

STEM EXPERIENCES IN EARLY YEARS AND PRIMARY SCHOOL EDUCATION: A RESPONSE FROM THE LEARNED SOCIETIES' GROUP ON SCOTTISH STEM EDUCATION TO THE SCOTTISH PARLIAMENT'S EDUCATION AND SKILLS COMMITTEE

May 2019

- > Interests and attitudes towards subjects are entrenched from a young age. While most young people enthusiastically enjoy early science education, very few aspire to become a scientist.
- > Science capital – that is, an individual's science related knowledge, qualifications, attitudes, contacts, experiences and resources – is unevenly spread among societal groups. 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.
- > Teacher expertise has the greatest effect on student achievement. It is vital, therefore, that practitioners are supported to develop their own knowledge of STEM subjects. There is currently no requirement for those aspiring to become primary teachers to have any level of formal science qualification. The Learned Societies' Group (LSG) is of the view that ITE applicants should be expected to achieve at least one SCQF level 5 qualification in a science as a minimum requirement.
- > The LSG recommends 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 is crucially important that practitioners are able to access high-quality and continuous career-long professional learning (CLPL), covering both subject-specific knowledge and pedagogy. Education Scotland launched its Professional Learning in STEM Grants Programme last year, to build the STEM capacity and confidence of practitioners. However, it is unclear as to whether grant funding will be made available this financial year. The LSG has highlighted the need for sustained funding to support the required step-change in CLPL.
- > There is evidence that gender biases can become ingrained as early as age six. Systemic change is required, moving away from single actions towards high-quality multiple, sustained interventions throughout the learner journey. A 'whole school' approach is needed to embed and mainstream cultural change to achieve gender equality.
- > Learners of all ages must be able to undertake science experimentation and practical work. This helps to engage learners, particularly young children in science, and also supports their understanding of scientific concepts. In 2014, the LSG investigated the resourcing of practical science in Scottish primary and secondary schools. Primary school respondents raised issues in relation to access to sufficient equipment and concerns about the funding available for science practical work. In its 2016 report, the STEM Education Committee (STEMEC) recommended that the Scottish Government should commission further research to identify the requirements, including appropriate funding, to enable the adequate delivery of practical science.

Summary

1 The Learned Societies' Group on Scottish STEM Education (LSG) brings together the learned societies and professional associations with a focus on the provision of STEM education at school.¹ We welcome the opportunity to respond to the Scottish Parliament Education and Skills Committee's call for evidence on the STEM experiences of three to seven year olds. We would be pleased to discuss our comments with the Committee should members consider this helpful and we look forward to contributing to future inquiries into STEM. We have attached, separately, an overview of the activities undertaken by the LSG organisations to support STEM education in Scotland, including resources aimed at early years and primary school practitioners.

Engaging young people in STEM from the early years

- 2 Interests and attitudes towards subjects are entrenched from a young age. Research has found that "liking science is not enough". While most young people enthusiastically enjoy early science education, very few aspire to become a scientist. The image of STEM as something abstract and difficult has repeatedly been found to be a major barrier to inspiring interest in and uptake of STEM subjects.²
- 3 Young people's misconceptions of STEM are compounded by the frequent lack of sufficient science capital – that is, an individual's science-related knowledge, qualifications, attitudes, contacts, experiences and resources. Young learners are influenced by teachers, careers advisers, the media, peers and, often to the largest extent, parents or carers. Research suggests that 65% of young people look to parents and families for career inspiration;³ and also finds that *"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".⁴ Science capital is unevenly spread among societal groups and tends to be higher in middle class families and the research shows that 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.

- 4 These points demonstrate the need for early and sustained interventions to build STEM capital among learners and their families, to inspire interest in STEM subjects from a young age. There is also an ongoing need to promote the message that STEM enables young people to keep their career options open and provides transferable skills that are useful for a wide range of careers, not only those within specific STEM disciplines. Teachers and educators need to be supported to help address these points. We comment on this in the next section.
- 5 While schools can help build science capital among families, action needs to be taken by a wide range of influencers. Yet there have been relatively few interventions aimed at increasing the science capital of parents and families, so that they are more likely to support their children. This is, however, changing. The grant funding that Scottish Government provides to Scotland's four science centres makes provision to support centres' engagement with a greater diversity of people and to support pupils in rural and deprived areas access the centres. In addition, the UK Association for Science and Discovery Centres and the Science Museum Group have launched a new 'Science Capital in Practice' Programme to increase diversity and inclusion in science.⁵ Three of the 15 UK science centres selected for the programme are based in Scotland: Aberdeen, Dundee and Glasgow. They will receive additional resources to enable children and adults from a more diverse range of backgrounds to participate in science-related experiences and feel that science 'is for me'.

1 This response has been signed off by the LSG membership comprising: The Association for Science Education; BCS, the Chartered Institute for IT; Edinburgh Mathematical Society; Institute of Physics; Royal Society of Biology; Royal Society of Chemistry; Royal Society of Edinburgh; and the Scottish Mathematical Council. More information about the LSG is available at: <https://www.rse.org.uk/policy/standing-committees/learned-societies-group/>

2 ASPIRES: Young People's science and career aspirations, age 10-14; King's College London; November 2013 <https://www.kcl.ac.uk/ecs/research/aspires/aspires-final-report-december-2013.pdf>

3 Girls in STEM Survey; Accenture; March 2018 <https://www.accenture.com/gb-en/company-news-release-research-opportunity-girls-stem>

4 ASPIRES: Young People's science and career aspirations, age 10-14; King's College London; November 2013

5 <https://www.sciencecentres.org.uk/projects/science-capital-practice/>

Practitioners' contributions and support needs

- 6 Teacher expertise has the greatest effect on student achievement. It is vital, therefore, that practitioners are supported to develop their own knowledge of STEM subjects and to deliver STEM education in an engaging, inspiring and, crucially, inclusive manner. However, it can be very challenging to provide early years and primary practitioners with the STEM support they need given the breadth of areas they are expected to cover and the focus demanded by other priorities.
- 7 The lack of confidence in STEM among early years professionals and primary teachers has been a perennial issue in Scotland. However, there is currently no requirement for those aspiring to become primary teachers to have any level of formal science qualification. In the LSG's recent response to the General Teaching Council for Scotland (GTCS) review of the Memorandum on Entry Requirements for Initial Teacher Education (ITE) Programmes in Scotland, we reiterated our view that ITE applicants should be expected to achieve at least one SCQF level 5 qualification in a science as a minimum requirement.⁶
- 8 'Teaching Scotland's Future' was clear on the need for science and mathematics to feature prominently in ITE programmes for primary teachers.⁷ 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.⁸ In our response to the GTCS, the LSG 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.
- 9 ITE is the starting point in practitioners' career development. It is therefore crucially important that they are able to access high-quality and continuous career-long professional learning (CLPL) covering both subject-specific knowledge and pedagogy. The CLPL surveys of practitioners undertaken by Education Scotland in June 2017 to inform implementation of the *STEM Education and Training Strategy*⁹ clearly show that of the various forms of CLPL, early years and primary practitioners most highly value the opportunity to work collegiately in their schools and clusters. However, time availability, staff shortages, difficulty obtaining supply cover, uneven provision, rurality and education authority budgetary pressures pose significant challenges to the uptake of CLPL. Through the *STEM Education and Training Strategy*, Education Scotland is developing a national level CLPL strategy for Scotland to streamline the support available. The *Professional Learning in STEM Grants Programme* was launched in October 2018 and awarded £187,000 in 2018/19 to a range of organisations, including learned scientific societies,¹⁰ to build the STEM capacity and confidence of practitioners.¹¹ However, it remains unclear as to whether grant funding will be made available to support STEM CLPL in the current financial year. During the development of the programme the LSG has highlighted the need for sustained funding to support the required step-change in CLPL.

6 LSG response to GTCS review of the Memorandum on Entry Requirements for ITE Programmes in Scotland; December 2018 http://www.rse.org.uk/wp-content/uploads/2019/01/LSG_GTCS_ITE.pdf

7 Graham Donaldson, *Teaching Scotland's Future: Report of a review of teacher education in Scotland*; 2010 <https://www2.gov.scot/resource/doc/337626/0110852.pdf>

8 *Initial Teacher Education: Content Analysis*; Scottish Government; May 2017 <https://www.gov.scot/publications/initial-teacher-education-content-analysis-2017/>

9 *STEM Education and Training Strategy*; Scottish Government; October 2017 <https://www.gov.scot/publications/science-technology-engineering-mathematics-education-training-strategy-scotland/>

10 IoP and RSC received grant funding in 2018/19

11 *Enhancing Professional Learning in STEM: overview of grant funding 2018/19* https://education.gov.scot/improvement/Documents/STEMProfessionalLearningGrantsOverview2018_19.pdf

10 The SSERC Primary Cluster Programme has worked with clusters of primary school teachers within every local authority with the aim of raising their levels of confidence and expertise in STEM. School clusters identify a group of mentor-teachers in STEM who design and implement professional development for all teachers in their cluster. The recently completed independent evaluation shows that the programme has been extremely successful.¹² The report recommends sustaining and expanding the programme, particularly in the context that given their resource constraints, local authorities find it increasingly challenging to support schools' CLPL. This is needed to ensure that an even greater number of primary schools and teachers can benefit from SSERC CLPL and to maintain the legacy impact of the programme. Similarly, *Raising Aspirations in Science Education* (RAiSE), delivered and funded by The Wood Foundation, Scottish Government and Education Scotland, has worked with eight local authorities on a 4-year pilot basis. Primary science development officers are appointed in the local authorities to help develop the STEM confidence and competence of primary teachers through the creation of support networks that allow teachers and schools to mentor, collaborate and share learning. Evaluation to date again provides useful insight into what appears to be working to enhance science education in Scottish primary schools and where the challenges still lie.¹³ On the basis that the full evaluation shows the programme to have been successful, again, the key issue will be sustaining it and broadening out access to it beyond the pilot local authorities.

Gender equality

11 As part of a holistic review of women in STEM, the RSE's *Tapping All Our Talents* 2018 report considered female participation in STEM from the early years.¹⁴ It found that gender stereotypes continue to be used in curricula, materials, language, careers advice, policies and culture in schools and early years settings. There is evidence that gender biases can become ingrained as early as age six. Systemic change is required, moving away from single actions towards high-quality multiple, sustained interventions throughout the learner journey. A 'whole school' approach is needed to embed and mainstream cultural change to achieve gender equality. This means that all strands of gender inequality should be tackled together; and not limited to girls and STEM.

12 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. Whole school/setting approaches were found to be most effective.¹⁵ Following the pilot project's successful evaluation, the Scottish Government made a commitment to embed the learning from IGBS in to the practice of every school by 2022. Education Scotland has recently established a new gender balance and equalities team to lead this work.

¹² Evaluation of the SSERC Primary Cluster Programme in Science and Technology; University of Glasgow Robert Owen Centre for Educational Change; March 2019 <https://www.sserc.org.uk/wp-content/uploads/2019/04/SSERC-PCP-Final-Report-30-March-2019.pdf>

¹³ Raising Aspirations in Science Education Interim Evaluation Report; The Robert Owen Centre for Education Change; April 2018 <https://www.thewoodfoundation.org.uk/wp-content/uploads/2018/05/RAiSE-Interim-Report-ROC-29April18.pdf>

¹⁴ Tapping All Our Talents 2018; A progress review of women in STEM in Scotland; Royal Society of Edinburgh; November 2018 http://www.rse.org.uk/wp-content/uploads/2018/11/Women-in-STEM-report-2018_final.pdf

¹⁵ Improving Gender Balance Project Summary of Key Findings <https://education.gov.scot/improvement/Documents/sci38-key-findings.pdf>

Resourcing of practical science

13 It is vitally important that learners at all ages are able to undertake science experimentation and practical work. This not only helps to engage learners, particularly young children in science, but also support their understanding of scientific concepts. In 2014, the LSG investigated the resourcing of practical science in Scottish primary and secondary schools.¹⁶ The LSG undertook this work in order to investigate concerns that the level of resource for science in schools was diminishing and because it had been more than 10 years since data were gathered about the funding of science practical equipment in Scottish schools. As far as primary schools are concerned, key findings included that 58% of respondents felt they did not have sufficient equipment and consumables to deliver science practical work effectively; 52% said they did not have sufficient access to training on the use of science equipment and consumables; less than half felt they had enough of specific listed equipment in working order; 44% were dissatisfied with funding for science practical work; and 98% of respondents said their school had to draw on additional funding sources for practical activities, with parental sources being the most common for extra-curricular activities. Recognising the small sample size and the time that has elapsed, the Committee could return to the reports of the STEMEC¹⁷ and SEEAG¹⁸ Committees on STEM education which recommended that *the Scottish Government should commission further research to identify the requirements, including appropriate funding, to enable the adequate delivery of practical science.*

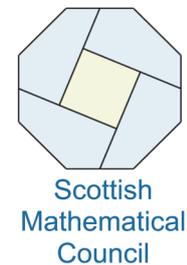
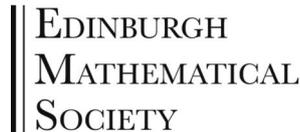
¹⁶ The Resourcing of Science in Scottish Schools; the Learned Societies Group on Scottish Science Education; November 2014
https://www.rse.org.uk/cms/files/education/Learned%20Societies%20Science%20Education/LSG_Pye_Tait_Summary.pdf

¹⁷ Final Report of the STEM Education Committee (STEMEC); September 2016
<https://www.gov.scot/publications/stemec-report-2016/>

¹⁸ Supporting Scotland's STEM Education and Culture; Science and Engineering Education Advisory Group report; 2012
<https://www.gov.scot/publications/supporting-scotlands-stem-education-culture-science-engineering-education-advisory-group/>

Additional Information

For further information about the Learned Societies' Group, contact its Secretariat,
William Hardie (whardie@theRSE.org.uk)



The Association for Science Education is registered charity in England and Wales (No.: 313123) and Scotland (No.: SC042473)

BCS is a registered charity No: 292786

The Edinburgh Mathematical Society (EMS) is a registered Scottish charity, No: SC000241

The Institute of Physics is Registered charity number 293851 (England & Wales) and SC040092 (Scotland)

The Royal Society of Biology is Registered Charity No: 277981

The Royal Society of Chemistry is Registered Charity No: 207890

The Royal Society of Edinburgh is Scottish Charity No: SC000470

The Scottish Mathematical Council is Scottish Charity No: SC046876

