# SUBJECT CHOICES: A RESPONSE FROM THE LEARNED SOCIETIES' GROUP ON SCOTTISH STEM EDUCATION TO THE SCOTTISH PARLIAMENT'S EDUCATION AND SKILLS COMMITTEE

*March 2019*

## Summary

- The introduction of Curriculum for Excellence (CfE) and the new national qualifications has undoubtedly coincided with a narrowing of the secondary curriculum, most notably in S4 where six qualification courses is the most common approach. The LSG is particularly concerned about the implications of narrowing of the curriculum for the study of the STEM subjects in S4-6 in the context of providing opportunities for learners to experience a broad curriculum.

- The number of candidates presenting for STEM qualifications has declined over the last five years. While demographic change is a factor, the changing structure of the senior phase, especially the reduction in subject choice at S4, would appear to be a key factor. Given that the total number of Higher entries increased between 2013 and 2018, we might reasonably have expected to see an increase in STEM entries. However, the data shows a decrease in the uptake of STEM subjects at Higher level relative to other subjects.

- Progression on to many STEM degree programmes is facilitated by students having studied multiple STEM subjects to Higher and Advanced Higher level. There is, therefore, a risk that reduced course options at S4 closes down both future learning pathways in STEM and subsequent career options.

- Curriculum structures within the Broad General Education will have a strong bearing on the extent to which learners are prepared for the qualification courses that follow. There is a need to consider the coherency of the school learner journey and progression pathways as a whole.

- The availability of subject specialist teachers is a key factor in enabling schools to offer a broad range of subjects. Computing, Chemistry, Physics and Mathematics are among the subjects with the lowest teacher replenishment rates. The LSG firmly believes that there is a need for improved data on teacher shortages and vacancies in Scotland in order to support accurate teacher workforce planning. The modelling that underpins teacher workforce planning should include a subject-specific component.

- A prominent issue for the teaching of the sciences is the practice of multi-course teaching of courses (i.e. where two or more distinct courses e.g. National 4 and 5 are taught simultaneously in one class). Science teachers have expressed concern that multi-course teaching does not allow them to fully support the needs and aspirations of pupils undertaking different levels of national qualifications. While the Scottish Government, Education Scotland and SQA recognise the challenges posed by multi-course teaching, it is not clear what action is being taken to address this issue.

## Background

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 inquiry into subject choices. The LSG continues to monitor the impact of the introduction of Curriculum for Excellence (CfE) and the new national qualifications on uptake of the STEM subjects. We are keen to ensure that learners can continue to take up and progress in STEM subjects as part of a broad curriculum offering. Through its member organisations, the LSG has links to networks of STEM teachers in Scotland. We are therefore well placed to contribute to STEM developments in schools. We would be pleased to discuss our comments with the Committee should members consider this helpful.

## Has the structure of the Senior Phase of Curriculum for Excellence allowed for better learning and overall achievement than previously?

2 It is not possible to provide a definitive answer to this question at this time due to the absence of independent evaluation of the impact of the senior phase structures on learning, teaching and attainment. The timing of the OECD review of the introduction of CfE meant it primarily focussed on the broad general education (BGE) phase rather than the BGE and the senior phase as a coherent whole.[2] This is an important issue since BGE curriculum structures will have a strong bearing on the extent to which learners are prepared for the qualification courses that follow. In this context, the study published last year by Professor Jim Scott highlights the very large range of ways in which secondary schools are structuring their curricula; the implication being that many of these approaches have taken root without a clear curricular rationale.[3] The LSG believes that there is a need to consider the coherency of the learner journey and progression pathways as a whole.

## Do you think there has been a narrowing of the range of subjects and subject choices in broad general education and in the senior phase, and what is the impact of any limitations on subject choice?

3 The introduction of CfE and the new national qualifications has undoubtedly coincided with a narrowing of the secondary curriculum, most notably in S4 where six qualification courses is the most common approach.[4] This narrowing is not the result of any conscious policy decision. It is an unintended consequence of the confusion schools have experienced in interpreting national guidance on the relationship between the BGE and the senior phase, particularly in relation to the extent to which the BGE can be used to prepare learners for qualifications, given that the qualification courses are based on 160 hours of directed study. The LSG is particularly concerned about the implications of narrowing of the curriculum for the study of the STEM subjects in S4-6 in the context of providing opportunities for learners to experience a broad curriculum.

4 In his report,[5] Professor Scott reflects that, 'Many parents and learners […] have opted for either "two Sciences and a Social Subject" or "two Socials and a Science"', alongside English, Mathematics and one other, which suggests a lack of appropriate breadth of study and may result in subjects being squeezed out.

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 Improving Schools in Scotland: An OECD Perspective; 2015 http://www.oecd.org/education/school/improving-schools-in-scotland.htm

3 Scott, J.; Curriculum for Excellence and the Early/Middle Secondary Curriculum in Scotland: Lessons Learned or Forgotten?; March 2018 https://discovery.dundee.ac.uk/en/publications/curriculum-for-excellence-and-the-earlymiddle-secondary-curriculu

4 Scott, J.; Curriculum for Excellence and the Early/Middle Secondary Curriculum in Scotland: Lessons Learned or Forgotten?; March 2018

5 Scott J., 2018, Unintended or unexpected? The impact of curriculum for excellence on secondary school curriculum and attainment, p.11 http://dundee.academia.edu/JimScott

**5** The Scottish Government has appropriately prioritised education and training in STEM subjects as necessary for growing Scotland's economy.[6] However, learners will make their senior phase course choices relatively early in their school careers (i.e. by the end of S3). At this point they may be unsure about their future career paths. A narrower curriculum at S4 therefore places pressure on learners in terms of the subjects that they choose during the BGE since this will have a significant bearing on their learning journey at and beyond school, as well as on their future career options. A narrowing of the curriculum at S4 also means that learners have less room for manoeuvre in the senior phase should they not succeed in one or more of their chosen subjects. Factors including timetabling and the availability of subject specialist teachers (which we return to, below), may also mean that learners are not able to take-up their first-choice subject selections, resulting in them being assigned subjects which they may not have chosen originally.

**6** Progression in STEM subjects requires learners to have gained the pre-requisite knowledge and skills required by the course. This reinforces the importance of ensuring that STEM subject content and coverage in the BGE prepares learners sufficiently for the senior phase qualifications. In this context, it would be useful to consider to what extent the CfE Benchmarks introduced in 2017 have helped support more coherent progression from BGE into the senior phase in the STEM areas.

**7** Additionally, progression on to many STEM degree programmes is facilitated by students having studied multiple STEM subjects to Higher and Advanced Higher level. There is, therefore, a risk that reduced course options at S4 closes down both future learning pathways in STEM and subsequent career options.

## Have you experienced any changes in the level of uptake in particular subjects in the past 5 years?

**8** The absolute number of candidates presenting for STEM qualifications at SCQF levels 3-5 has declined substantially over the last five years.[7] Between 2013 (last year of Standard Grades) and 2018, Computing-related[8] entries have decreased by 44%, Chemistry entries are down by 27%, both Physics and Biology are down by around 22% and entries to Maths are down by around 11%. These declines in absolute entries should be set in a demographic context where the size of the S4 cohort has fallen by around 10% between 2013 and 2018. However, it is clear that with the possible exception of Maths, the declines in entries are not driven solely by demographic factors. The primary factor for the decline would appear to be the changing structure of the senior phase, especially the reduction in subject choice at S4, which can constrain the ability of learners to take up STEM courses (and other subjects) at the levels seen pre-2014.

**9** In the case of Computing, an additional factor for the substantial decline in presentations could be the change in the substance of the courses, with computational thinking and programming featuring much more prominently in the new Computing Science courses compared with previous courses. Given the substantial skills gap in the tech sector in Scotland and the ongoing developments in automation, the drop-off in the uptake of Computing is particularly concerning.[9]

6 STEM Education and Training Strategy, Scottish Government, 2017 https://www.gov.scot/publications/science-technology-engineering-mathematics-education-training-strategy-scotland/

7 SQA Attainment Statistics for 2013 and 2018

8 Includes Computing, Computing Studies, Computing Science and Information Systems

9 Building a World-Leading AI and Data Strategy for an Inclusive Scotland, SCDI, BT Scotland, ScotlandIS and RSE, February 2019 https://www.scdi.org.uk/policy/ai-and-data/

**10** We also see reductions in the number of STEM Highers being taken between 2013 and 2018. Entries to Higher Biology have declined by 28% over this period. Entries to Computing-related[10] Highers are down by 21%, Physics are down by 14%, Maths are down by 9% and Chemistry are down by 6%. As well as the reductions in absolute terms, the percentage of STEM entries at Higher level as a proportion of total entries has decreased between 2013 and 2018. Biology has declined from 5.5% to 3.8%, Maths is down from 11.3% to 9.8%, Physics is down from 5.3% to 4.3%, Computing is down from 2.8% to 2.1% and Chemistry is down from 5.8% to 5.2%.

**11** While changing demographics have resulted in a reduction in the size of the senior phase school roll between 2013 and 2018, the total number of Higher entries has actually increased by 4.7% over this period. We might therefore reasonably have expected to see an increase in Higher STEM entries. However, the above data on Higher entries in STEM subjects as a proportion of total entries indicates a decrease in the uptake of STEM subjects relative to other subjects.

**12** It should be noted that entries to Higher Human Biology increased by 39% between 2013 and 2018. By design, this course covers a narrower bioscience curriculum than Higher Biology. However, a lack of broader bioscience skills covering non-human biology has implications for the skills base in Scotland.

**13** The preceding points indicate that the main concern is the narrowing of subject choice in S4 and the implications this has for the uptake of, and progression in, STEM courses in the senior phase.

### *Gender inequality*

**14** Recent work highlights the ongoing gender disparity in the STEM subjects.[11] While around 52% of entrants to National 5 courses in Chemistry and Maths were female in 2018, females account for 28% of Physics entrants and only 18% in Computing Science. Meanwhile, females account for 67% of Biology students. The RSE report, *Tapping All Our Talents* 2018, provides a detailed account of the issues and demonstrates the range of work being undertaken, including that led by the learned scientific societies, to address gender inequality in STEM. This makes clear the need for systemic and sustained interventions from the very early years, including the adoption of whole school approaches. Tackling gender inequality in STEM at school is a focus of the STEM Education and Training Strategy and we welcome the appointment of a new team of Gender Balance and Equalities Officers to help support developments in this area.

## What are the factors that influence the range of subject choices?

**15** The availability of subject specialist teachers is a key factor in enabling schools to offer a broad range of subjects. Teacher workforce planning is a prominent area of interest for the LSG, especially as it is clear that schools are experiencing significant challenges in the recruitment of specialist teachers in the sciences and in mathematics, with work showing that Computing, Chemistry, Physics and Mathematics are among the subjects with the lowest teacher replenishment rates[12] and, in the case of Computing, research has shown that 17% of secondary schools do not have a specialist Computing Science teacher.[13]

10 Includes Computing, Information Systems and Computing Science

11 Tapping all our Talents, A progress review of women in STEM, Royal Society of Edinburgh, November 2018 https://www.rse.org.uk/inquiries/womeninstem-2018/

12 Report of the Teacher Workforce Planning Working Group; December 2013 http://www.gtcs.org.uk/web/FILES/about-gtcs/dual-reg-consultation-report-of-the-twpwg.pdf

13 Computing Science Teachers in Scotland 2016; Computing at School Scotland http://www.cas.scot/wp-content/uploads/2016/08/ComputingTeachersinScotland-CASSReport2016.pdf

**16** While the Scottish Government publishes annually the Teacher Census, this does not provide a clear picture of teacher need either in subjects or in different localities. The UK Government Migration Advisory Committee (MAC) reported that *'there is very limited data to draw on to assess the shortage of teachers by subject in Scotland'.*[14] More recently, the Scottish Government has started to collect and publish limited snapshot data on vacancy figures in local authorities and across subjects. However, the absence of contextual information makes it difficult to analyse the data in terms of subject-specific and regional based need. The LSG firmly believes that there is a need for improved data on teacher shortages and vacancies in Scotland in order to support accurate teacher workforce planning. The modelling that underpins teacher workforce planning should include a subject-specific component.

**17** In order to ensure equity, all learners irrespective of the size and location of their school should have the opportunity to access all of the STEM subjects at both the BGE and the senior phase as part of a broad curriculum. This may require partnership arrangements among schools and school clusters and with college and university partners.

## Other related issues

### *Difficulty of the sciences and maths relative to other subjects*

**18** The SQA's guidance on setting grade boundaries makes clear that the SQA has to ensure that it is not easier or harder to achieve the same result across different courses. As an example, the guidance states, *"a Grade B in Higher Chemistry should broadly represent the same standard of attainment as a Grade B in Higher French."*[15] However, the SQA's Attainment Statistics show that there are in some cases quite marked differences among different courses in the proportion of pupils who achieve passes. In 2018, for example, 65% of Maths, 73% of Biology and 75% of Computing Science and Physics candidates passed National 5 courses in these subjects. In comparison, 85% of English, 87% of French and 95% of Music and Physical Education candidates achieved N5 passes. We recognise that the underlying picture is more complex than these figures alone would suggest. We are, however, concerned about the implications of the resulting perception that the STEM subjects are more difficult in terms of influencing learners' senior phase course choices. To ensure broadly similar standards of attainment between different subjects at the same qualification level, it will be important that SQA examines trends over longer time periods and not only year-to-year or short-term changes which may mask changes over time. The LSG has been discussing these issues with the SQA.

### *Multi-course teaching*

**19** A prominent issue for the teaching of the sciences is the practice of multi-course teaching of courses (i.e. where two or more distinct courses e.g. National 4 and 5 are taught simultaneously in one class). Science teachers have expressed concern that multi-course teaching does not allow them to fully support the needs and aspirations of pupils undertaking different levels of national qualifications. While N4 and N5 courses adopt the same unit titles, they were designed so that the content and learning outcomes between the levels should not overlap, making multi-course teaching very demanding. The issues are exacerbated when teaching of N4 and/or N5 is combined with the teaching of Higher in a multi-course class. In addition, it will be important to ensure that multi-course teaching does not inhibit practical work since this is crucial to engaging learners in science and supporting their understanding of scientific concepts.

14 Partial Review of Teacher Shortages in the UK; Migration Advisory Committee; January 2017 https://www.gov.uk/government/publications/migration-advisory-committee-mac-report-teacher-shortages-in-the-uk

15 A Guide to Setting Grade Boundaries, SQA, July 2017 https://www.sqa.org.uk/files_ccc/A_Guide_to_Setting_Grade_Boundaries_v1.3.pdf

**20** To investigate the issue of multi-course teaching, in 2016 the Royal Society of Chemistry's Education Division Regional Committee for Scotland undertook a survey into Chemistry teaching in the Senior Phase capturing responses from 259 teachers. This survey revealed how common multi-course classes have become with 73% of National 5 classes containing students studying towards different national qualification courses. The most common combination found containing National 5 students was combined National 4 & National 5 classes. When asked how well students can be supported within such composite N4/5 classes, 69% said "not at all" or "not very well". For Higher students, around a fifth of classes contain multi-course groupings. Alarmingly, when asked how well students' learning could be supported in the most common combination, National 5/Higher classes, 99.5% responded "not at all" or "not very well". While the Scottish Government, Education Scotland and SQA recognise the challenges posed by multi-course teaching, it is not clear what action is being taken to address them.

## Additional Information

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