

COMPUTING AT SCHOOL SCOTLAND

Briefing on Computing Science Education in Scotland February 2015

Executive summary

In the next five years, Computing Science education could be a great success story for Scotland, or it could have completely withered. With our existing Computing Science (CS) teacher workforce, a world-class CS curriculum waiting in the wings, and research-led subject-specific professional development already in practice, a sharp focus on the five key issues highlighted in this document and a relatively modest investment could transform the opportunities of Scotland's young people and make us world-leaders in CS education in the next 3-5 years. This will obviously have a strong positive effect on industry as well. If the five key issues are ignored, then we are likely to lose our ability to deliver any kind of effective curriculum at all, a position that will take 10-20 years to remedy.

The five key structural issues endangering CS education in Scotland are as follows:

- **Numbers of teachers:** We have reached a crisis with the number of Computing Science teachers in our school system. 12% of secondary schools have closed their computing departments and have no active Computing Science teachers. We need Head Teachers and Local Authorities to realise the value of Computing Science. Schools speak of extreme difficulty in recruiting Computing Science teachers and finding subject-specific cover, even in the Central Belt. We need to retain our existing teachers and increase the numbers of teachers in the system.
- **Teacher training and workforce replenishment:** there are not enough quality candidates for PGDE courses and targets are being missed. The replenishment rate for Computing Science is the lowest of all STEM subjects. We would welcome more flexible, open and part-time PGDE courses to attract more applicants from the IT industry, and PGDE courses in more areas of Scotland. Recruitment and incentivisation programmes are required to train more teachers.
- **Over-crowded Computing Science classes:** Computing Science is not on the SNCT list of practical subjects. In the last couple of years we have learned of an increasing number of Computing Science teachers being told to teach classes of up to 33 in rooms designed for 20. In addition to health and safety concerns, the educational experience of those young people is hugely deteriorated. We are greatly concerned that more Head Teachers will learn of this 'trick' and will try this in desperation to resolve a staffing crisis in their school.
- **Amount of Computing Science taught at S1-3:** Computing Science has the lowest amount of time in the timetable than any other subject in the majority of Scottish schools. We recommend that schools

increase the class time committed to Computing Science in S1-S3 for all pupils, which will both engage students in the subject and develop deeply the necessary thinking skills required for National qualifications.

- **Development of Computing Science in Primary and Early Years:** The professional learning needs of the primary and early years sectors for Computing Science needs to be addressed.

Key Definitions

CT - Computational Thinking:

The key themes of computational thinking are not directly related to current computers or technology, but instead to the underlying abstract concepts of information and process and the associated intellectual skills.

CS - Computer Science:

Computer Science is the study of principles and practices that underpin an understanding and modelling of computation, and of their application in the development of computer systems. Study of computer science typically incorporates development of CT skills.

ICT - Information and Communication Technology:

ICT involves using technological devices such as laptops and tablets in learning across the curriculum to communicate with others. For example using computers to create animations, videos or presentations in class.

Issues and Solutions

Numbers of Computing Science teachers in Scotland

In November we compiled a report into the number of Computing Science teachers.

<http://www.cas.scot/2014-full-report-into-computing-science-teachers-in-scotland/>.

Key findings from this report are:

- There has been a drop of 14% in Computing Science teachers over the last two years.
- 12% of schools do not have a Computing Science teacher. This is 43 Secondary schools that are not in a position to offer Certificate-level Computing Science courses. Many other schools have only a single CS teacher.
- This is a problem not limited to the outlying areas of Scotland. For example the numbers of Computing Science teachers in Glasgow City has reduced from 74 in 2012 to 32.4 in 2014
- Low uptake, staff leaving and a need to reduce staffing were reasons given by some Local Authorities for the reduction. Reduction in the column choices due to the introduction of National 5 will be a factor in lower uptake by pupils.

- Many schools claim to be delivering Computing Science outcomes across the curriculum, but there is evidence of confusion of Computing Science with ICT skills.
- 10 of the 32 Local Authorities have had problems recruiting Computing Science teachers.

Teacher Training in Scotland

In addition to issues retaining teachers, the Initial Teacher Education institutions (ITEs) are not able to source enough quality applicants to train up new CS teachers.

- The target for educating PGDE Computing Science students in 2014 was 25 places with a top limit of 42. The target was not been met in 2014 with only 21 students training this year. ITE institutions are not getting enough quality applicants in a competitive job market for Computing Science graduates.
- This PGDE target of 25 and replenishment rate of 2.81% is the lowest of all STEM subjects. For comparison, technological education at 37 places and a replenishment rate (5.21%) is close to the overall average of (5.95%) and Physics is 52 places and a replenishment rate of 4.15%.
- There are only 2 institutions offering full time PGDE courses, both in Glasgow, and a four year B.Ed. in Stirling. We need more options for training Computing Science teachers in Scotland both in terms of location and flexibility of delivery as this is one of the factors restricting the number of applicants.

We would welcome more ITEs offering flexible, open and part-time PGDE courses to attract more applicants from the IT industry. Recruitment and incentivisation programmes are required to train more teachers.

Time allocation for Computing Science in Secondary

Computing Science is regularly allocated less than one period per week in secondary levels S1-S3. In a 2012 survey the average class time for computing in S1 was 0.6 of a period and in S2 it was 1.1 periods, the lowest of all subject in many schools. A period can vary between 30 to 60 minutes. This very limited time is sometimes shared with ICT training, which does not develop Computing Science skills and understanding. The new National 5 qualifications were designed to build on a solid foundation developed in broad general education (age 3-15), but in many cases core Computing Science have not been covered prior to S4.

We could make a huge impact now by simply resourcing Computing Science in S1-S3 properly. We recommend that schools increase the class time committed to Computing Science in S1-S3 for all pupils, and clearly separate this from time committed to ICT training. We suggest that two periods per week in S1-S3 for Computing Science will both engage students in the subject and develop deeply the necessary thinking skills required for National qualifications.

We have many teaching resources already with exemplification materials from the RSE and we could develop additional materials in 2015-16. It is reliant on Local Authorities and Head Teachers seeing the importance of Computing Science and dedicating more time in the timetable for the subject.

Development of Computing Science education in Early Years and Primary

Computing Science education has traditionally started late in the secondary programme or at university, and has been viewed as hard, with many learners achieving poorly. Just as mathematical thinking must be developed from the early years, so must the foundational skills for Computing Science proficiency.

Professors Cutts and Connor of Glasgow and Strathclyde Universities respectively have been working on a new curriculum starting from the early years. It is the underlying concepts and ways of thinking that are the crucial innovation in this curriculum. For this reason, the early years and much of the primary level education need not involve computers extensively, nor deep knowledge of information technology. We recognise this as an important factor in enabling adoption of the curriculum across the primary sector.

The PLAN C professional learning project, funded by Scottish Government, has initiated the process of promoting best practice methods for delivering CT education at the secondary level, in line with the findings in this report. Around a third of all Computing Science teachers are currently regularly attending PLAN C meetings. We recommend the expansion of the project to include the professional learning needs of the primary and early years sectors, with collaborative working between secondary schools and their associated primaries, to ensure smooth transition as pupils move between schools. Negotiations with SDS, under the Strategic Investment Plan for IT, are underway in this respect. However, this will only cover the first year or two of funding for development and support. This work will require longer term support and finance.

Computing Science as a practical subject

For decades Computing Science has been classified as a practical subject in secondary schools across Scotland. It has been timetabled as a practical subject like Science subjects so that a maximum of 20 children are in each class. Computing Science classrooms across Scotland are designed and built for classes of 20, generally with twenty computer desks and computers, and with many classrooms also having twenty individual writing desks too. The network and power infrastructures of these classrooms are fixed too.

Computing Science is not listed on the Scottish Negotiating Committee for Teachers (SNCT) list of practical subject, although all other Science and Technology subjects are listed, including "Administration and IT"

http://www.snct.org.uk/wiki/index.php?title=Appendix_2.9

In the last couple of years we have learned of a number of Computing Science teachers being told to teach classes of up to 33. In addition to the health and safety concerns of large numbers of pupils being crammed into a room designed for 20, the educational experience of those young people will be hugely deteriorated. The number of Computing Science teachers being instructed to do this is increasing, alarmingly so. We are greatly concerned that as more Head Teachers learn of this 'trick' then more will try this in desperation to resolve a staffing crisis in their school.

Computing in Scotland compared to internationally

- We have great potential in Scotland but it's being strangled by a lack of understanding about the nature and benefit of a Computing Science related education.
- Most countries in the world do not have compulsory Computing Science or Informatics components in their curriculum however those that have kept a compulsory or a strongly supported optional pathway also have a much higher proportion of technology start-ups per head of population in their geographic area with Estonia, Israel and Costa Rica providing the clearest examples. Many of the rest that mostly focused on an ICT/Technology Enhanced learning focus have only recently re-introduced Computing Science in the last few years so it is too soon to see the impact of those changes.
- 17 European countries have started or are planning a strategic approach to Computing Science education from early stages of schooling.
- Although they are limited, we have Computing Science outcomes in our Primary and lower Secondary curriculum, whereas most countries don't. We need to develop our curriculum to cover a broader range of concepts and contexts. This will help all industries as well as those IT areas where there is a great need for expertise in Scotland and internationally, such as in cyber-security.
- We have great potential in Scotland with one of the largest concentrations of Computing Science researchers and academics in Europe at the University of Edinburgh and other world class departments in Glasgow and St Andrews. A large proportion of our existing Computing teachers have a Computing degree or other STEM undergraduate qualification.
- It won't take a lot to address the issues we are facing but it does require clear policy direction and sustained engagement with school leaders by Scottish Government and Education Scotland. These need to be addressed now in order to not lose the positive advantage we currently have.

Summary

This situation – a weak curriculum, limited class-time, and patchy provision across the country – is entirely inappropriate for a nation that aspires to be a leader in the research, design and development of digital/computational technologies, with a workforce that can make maximum use of these in all walks of life. We are at a tipping point in terms of the viability of the teacher workforce and action is needed now to stabilise the situation for the next few years with a hope of improving the situation over the next 5-10 years and being world-leading in Computing Science education.

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Computing At School Scotland
6th February 2015