After the reboot: computing education in UK schools

SUMMARY

THE ROYAL SOCIETY

Introduction

The demand for computing skills and knowledge is growing – the nation's economy depends on it, and young people must be equipped with the necessary skills for the future.

Data and digital technologies promise revolutionary transformational changes across the full range of industry sectors and spheres of life. This unprecedented digital revolution will impact everyone. It will have extraordinary implications on the range of skills that today's young people will require in every aspect of their lives. Computing education must enable young people to continue to keep up with the pace of technological change so that they can remain effective, well-informed and safe citizens.

However, our evidence shows that computing education across the UK is patchy and fragile. Its future development and sustainability depend on swift and coordinated action by governments, industry, and non-profit organisations. Neglecting the opportunities to act would risk damaging both the education of future generations and our economic prosperity as a nation.

The Royal Society's report, *After the reboot: computing education in UK schools*, provides a snapshot of the changes that have taken place since the introduction of the computing curriculum in 2014 and examines the impact of these changes across the UK. The report identifies a number of urgent challenges that governments, industry and school leaders need to address in order to safeguard the nation's future efficacy in the digital world.

To read the full report, visit **royalsociety.org/computing-education**

Image
Year 9 computing class at Sandringham School.

Computing for all

To realise the ambition of recent curriculum and qualification reforms.

Address gender imbalance in computing, which is the lowest of the STEM subjects
Though many of the great pioneers of computing were women, across the UK computer science is an overwhelmingly male-dominated subject and workforce. At GCSE, there is a 20% uptake from girls, while Scotland also had a 20% female uptake at National 5 in 2017. At A level, there is only a 9% uptake from girls, and this has not changed for many years. Scotland has a similar picture with 14% female uptake at Advanced Highers. Although Information and Communication Technology (ICT) qualifications fared better, they still only had 36% female uptake at A level[1].

Making computing education compulsory will not automatically lead to a higher proportion of young women choosing to study the subject once it becomes optional. Compulsory mathematics and physics to age 16 has not significantly improved the gender balance in these subjects in post-16 education or higher education. In order to meet the current and future skills needs in the UK, governments, employers and schools must prioritise changing the gender balance in computing. This is a challenge that requires people to take innovative approaches and draw on lessons learned in other disciplines.

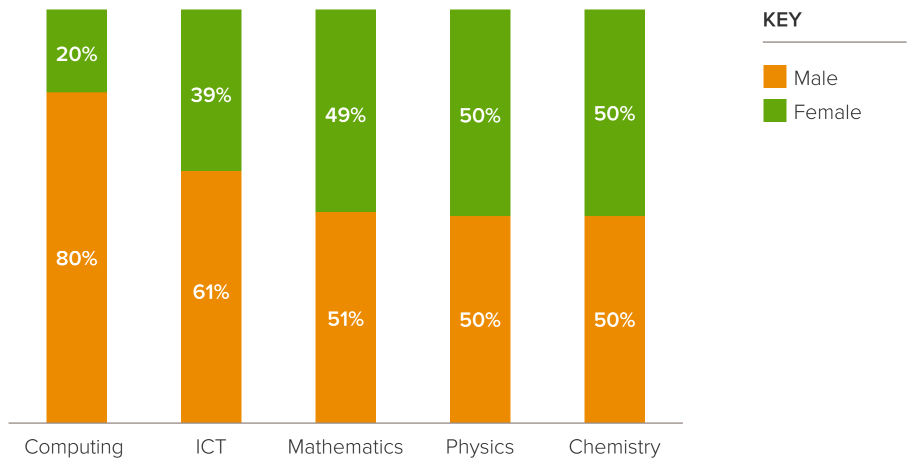
RECOMMENDATION

Government and industry-funded interventions must prioritise and evaluate their impact on improving the gender balance of computing.

1. JCQ. 2017. Examination results: A, AS and AEA results, Summer [2017]. See https://www.jcq.org.uk/examination-results/gcses/2017 (accessed 125 August 2017).

FIGURE 1

Gender balance percentage at GCSE for computing, ICT, mathematics, physics and chemistry (all UK 16-year-old candidates).



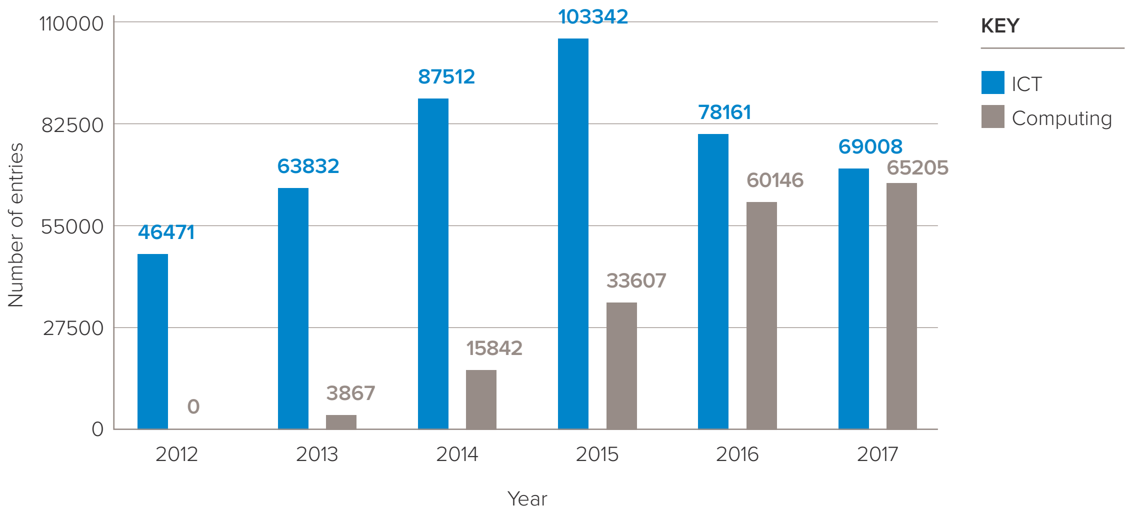
Note: JCQ uses the category 'computing' to include all GCSE qualifications in computing and computer science.
Source: JCQ.

Improve the uptake of computing by 14 – 16 year olds
Today, 70% of students in England attend schools offering GCSE computer science, which is a very positive development. However, although the overall number of entries continues to grow, only a disappointing 11% of all students take GCSE computer science[2]. Moreover, the range of qualifications on offer does not reflect the full breadth of computing. It should be possible to study computer science or information technology (or both). GCSE ICT makes up 55% of the total entry numbers of all computing qualifications at age 16 and there is a risk that there will be a drastic drop in the number of pupils studying computing as ICT is phased out[3]. The qualification landscape needs urgent attention to ensure the broadest range of pupils become equipped with relevant digital skills.

2. GOV.UK. 2017. Find and compare schools in England. See www.gov.uk/school-performance-tables (accessed 10 July 2017).
3. JCQ. 2017. See www.jcq.org.uk/examination-results/gcses/2017 (accessed 24 August 2017).

FIGURE 2

Entries to GCSE ICT and Computing in England, Wales and Northern Ireland.



RECOMMENDATION

Ofqual and the government should work urgently with the learned societies in computing, awarding bodies, and other stakeholder groups, to ensure that the range of qualifications includes pathways suitable for all pupils, with an immediate focus on information technology qualifications at Key Stage 4.

The learned societies in computing should establish a curriculum committee, to provide government with ongoing advice on the content, qualifications, pedagogy, and assessment methods for computing.

Supporting our teachers

To ensure there is a strong supply of confident computing teachers.

There is much to celebrate and there are many pockets of excellence. The broad subject of computing – covering the three vital areas of computer science, digital literacy and information technology (IT) – has become mandatory in English schools from ages 5 to 16. In Scotland, we have seen the implementation of the Significant Aspects of Learning, a framework where computing is broken down into distinct areas of knowledge. In Wales, the Digital Competence Framework is bringing computing in schools to the forefront, while Northern Ireland has continued to deliver a comprehensive computing framework. From ages 5 to 14, pupils typically have one hour per week of computing lessons, and some schools take opportunities to teach computing within other subjects.

Increase the availability of computing CPD opportunities for in-service teachers

In our survey, 44% of secondary school teachers only felt confident teaching the earlier stages of the curriculum where there is a less of a computer science focus. Despite this lack of confidence, 26% of secondary school teachers we surveyed indicated that they had not undertaken any computing-related professional development activities in the past year[4].

To truly transform computing education, teachers need unhindered access to a structured and ongoing programme of professional development. The programme must support teachers in all schools across the country. The existing university-based Computing At School Network of Excellence has been successful with minimal resources through a model built on enthusiastic volunteers developing a mutually supportive community of practice. However, the current level of resourcing and approach to execution is not sufficient to meet the challenges we have identified. A fully resourced national professional development programme building on the Network of Excellence requires a tenfold increase in funding from government and industry. This would provide computing teachers with a comparable level of support to mathematics and the sciences[5].

4. Pye Tait. 2017. After the Reboot: The State of Computing Education in UK Schools and Colleges.
5. For example, the Maths Mastery Programme was introduced in 2012 to provide a professional development network for maths teachers (See https://www.mathematicsmastery.org, accessed 11 October 2017.), the Stimulating Physics Network supports physics teachers through an extensive CPD programme (See http://www.stimulatingphysics.org, accessed 11 October 2017.) and STEM Learning provides CPD support for science teachers. (See https://www.stem.org.uk, accessed 11 October 2017.)

Headline teacher confidence at different stages of the curriculum

32%

of primary teachers feel more confident teaching the earlier stages of the curriculum than the latter.

44%

of secondary teachers feel more confident teaching the earlier stages of the curriculum than the latter.

Source: Pye Tait. 2017. *After the Reboot: The State of Computing Education in UK Schools and Colleges.*

RECOMMENDATION

Governments and industry need to play an active role in improving continuing professional development (CPD) for computing teachers, such as exemplified by the Network of Excellence. Investment in a national network needs at least a tenfold increase to expand the reach, and to have rigorous evaluation measures in place to strengthen the offer of such networks. Importantly financial support should be made available to schools to release staff to attend professional development opportunities.

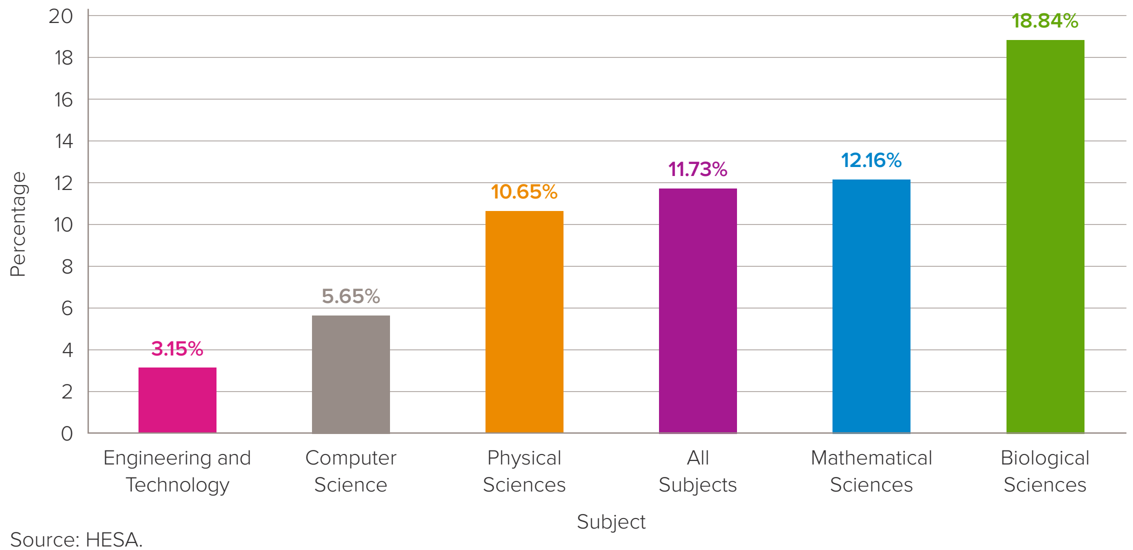
Tackle the undersupply of computing teachers entering the profession

A majority of teachers are teaching an unfamiliar school subject without adequate support. Moreover, they may be the only teacher in their school with this task. Governments must address a severe and growing shortage of computing teachers. From 2012 to 2017, England met only 68% of its recruitment target[6]. Since 2005, Scotland has also seen a 25% decrease in the number of computing teachers[7].

6. House of Commons Education Committee. 2017. Recruitment and retention of teachers: Fifth Report of Session 2016–17.
7. Computing At School Scotland. 2016. Computing Science Teachers in Scotland 2016.

FIGURE 3

Percentage of full-time first-degree leavers working in education post-graduation by subject area (2011/12 to 2015/16).



Source: HESA.

RECOMMENDATIONS

Governments should introduce quality-assured computing conversion courses for existing teachers, equivalent to those in physics and maths. Individual teachers or schools should not have to contribute to the costs of this training.

Industry and academia should support and encourage braided careers for staff that want to teach as well as work in another setting.

Improving computing education through research

To improve the availability of computing education research in the UK.

Understanding the pedagogies and assessment methodologies that underpin computing education helps teachers improve pupil outcomes. Our literature reviews show that a majority of the research in computing education relates to higher education, and the volume of education research in computing is much smaller than in subjects such as physics or maths.

Invest in computing education research to inform curriculum and pedagogy

With the emergence of computing in schools, and organisations such as the Education Endowment Foundation seeking to grow the evidence base in attainment in education, there is an ideal opportunity for the UK to conduct research to develop computing pedagogies and assessment. However, the capacity of the current research base is quite limited and needs further support if the UK is to lead the world in computing education research in schools.

RECOMMENDATION

Education research funders, researchers, teachers and policymakers should develop a strategic plan that achieves:

- the establishment of the long-term research agenda for computing education in schools; and
- the development of UK capacity to conduct the research.

The Royal Society

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society. These priorities are:

- Promoting excellence in science
- Supporting international collaboration
- Demonstrating the importance of science to everyone

For further information

The Royal Society
6 – 9 Carlton House Terrace
London SW1Y 5AG

T +44 20 7451 2500
E science.policy@royalsociety.org
W royalsociety.org

Founded in 1660, the Royal Society is the independent scientific academy of the UK, dedicated to promoting excellence in science

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