education Scotland, because we launched a second round of that grants programme. We now have a budget of £1.3 million, which is really exciting. [89]

155. When asked about the extent to which the programme can effectively identify gaps and then target particular areas and groups, Education Scotland explained that its new team of regional officers are in part tasked with going into local communities and identifying where funding could be used to great effect and they support the relevant people by encouraging them to apply for the grants. This work is to be welcomed, although the demand for such funding obviously outstrips the level of funding available. In addition the task of finding those who would benefit from the funding across Scotland is a substantial task and there are a limited number of Education Scotland regional officers covering 32 local authority areas.

156. The Committee also considered the progress and future plans for the Raising Aspirations in Science Education programme (RAiSE) which has worked across 532 school clusters since August 2017. The Minister highlighted the positive outcomes of the programme:

> .... An evaluation showed that 87 per cent of the pupils involved had enjoyed more challenge in STEM learning and 77 per cent had increased their STEM aspirations. [12]

157. Education Scotland also highlighted the role that Raising Aspirations in Science Education (RAiSE) programme support can play in assisting practitioners in navigating other available funding and opportunities:

> The RAiSE team has found different organisations across Scotland and the United Kingdom that provide funding for resources. RAiSE officers have been providing training to practitioners in different settings to point them in the direction of, and enable them to access, the funding resources that are available. [90]

158. The Minister also highlighted that the initial tranche of four local authorities involved in the programme deliberately included remote and rural local authorities (Moray and Highland Council) in recognition of specific requirements of such areas. The programme includes 23 months of pilot funding from the Wood Foundation, the relevant local authority and the Scottish Government. This includes funding for a dedicated development officer.

159. Kathryn Thomas is a RAiSE development officer from Highland Council who made a submission which highlighted the positives of the RAiSE programme but also the concern that the development officer post may not be sustainable in the Highland area. Ms Thomas also highlighted work linked to the RAiSE programme that would continue including membership of the RAiSE network and also the Newton Room approach established as part of the programme. Ms Thomas highlighted the benefits of the knowledge sharing generated during the programme:

> The beauty of being part of the RAiSE network is that we have been able to share the good examples that we have seen elsewhere. Through that sharing, we hope that such approaches can become embedded. [37]

160. When asked about the continuity of the RAiSE development officer post, specifically in Highland, the Minister responded that he understood the posts were continuing but that he would look at the evidence further. [91] Supplementary information provided by Education Scotland stated that: "Of the six authorities who engaged with the pilot programme from January 2017-June 2019, 6 continue to have a PSDO or an equivalent STEM officer in post at this time."

161. Education Scotland also explained that additional funding is being made available to authorities exiting the pilot to seek to ensure continuity of the work on a long term basis. This is in conjunction with work to roll out the programme on a national basis through further tranches of the pilot programme:

> Where required, Scottish Government has provided additional funding to authorities that are exiting the programme to help them move to a sustainable model. Four authorities have benefitted from this funding to date. This is at a reduced level of funding than was granted during the pilot phase. A total of £90K in additional sustainability funding has been made available in FY 18-19 and 19-20. Six of the authorities have identified ways to self-fund and continue activity beyond the agreed funding period...
>
> As the result of a positive external evaluation of the pilot, a national invitation was sent to those authorities that have not been engaged with the RAiSE Programme as yet. The hope is to engage up to 5 authorities each academic year on a rolling basis.

162. The Committee has heard that there are lots of 'pockets of excellence' across Scotland and the challenge is how this specialist knowledge can be shared. Barriers to improving knowledge sharing or accessing STEM capital can be exacerbated in rural and remote areas of Scotland. This can include higher travel costs to access training or learning experiences, larger distances between schools impacting on them setting up cluster arrangements, more smaller schools without dedicated technology suites or adequate internet connections etc. In addition, projects run by businesses, charities and academics are often limited in their reach and can focus on the central belt and other populated areas close to their bases.

163. **The Committee recommends that the Scottish Government reviews its approach to publicly funded large STEM related initiatives to ensure the approach taken by such initiatives focuses sufficiently on remote and rural areas. Such a review should take into account the need to counteract the urban bias and 'self-selection' bias of numerous smaller projects.**

164. **In relation to the Raising Aspirations in Science Education programme, the Committee welcomes the decision to roll out the programme to all interested local authorities as a result of the positive outcomes generated by the initial pilots. However, the Committee would be concerned if the continuity of such a valuable programme was lost where the pilot has already run in remote and rural areas. The Committee requests an update on the sustainability of all pilots in the Government response to this report. Progress in mainstreaming STEM is being pursued through various initiatives and it is important that large scale publicly funded initiatives with the potential for long-term positive impact are sustained.**

Gender

165. The 2018 report *Tapping All Our Talents* provides a progress review on women in science, technology, engineering and mathematics in Scotland, updating the 2012 report of the same name. The 2018 report notes that:

> Gender stereotypes and biases abound in all parts of society. Reflecting this, awareness of gender equality issues amongst teachers, school leaders, careers advisers and parents is frequently low. Evaluation has identified the stereotypical views of key influencers, including teachers, as a major cause of different treatment of boys and girls. This reinforces gendered expectations of children, both boys and girls, from a young age. In addition, gender stereotypes continue to be used across curricula, materials, language, careers advice, policies and culture in schools and early years settings... Where progress has been made, this is frequently due to the personal interest in the issue of one or several individuals within a school, and their drive to create change.

166. In their submission Marsh et al noted that research has identified that children as young as six report gendered differences in relation to levels of interest, confidence and self-efficacy with regard to STEM learning, and children of that age already associate reading with girls and mathematics with boys. Stereotypes about cultural and social fit with STEM subjects, as well as the ability to undertake them, influence girls' and some groups of BME children's orientation to STEM in early childhood, which persists into the middle years. They go on to point out that, outside of school, young girls generally have greater exposure to life-sciences, such as gardening and animal care, while boys are more exposed to physics toys and equipment such as microscopes and batteries, play with more spatial and science-related games, and have read more science books than girls. Further, girls are socialised away from science at very early ages through parental guidance and micro-pedagogical practices in schools, for example with parents of young children much more likely to explain science topics to boys than girls. [92]

167. *Tapping All Our Talents* suggests that interventions to, "shift norms around gender stereotypes and attitudes towards STEM must begin early in children's learning and development." It points to efforts being made to tackle gender inequality in early years centres and schools and to support teachers to understand and address gender issues, in relation to their own awareness and that of their pupils, with many of these having a positive local impact. However, interventions to improve gender equality and perceptions of STEM, "must be delivered in a coherent, collaborative and consistent manner across all early years' centres and schools, with proper evaluation. Until then, Scotland will not achieve the large-scale shift in attitudes that it requires to meaningfully increase the numbers of young women choosing STEM paths."

168. The Scottish Parliament Economy, Jobs and Fair Work Committee in its inquiry in 2017 into the gender pay gap entitled *No Small Change: The Economic Potential of Closing the Gender Pay Gap* looked at the ability to scale up exisitng initiatives to reach larger cohorts of girls and young women. Close the Gap stated in evidence to that inquiry:

> We have seen solutions in a myriad of interventions to get more girls and women into science, technology, engineering and mathematics, for example. Those evaluations are, of course, laudable and they tend to be evaluated very well, but the problem is that they affect just a small number of girls and women. They are usually quite intensive and take a lot of resources, but only a small number of women end up going on to study engineering, for example. They are also very expensive, so they are difficult to scale up.

169. Talat Yaqoob, Director, Equate Scotland, emphasised to this inquiry that the most effective approach is sustained activity within schools and early learning settings:

> The point about women's spaces and girls' spaces is really important, because we need to do something to counteract what is going on elsewhere. We can have a role model at school assembly, however what is actually needed is sustained activity. We know that single interventions do not work, but sustained intervention over a longer period requires investment, especially with young women. I emphasise the need for women's spaces in which they feel that they cannot just take a back seat because of their perception that the boys know more.
>
> I would also like to emphasise, as Toni Scullion [secondary teacher] said, that it is not about changing what engineering, computing or chemistry are. It is not about making chemistry about making a perfume kit—which I have actually seen and rolled my eyes at. It is not about changing what science is: science works the way it works. The difference should be that we provide spaces in which we can encourage and develop confidence in girls and women. [93]

170. The Learned Societies Group also argued that systemic change is required, moving from single actions toward multiple, sustained interventions throughout the learner journey and that a 'whole-school' approach is required to mainstream culture change. Engender sets out what a 'whole-school' approach means:

> A whole-school approach is an educational strategy whereby work in different spaces across the school, including within the curriculum, extracurricular activities, teacher training and engaging the community, is coordinated and links to an overarching vision.

171. The Learned Societies Group view is that this should focus on "all strands of gender inequality" - not being limited to only focusing on girls and STEM. Developed and led by the Institute of Physics, in partnership with Skills Development Scotland and Education Scotland, the Improving Gender Balance Scotland (IGBS) project has supported schools and early learning and child care centres to establish interventions to effect long-term cultural change with regard to gender stereotypes, unconscious bias and inequity. This project has found that a whole school approach is most effective. Following successful evaluation, the Scottish Government has made a commitment to embed the learning from IGBS in to the practice of every school by 2022. [2]

172. Education Scotland noted in its submission that it has recruited a team of Improving Gender Balance and Equalities (IGBE) Officers to work with regional teams as part of this project. On the extent of the challenge and the work of Education Scotland, Ian Menzies responded:

> Improving gender balance and equality is a complex issue...There is a lot of complex work to do, which will involve changing the whole system and shifting the mindset in the whole of society. That is why Education Scotland has in place a new gender balance team, which will be embedded within the new regional teams. [94]

> Another big piece of work that we have been involved in is the improving gender balance and equalities programme, which I also oversee. That pilot programme was started three years ago, with the Institute of Physics and Skills Development Scotland, to tackle the ingrained gender imbalance in STEM subjects at school. Again, that programme has been really positively evaluated, and we are extending it to schools and clusters around Scotland with the support of a new team. [94]

173. Lorna Hay highlighted the positive outcome of a whole school and nursery approach supported by the IGBE team:

> The improving gender balance team, which we have been working alongside, is doing an incredible amount of good work. We had one of the pilot schools and nurseries, and that has fed through into our other schools. The Government has provided money to expand that team, which can only be a positive thing. Its work needs to be disseminated to everyone. [95]

174. Nicola Connor also welcomed the work of the improving gender balance team but questioned the feasibility of a limited number of officers making an impact on a Scotland wide basis:
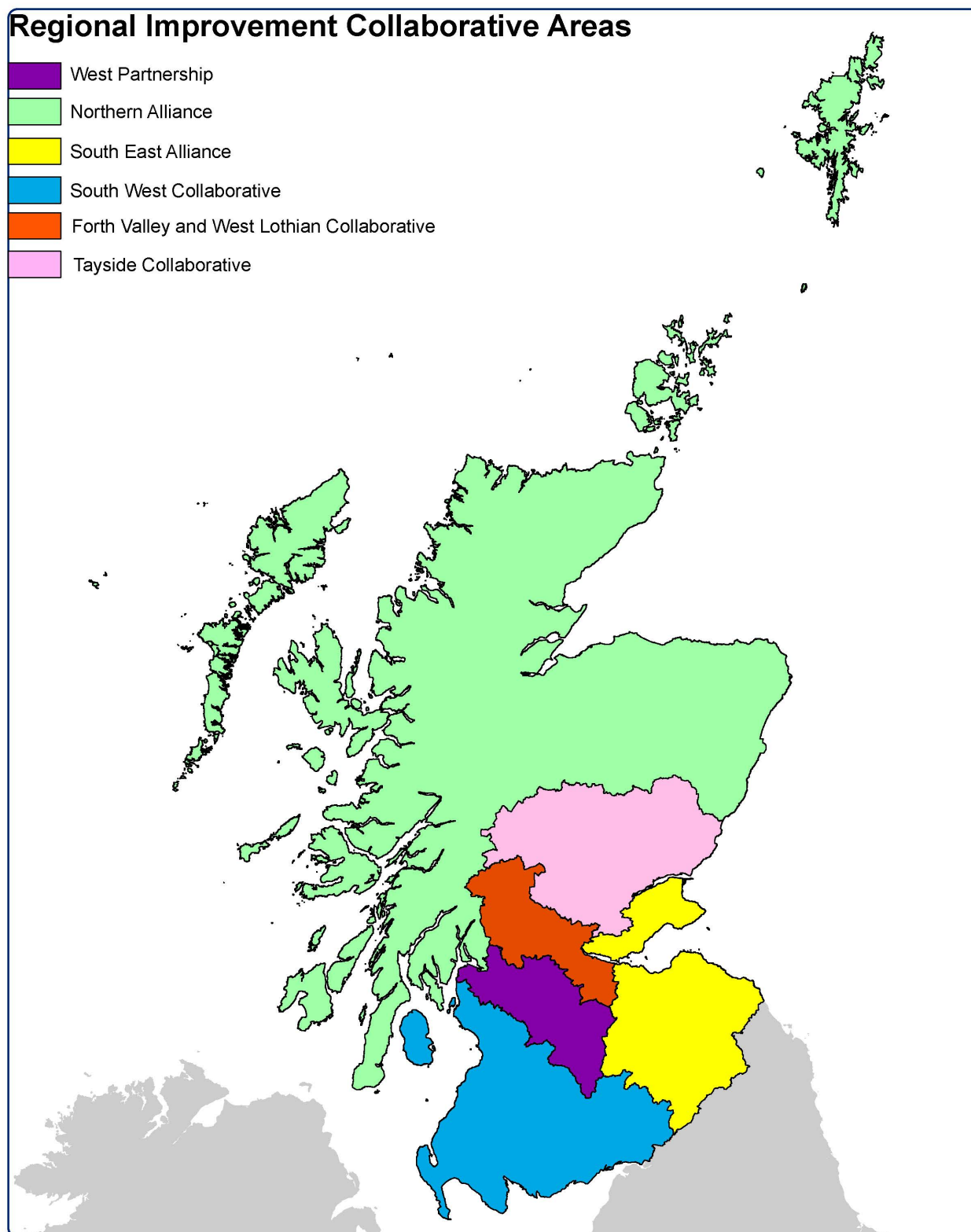
> I welcome the improving gender balance team in Education Scotland, which has six officers who will deliver training. The aim is to deliver training in all schools by, I think, 2022. I question how feasible it is for six officers to do that, because it is such a wide remit, but I welcome the fact that training will be made available to teachers. [96]

175. Each of the six officers Nicola Connor mentions will be within a team of Education Scotland staff supporting a regional improvement collaborative (RIC). The Scottish Government website explains RICs:

> RICs are not intended to be formal bodies within the education system. They are intended to bring together local authorities and Education Scotland to develop different ways of working, bring together capacity across a region and add value through collective efforts... There are six RICs, involving between three and eight local authorities.

176. In addition to the size of the remit of these officers, the Committee notes the scale of the geographic areas each officer is seeking to cover. The map below shows the areas covered by each RIC.

Map of areas covered by each Regional Improvement Collaborative

Regional Improvement Collaborative Areas

- West Partnership
- Northern Alliance
- South East Alliance
- South West Collaborative
- Forth Valley and West Lothian Collaborative
- Tayside Collaborative

Regional Improvement Collaborative Areas

Scale: 1:2,800,000

Scottish Government GI Science & Analysis Team, February 2018, Job 5910 - ab,ld

Source: Scottish Government

177. There are no specific Key Performance Indicators in the STEM strategy that relate to early years education and gender. There are Key Performance Indicators on qualifications achieved at school, and subject uptake in college and university and also in relation to foundation apprenticeships. Barbara Morton, Scottish Government, expanded on the evaluation work underway including for the new Education Scotland IGBE officers:

> The improving gender balance and equalities programme will also be evaluated and that will give us an indication of its effectiveness. It is possible that that evaluation data will not necessarily be robust enough to base a very strong KPI on, but you can be assured that the effectiveness of that programme will be monitored and evaluated as it grows and develops. As the minister says, we will also look at finding other sources of evidence of how awareness is growing, so that we can talk about it in the annual reports on the strategy. [97]

178. The Minister described the role of the gender balance and equalities officers detailed above as "tasked with working to make progress with all practitioners and providers in their regions" and stated, "Gender equality has been put much higher up the agenda in early years and primary education: the officers have a key role to play in that." [98]

179. In relation to training, the GTCS provided the Committee with assurances that in accrediting course content for ITE it was strong on the need for in-depth course content that challenged conscious and unconscious bias. On CPD, Nicola Connor suggested personal interest drives learning (Nicola Dasgupta supported this point):

> I do not think that there is very much training on that. My awareness of the issue has only come through my personal reading on the subject and everything that I do in the local authority and the cluster and and through the discussions that I have had with people such as Heather Earnshaw—I think that she now works for Education Scotland—who has been looking at gender balance issues. We need to make staff more aware that they might have unconscious bias and that things from their culture or childhood might have an effect on how they teach something or how they disseminate information in the classroom. [99]

180. The potential for self-evaluation at school level as a means of addressing bias was highlighted by Shona Birrell, a primary teacher:

> ...gender bias should be looked at more carefully, but I do not see that happening as part of schools' self-evaluation. Looking at gender bias could be a really useful tool for schools. Schools could talk to children and parents about why the children play with certain toys or go to certain clubs and they could consider, with parents, how to address barriers. [100]

181. Professor Ian Wall also reflected, based on his Science, Technology, Engineering and Mathematics Education Committee (STEMEC) work, on the potential for an increased role for inspections:

> On equalities, if you look, as [STEMEC] did, at the last five inspection reports of primary schools in a year, equalities was dealt with in one case in two sentences, and in the others in one sentence. There was clearly a formula. I am not saying that they had not checked, but there was no sense that the schools had had to explain what they did and how they did it, or of whether they had used role models, whether they were trying to create spaces for girls and so on. [101]

182. A whole school or whole early learning and childcare setting approach is key to countering the ingrained pattern of early stereotypes limiting people's aspirations and informing future career decisions and attitudes. The Committee has heard evidence of the potential for more progress to be made in improving understanding of conscious and unconscious gender bias through: more focus in inspections; more focus during self-evaluation in schools and early years settings, and more tailored training for teachers and early years practitioners.

183. **The Committee recommends that the Improving Gender Balance and Equalities programme should specifically monitor whether the new Education Scotland IGBE team has the staff numbers and the capacity to provide support that can reach schools and early learning settings across Scotland in a meaningful way.**

184. **The Committee recommends that the Scottish Government, in its work measuring progress against the aims of its STEM strategy, develops a means of measuring tangible progress in schools and early years settings in relation to gender balance. The Committee considers there is a need to be able to assess progress, including where the Minister suggests that some work may deliver "long-term impacts".**

[1] Education and Skills Committee Official Report, 2 October 2019 Col 26. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf

[2] Learned Societies Group. (2019). written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190515LSG_STEM.pdf [accessed 11 November 2019]

[3] Education and Skills Committee Official Report 2 October 2019 Col 20. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf

[4] Education and Skills Committee Official Report 27 March 2019 Col 3. (2019). Professor Ian Wall. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf

[5] Professor Ian Wall. (2019). written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190321Professor_Ian_Wall_STEMEC_Executive_Summary.pdf [accessed 2019]

[6] Elisabeth Kelly. (2019). written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190508Elisabeth_Kelly.pdf [accessed 2019]

[7] Education and Skills Committee Official Report 27 March 2019 Col 10. (2019). Lorna Hay. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf [accessed 2019]

[8] Dr Kirsty Ross, University of Strathclyde. (2019). written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190514Dr_Kirsty_Ross.pdf [accessed 2019]

[9] Susan Boyd. (2019). written submission. Retrieved from https://www.parliament.scot/S5_Education/Meeting%20Papers/20190605ES_Meeting_papers.pdf [accessed 2019]

[10] Education and Skills Committee Scottish Learning Festival workshop 25 September 2019. (2019). Note of workshop. Retrieved from https://www.parliament.scot/S5_Education/General Documents/20190927Scottish_Learning_Festival_notes.pdf [accessed 2019]

[11] Education and Skills Committee Official Report 5 June 2019 Col 8. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[12] Education and Skills Committee Official Report 2 October 2019 Col 19. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[13] Education and Skills Committee Official Report 2 October 2019 Col 23. (2019). Minster for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[14] Learned Societies Group. (2018, December). Submission to the GTCS on the memorandum on entry requirements for ITE. Retrieved from http://www.rse.org.uk/wp-content/uploads/2019/01/LSG_GTCS_ITE.pdf [accessed 2019]

[15] Education and Skills Committee Official Report 2 October 2019 Col 3. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[16] Education and Skills Committee Official Report 2 October Col 2. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[17] Education and Skills Committee Official Report 2 October Col 6. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[18] Education and Skills Committee Official Report 27 March 2019 Col 14. (2019). Dr Fiona McNeill. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf [accessed 2019]

[19] Education and Skills Committee Official Report 2 October 2019 Col 3 -4. (2019). Charlaine Simpson. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[20] Education and Skills Committee Official Report 2 October 2019 Col 16-17. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[21] Education and Skills Committee Official Report 5 June 2019 Col 7. (2019). Elisabeth Kelly. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[22] Education and Skills Committee Official Report 5 June 2019 Col 26. (2019). Susan Boyd. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[23] Education and Skills Committee Official Report 2 October Col 25. (2019). Niamh O'Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[24] Education and Skills Committee Official Report 12 June 2019 Col 3. (2019). Alastair MacGregor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[25] Education and Skills Committee Official Report 12 June 2019 Col 14. (2019). Alastair MacGregor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[26] Education and Skills Committee Official Report 2 October 2019 Col 24. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[27] Education and Skills Committee Official Report 2 October 2019 Col 25. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[28] NASUWT. (2019). Written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/NASUWT.pdf [accessed 2019]

[29] Education and Skills Committee Official Report 26 June 2019 Col 7. (2019). Nicola Dasgupta. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[30] Education and Skills Committee Official Report 12 June Col 5. (2019). Lorna Hay. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[31] Education and Skills Committee Official Report 12 June 2019 Col 16. (2019). Alastair MacGregor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[32] Education and Skills Committee Official Report 26 June 2019 Col 8. (2019). Kathryn Thomas. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[33] Education and Skills Committee Official Report 5 June 2019 Col 9. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[34] Education and Skills Committee Official Report 26 June 2019 Col 8. (2019). Matt Lancashire. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[35] Education and Skills Committee Official Report 26 June 2019 Col 8. (2019). Dr Simon Gage. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[36] Education and Skills Committee Official Report 26 June 2019 Col 12. (2019). Dr Simon Gage. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[37] Education and Skills Committee Official Report 26 June 2019 Col 14. (2019). Kathryn Thomas. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[38] Education and Skills Committee Official Report 26 June 2019 Col 16. (2019). Nicola Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[39] Education and Skills Committee Official Report 2 October 2019 Col 13. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[40] Education and Skills Committee Official Report 2 October 2019 Col 21. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[41] Education and Skills Committee Official Report 2 October 2019 Col 26. (2019). Minister for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[42] Education and Skills Committee Official Report 2 October 2019 Col 15. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[43] Scottish Government. (2019, July). Letter from Minister for Further Education, Higher Education and Science. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190704In_ltr_fromMinister_for_FEHES_re_STEM_funding.pdf [accessed 2019]

[44] Education and Skills Committee Official Report 5 June 2019 Col 14. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[45] Education and Skills Committee Official Report 5 June 2019 Col 21-2. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[46] Education and Skills Committee Official Report 12 June 2019 Col 6. (2019). Professor Lesley Yellowlees. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[47] Education and Skills Committee Official Report 26 June 2019 Col 6. (2019). Nicola Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[48] Education and Skills Committee Official Report 12 June 2019 Col 14. (2019). Alastair Macgregor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[49] Education and Skills Committee Official Report 12 June 2019 Col 18. (2019). Professor Lesley Yellowlees. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[50] Education and Skills Committee Official Report 5 June 2019 Col 2. (2019). Susan Boyd. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[51] Education and Skills Committee Official Report 5 June 2019 Col 23. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[52] Education and Skills Committee Official Report 5 June 2019 Col 23. (2019). Andrew Bruce. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[53] Education and Skills Committee Official Report 5 June 2019 Col 31. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[54] Education and Skills Committee Official Report 5 June 2019 Col 10. (2019). Elisabeth Kelly. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[55] Education and Skills Committee Official Report 26 June 2019 Col 5. (2019). Kathryn Thomas. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[56] Education and Skills Committee Official Report 26 June 2019 Col 13. (2019). Nicola Dasgupta. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[57] Education and Skills Committee Official Report 5 June 2019 Col 24. (2019). Andrew Bruce. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[58] Education and Skills Committee Official Report 5 June 2019 Col 5. (2019). Elisabeth Kelly. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[59] Education and Skills Committee Official Report 26 June 2019 Col 20. (2019). Nicola Dasgupta. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[60] Education and Skills Committee Official Report 12 June 2019 Col 10. (2019). Dr Karen Petrie. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[61] Education and Skills Committee Official Report 5 June 2019 Col 23. (2019). Elisabeth Kelly. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[62] Education and Skills Committee Official Report 5 June 2019 Col 25. (2019). Elisabeth Kelly. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[63] Education and Skills Committee Official Report 5 June 2019 Col 33. (2019). Elisabeth Kelly. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[64] Education and Skills Committee Official Report 12 June 2019 Col 8. (2019). Alastair MacGregor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[65] Education and Skills Committee Official Report 2 October 2019 Col 5. (2019). Ken Muir. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[66] Education and Skills Committee Official Report 12 June 2019 Col 2-3. (2019). Dr Karen Petrie. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[67] Education and Skills Committee Official Report 12 June 2019 Col 17. (2019). Dr Karen Petrie. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[68] Education and Skills Committee Official Report 27 March 2019 Col 15. (2019). Talat Yaqoob. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf [accessed 2019]

[69] Education and Skills Committee Official Report 27 March 2019 Col 16. (2019). Toni Scullion. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf [accessed 2019]

[70] Education and Skills Committee Official Report 26 June 2019 Col 8. (2019). Nicola Dasgupta. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[71] Education and Skills Committee Official Report 12 June 2019 Col 12. (2019). Lorna Hay. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[72] Education and Skills Committee Official Report 12 June 2019 Col 25. (2019). Dr Karen Petrie. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[73] Education and Skills Committee Official Report 12 June 2019 Col 23-4. (2019). Alastair MacGregor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[74] Education and Skills Committee Official Report 5 June 2019 Col 12. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[75] Education and Skills Committee Official Report 12 June 2019 Col 22. (2019). Professor Lesley Yellowlees. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[76] Education and Skills Committee Official Report 5 June 2019 Col 18. (2019). Andrew Bruce. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[77] Education and Skills Committee Official Report 5 June 2019 Col 17. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[78] Education and Skills Committee Official Report 26 June 2019 Col 9. (2019). Nicola Dasgupta. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[79] Education and Skills Committee Official Report 26 June 2019 Col 11. (2019). Nicola Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[80] Education and Skills Committee Official Report 26 June 2019 Col 2. (2019). Dr Simon Gage. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[81] Education and Skills Committee Official Report 5 June 2019 Col 15. (2019). Dr Emma Woodham. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12174&mode=pdf [accessed 2019]

[82] Education and Skills Committee Official Report 5 June 2019 Col 21. (2019). Elisabeth Kelly. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12174&mode=pdf [accessed 2019]

[83] Education and Skills Committee Official Report 12 June 2019 Col 32. (2019). Professor Lesley Yellowlees. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[84] Education and Skills Committee Official Report 26 June 2019 Col 13. (2019). Nicola Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[85] Dr Francesca Iezzi, University of Edinburgh. (2019). Written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190513Dr_Francesca_Iezzi.pdf [accessed 2019]

[86] Sylvia Battcock, University of Strathclyde. (2019). Written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190513Sylvia_Battcock.pdf [accessed 2019]

[87] Education and Skills Committee Official Report 5 June 2019 Col 5. (2019). Dr Emma Woodham. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[88] Education and Skills Committee Official Report 5 June 2019 Col 34. (2019). Dr Emma Woodham. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[89] Education and Skills Committee Official Report 5 June 2019 Col 5. (2019). Ian Menzies. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[90] Education and Skills Committee Official Report 5 June 2019 Col 11. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[91] Education and Skills Committee Official Report 2 October 2019 Col 31. (2019). Minster for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[92] Marsh et al. (2019). Written submission. Retrieved from https://www.parliament.scot/S5_Education/Inquiries/20190513University_of_Sheffield-_Professor_Jackie_Marsh.pdf [accessed 2019]

[93] Education and Skills Committee Official Report 27 March 2019 Col 8-9. (2019). Talat Yaqoob. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf [accessed 2019]

[94] Education and Skills Committee Official Report 5 June 2019 Col 34. (2019). Ian Menzies. Retrieved from https://www.parliament.scot/parliamentarybusiness/28862.aspx?r=12174&mode=pdf [accessed 2019]

[95] Education and Skills Committee Official Report 12 June 2019 Col 28. (2019). Lorna Hay. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[96] Education and Skills Committee Official Report 26 June 2019 Col 18. (2019). Nicola Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[97] Education and Skills Committee Official Report 2 October 2019 Col 29. (2019). Barbara Morton. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[98] Education and Skills Committee Official Report 2 October 2019 Col 27. (2019). Minster for Further Education, Higher Education and Science. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12301&mode=pdf [accessed 2019]

[99] Education and Skills Committee Official Report 26 June 2019 Col 17. (2019). Nicola Connor. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12219&mode=pdf [accessed 2019]

[100] Education and Skills Committee Official Report 12 June 2019 Col 27. (2019). Shona Birrell. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12187&mode=pdf [accessed 2019]

[101] Education and Skills Committee Official Report 27 March 2019 Col 13. (2019). Professor Ian Wall. Retrieved from http://www.parliament.scot/parliamentarybusiness/report.aspx?r=12031&mode=pdf [accessed 2019]