THE ROYAL SOCIETY

# Policy briefing on teachers of computing
## Recruitment, retention and development

A digitally skilled workforce is an essential component of a successful economy[1]. Across the United Kingdom, computing school curricula have been established, or will be established shortly[2]. However, the Royal Society's 2017 report *After the reboot: computing education in UK schools*[3] found computing provision to be 'patchy and fragile', and identified concerns around poor teacher recruitment, a shrinking workforce and teachers' readiness to implement new curricula.

This briefing updates aspects of the 2017 report to gain a better understanding of what has changed since then, and to note any significant developments in computing education. It draws on a range of sources to provide an overview of current computing provision in schools, focusing on computing teacher workforce supply and development, the uptake of computing in schools and areas for action. The data included in this briefing concern the secondary school system in England, unless stated otherwise. The term 'computing' incorporates both computer science and ICT related courses.

### Essential 'take home' messages

1. The Industrial Strategy's ambition to boost the supply of digital skills across the economy contrasts with the precarious state of computing education in the UK:
   - the number of computing teachers continues to decline;
   - fewer hours are being spent on teaching computing; and
   - the removal of the ICT GCSE has prompted a substantial fall in the number of secondary school students studying for computing-related qualifications.
2. Fewer schools are offering computing courses and there are fewer options available[4].
3. There is a need for better computing teacher supply data across the whole of the UK.
4. There is a need to learn from successful initiatives to boost teacher recruitment and retention.
5. The establishment in 2018 of the National Centre for Computing Education (NCCE) represents a positive step towards supporting and upskilling the computing teacher workforce.
6. Realistic expectations must be set for improving computing education during the initial four years for which the NCCE has been funded. Ultimately, a long-term vision supported by sustained investment is needed to address the issues raised in this briefing.

1. See, for example, http://www.edge.co.uk/SkillsShortageBulletin1, accessed 16 July 2019.
2. Computing was introduced in England from September 2014. In Scotland, the Curriculum for Excellence – Technologies was refreshed in 2016. In Northern Ireland, 'Using ICT' is embedded across the curriculum. In Wales, the 2008 national curriculum for ICT is to be replaced by a new curriculum due to be fully implemented by 2022.
3. https://royalsociety.org/topics-policy/projects/computing-education/
4. See https://www.bbc.co.uk/news/technology-48188877, accessed 22 July 2019.

# Teacher recruitment

There is a shortage of appropriately qualified computing teachers in secondary schools. Recruitment targets for computing teachers have consistently not been met.

Secondary schools are experiencing significant difficulty in recruiting computing teachers. While the numbers of entrants to computer teacher training in England are higher now than when the curriculum changed in 2014, they have fallen far short of Government targets. Since 2014/15, there have been 1,012 fewer entrants to computing teacher training than the Government required[5].

Various factors are likely to be responsible for this continuing shortfall. For instance, as a graduate profession, teaching must compete with many other sectors of employment to attract talent; and the salary differentials between teaching and other areas of employment are greatest in computing (alongside mathematics and physics)[6,7]. In addition, wider negative perceptions about teaching may well be deterring graduates from entering the profession[8,9,10].

The failure to meet recruitment targets is compounded by the fact that each year a proportion of trainees fail to complete their teacher training. Government statistics show that the drop-out rate among computing trainees is higher than that in most other subjects, and that from 2014/15 to 2017/18, more than 250 computing teacher trainees failed to gain Qualified Teacher Status (QTS). Moreover, a proportion of those who do obtain QTS are no longer in a teaching position six months later: for instance, data for 2016/17 show that 91% of those who obtained QTS were in a teaching post six months later[11].

According to the Department for Education, some 3,000 additional 'ICT-specialist' teachers are required to teach the hours of lessons that are currently taught by non-specialist teachers[12]. This is despite a decrease in the number of taught hours (see page 4).

5. Shortfalls: 2014/15 (–90 entrants, 85% target achieved); 2015/16 (–218 entrants, 70% target achieved); 2016/17 (–238 entrants, 67% target achieved); 2017/18 (–273 entrants, 62% target achieved); 2018/19 (–193 entrants, 73% target achieved. See https://www.gov.uk/government/statistics/initial-teacher-training-trainee-number-census-2018-to-2019, main tables, table 1c, accessed 9 August 2019.
6. See https://epi.org.uk/wp-content/uploads/2018/08/EPI-Teacher-Labour-Market_2018.pdf, accessed 21 January 2019.
7. See https://royalsociety.org/~/media/policy/Publications/2018/14-03-2018-maths-snapshot-teaching.pdf, accessed 22 July 2019.
8. See https://royalsociety.org/~/media/policy/Publications/2018/14-03-2018-maths-snapshot-teaching.pdf, accessed 22 July 2019.
9. See https://www.varkeyfoundation.org/media/4850/gtsi-uk-chart-findings.pdf, accessed 8 February 2019.
10. Worth, J & Van den Brande, J 2019 Retaining science, mathematics and computing teachers. A report for the Royal Society. Slough, Berks: National Foundation for Educational Research. (Forthcoming.)
11. See https://www.gov.uk/government/statistics/initial-teacher-training-performance-profiles-2016-to-2017, table 6, accessed 12 August 2019.
12. No satisfactory definition of a 'specialist' teacher exists. The Government counts specialist teachers as 'those with a degree in their relevant teaching subject in the week of the collection of the School Workforce Census' (see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786481/STRB_Written_Evidence.pdf, accessed 10 April 2019).

# The computing teacher workforce

## England

The number of secondary teachers who teach computing science has declined substantially across England and schools are struggling to ensure that computing lessons are taught by appropriately qualified staff. Moreover, subject to growth in the numbers of pupils opting to pursue computing qualifications, the demand for computing teachers will intensify because secondary pupil numbers are set to increase: by 2027 there will be 427,000 more secondary learners, 15% more than in 2018. However, poor recruitment and retention of computing teachers, coupled with the removal of GCSE ICT, has led to a decline in the numbers of students studying a computing-related qualification at key stage 4[13] (see also page 4).

The number of teachers delivering computing lessons in England decreased from 15,400 in 2013 to 12,788 in 2018, a fall of 17%[14]. The actual figure for 2018 is probably lower as it combines computing (3,954) and ICT teachers (8,834), with a teacher potentially being counted as teaching both subjects.

The number of equivalent full-time teaching roles in 2017/18 was 6,529[15], down from 7,633 in 2015 – 16[16], a decrease of 14.4%.

The percentage of computing teachers in England having a relevant post A Level qualification was 35.9% in 2018. Only media studies, citizenship and engineering recorded lower percentages[17].

The vast majority of computing trainee teachers are male, are lacking in subject specific qualifications, and are older when compared to trainee teachers in other subjects. Females made up 32% of all computing teacher trainees in England in 2018/19, a drop of 8% on the previous year; only physics (29%) had a lower proportion[18].

The secondary computing teacher workforce in England has fewer young teachers than the general teaching workforce, with 30.6% of computing teachers under 35 compared to 38.1% of all secondary teachers[19].

## Wales

The number of registered computing teachers in Welsh secondary schools has decreased by 12.1%, from 762 in 2013 to 670 in 2017. Only 40% of these teachers were trained in computing, the second lowest amongst all the foundation and core subjects[20].

## Scotland

In 2016, 47% of Scottish local authorities reported difficulties in recruiting computing teachers[21].

The number of Scottish secondary teachers with computing as their main subject has decreased by 10.3%, from 649 in 2013 to 582 in 2017[22].

In 2017, 45.4% of computing teachers in Scotland were female, lower than the average for all subjects of 64%, only physics and technical education had lower figures[23].

In 2017, the average age of a computing teacher in Scotland was 45 years old; excluding subjects with fewer than 20 teachers, only teachers of German were older, at 46. The average age for all teachers was 41[24].

In 2016, 17% of secondary schools in Scotland did not have specialist computing teachers[25].

13. https://www.gov.uk/government/statistics/national-pupil-projections-july-2018 Pupil projections tables, 2018 Tables 1 and 2.
14. See https://www.gov.uk/government/collections/statistics-school-workforce, 2013-18, table 12, accessed 28 June 2019.
15. See https://www.gov.uk/government/statistics/tsm-and-initial-teacher-training-allocations-2019-to-2020, accessed 12 June 2019.
16. See https://www.gov.uk/government/statistics/teacher-supply-model-2017-to-2018, accessed 12 June 2019.
17. See https://www.gov.uk/government/statistics/school-workforce-in-england-november-2018, accessed 28 June 2019.
18. See https://www.gov.uk/government/statistics/initial-teacher-training-trainee-number-census-2018-to-2019, table 3, accessed 12 June 2019.
19. See https://www.gov.uk/government/statistics/tsm-and-initial-teacher-training-allocations-2019-to-2020, accessed 12 June 2019.
20. See http://www.ewc.wales/site/index.php/en/documents/research-and-statistics/annual-statistics-digest/762-ewc-statistics-digest-2017.html, accessed 13 June 2019.
21. See http://www.cas.scot/wp-content/uploads/2016/08/ComputingTeachersinScotland-CASSReport2016.pdf, accessed 13 June 2019.
22. See https://www2.gov.scot/Topics/Statistics/Browse/School-Education/teachcenssuppdata, table 3.9, accessed 13 June 2019.
23. See https://www2.gov.scot/Topics/Statistics/Browse/School-Education/teachcenssuppdata, table 3.9, accessed 13 June 2019.Note: this excludes economics, which had 3 teachers in total in 2017.
24. See https://www2.gov.scot/Topics/Statistics/Browse/School-Education/teachcenssuppdata, table 3.10, accessed 13 June 2019.
25. See http://www.cas.scot/wp-content/uploads/2016/08/ComputingTeachersinScotland-CASSReport2016.pdf, accessed 13 June 2019.

# The uptake of computing in schools

The continuing decrease in the numbers of secondary computing teachers described on page 3 is deeply concerning given that the development of computing skills is vital in enabling young people to become digitally literate, well-informed and digitally safe citizens, and to be successful in an economy that is rapidly being transformed by data and digital technologies[26].

### Fewer schools are offering computing courses and there are fewer options available

The curriculum changes have coincided with a drop in the number of hours of computing taught at key stages 3 – 5 (ages 11 –18), although it is not clear whether this decline has been prompted by curriculum changes per se, or by changes to the suite of qualifications. In 2013 there were 152,500 hours of ICT being taught across key stages 3, 4 and 5[27]; in 2018, 102,338 hours of computing and ICT were taught[28], a 33% decrease in hours from 2013. Secondary pupil numbers in state-funded schools changed little during this time-period[29].

The reasons for this decline are not entirely clear, but are likely to be linked to a lack of capacity in the workforce to deliver new courses leading to new qualifications. This means that fewer schools can support the revised expectations for the subject and there is a lack of confidence among computing teachers who are having to adapt to teaching a more demanding computing curriculum. For teachers with varying experience, confidence and subject-specific qualifications, a more demanding curriculum may present a real challenge[30,31].

Between 2017 and 2018, 143,551 fewer key stage 4 computer science and other computing qualifications were taken by students. A large proportion of this decline might be attributed to schools no longer offering the European Computing Driving Licence qualification, which was removed from performance measures[32]. ICT GCSE and A level have been phased out, leaving only computer science and vocational qualifications for students wanting to take computing at these levels[33].

26. See https://royalsociety.org/~/media/policy/projects/computing-education/computing-education-report.pdf, accessed 10 April 2019.
27. See https://www.gov.uk/government/statistics/school-workforce-in-england-november-2013, table 13, accessed 13 June 2019.
28. See https://www.gov.uk/government/statistics/school-workforce-in-england-november-2018, table 13, accessed 13 June 2019.
29. See https://www.gov.uk/government/statistics/initial-teacher-training-trainee-number-census-2018-to-2019, table 1a, accessed 16 July 2019.
30. See https://royalsociety.org/~/media/policy/projects/computing-education/computing-education-report.pdf, p. 53 accessed 13 March 2019.
31. See https://royalsociety.org/~/media/events/2018/11/computing-education-1-year-on/after-the-reboot-report.pdf, accessed 22 July 2019.
32. See https://www.bcs.org/upload/pdf/computing-education-report.pdf, accessed 15 May 2019.
33. See https://www.gov.uk/government/speeches/further-additional-gcse-and-a-level-subject-content-consultation, accessed 13 June 2019.

# Areas for action

Since teachers of computing may teach other subjects and may lack subject-specific qualifications, access to more detailed data is required to fully understand how many teachers teach computing courses. An in-depth understanding of the supply of computing teachers could then be used to pilot targeted initiatives to improve the health of computing education in secondary schools.

### There is a need for better computing teacher supply data across the whole of the UK.

In order to plan effectively for the future, a clearer picture of the workforce is required. The Teacher Supply Model projections are based on an assessment of the amount of time that is spent teaching each discipline[34]. However, this model is not a true reflection of teacher supply in computing. Reliable modelling would require accurately assessing the numbers of teachers in the system that are qualified to teach computing, rather than ICT (and that are teaching computing).

While there are data on the uneven distribution of computing courses across England's regions and school types[35], there is a need for data on computing teacher distribution patterns and qualifications of teachers broken down by the schools and areas they serve, to help target subject-specific professional development to areas of need.

The ongoing demand for computing teachers needs to be studied together with schools' demand for and examination performance in the subject. Despite steady increases in the number of students taking GCSE and A Level Computer Science, the reduction in taught hours of computing and the number of qualifications taken in schools suggests the subject may, as a whole, be in decline. The impact of curriculum change in England, and any proposed further changes to qualifications, needs to be evaluated in terms of teacher workforce capacity.

### There is a need to learn from initiatives to boost teacher recruitment and retention

The Government has invested substantially in bursaries in order to attract suitably qualified graduates into teacher training[36], but there is no evidence that bursaries and scholarships in computing have led to improved educational performance[37]. In fact, data from 2009/10 to 2015/16 show that bursary holders in computing, which attract higher awards than most other subjects, were among the poorest in achieving QTS[38]. The effectiveness of the bursary in recruiting suitable candidates and its ability to incentivise trainees to complete the course need to be studied.

The Government has recently committed to introducing phased bursaries, with payments being staggered over three years in order to aid retention, and weighted such that they are higher for teachers working in more challenging schools[39].

34. Julie Glenndenning, Senior Statistical Officer, Department for Education, personal communication (22 November 2018).
35. See https://www.bcs.org/category/19331, tables 11 and 12, accessed 13 June 2019.
36. According to the National Audit Office, the Department for Education spent £620 million on bursaries in the 5 years to 2014/15, and (See https://www.nao.org.uk/wp-content/uploads/2016/02/Training-new-teachers.pdf and, more recently, the Labour Party has estimated that bursaries totalling £22 million were spent on trainees who subsequently did not take up a teaching post (see https://www.theguardian.com/education/2019/jan/10/teacher-bursaries-are-a-22m-waste-of-money-says-labour, accessed 14 January 2019).
37. See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/598689/OME_report_Final_020317_RJL.pdf, accessed 13 June 2019.
38. See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/751197/Annex_-_Destinations_of_trainee_teachers_awarded_a_bursary__1_.pdf, accessed 25 October 2018.
39. See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773930/Teacher_Retention_Strategy_Report.PDF.pdf, accessed 12 February 2019.

### Informing strategies to boost teacher recruitment and/or retention

There is a need to understand both the reasons why too few graduates are attracted to train to become computing teachers, and the high level of attrition from the profession at an early stage of those who do complete their training.

In order to improve retention, it may also be worth exploring whether concerns felt more widely in the profession, particularly affect computing teachers. For example, is there something unique about the nature of teaching the subject, resource demands, workload issues or class control that should be investigated for this group of teachers? It is reasonable to expect that the extent to which individual schools and their teachers have access to well-equipped computing facilities and other teaching resources will affect the likelihood that computing teachers remain in the classroom.

In addition, there is a need to follow up recent analysis of OECD's Teaching and Learning International Survey (TALIS) data, which suggests that low levels of self-efficacy (teachers' belief in their own abilities) may be particularly associated with especially low levels of retention among Technology (including Computing), as well as science and mathematics teachers[40].

Finally, concerns about the readiness of teachers to deliver computing in school and their ability to access training need to be tackled by:

- enabling them to access training provided by the new National Centre for Computing Education (NCCE), which must be of high quality;
- exploration of the effect on teacher confidence and impact on teacher retention of examination performance, which has on average been lower in computing than in other subjects at GCSE and A Level.

### Strategies to boost teacher recruitment and wider retention

A reduced focus is needed on high-stakes accountability measures based on testing, and in their place, more coherent methods to assess the performance of students, teachers, head teachers and principals, and the overall performance of schools and colleges[41]. The Society believes in the notion of a broad, balanced and connected curriculum, which may mean that a range of pathways and qualifications should be made available.

Braided careers in teaching, offering flexible working for those who would like to teach part-time and work part-time in industry or a research institution, could help increase the numbers of computing teachers, further enhance their professional status and encourage more of them to stay in teaching for longer[42].

Schools and colleges should be encouraged to partner with local employers that have significant computing expertise.

The Department for Education should monitor the impact of its pilot to improve retention of mathematics and physics teachers by offering them cash incentives, with a view to extending these payments to computing teachers if the scheme proves to be effective[43].

40. Worth, J & Van den Brande, J 2019 *Retaining science, mathematics and computing teachers. A report for the Royal Society.* Slough, Berks: National Foundation for Educational Research. (Forthcoming.)
41. See https://royalsociety.org/topics-policy/projects/vision/, accessed 4 April 2019.
42. See https://royalsociety.org/topics-policy/publications/2018/braided-careers-teaching/, accessed 21 January 2019.
43. See https://www.gov.uk/government/news/cash-incentives-for-maths-and-physics-teachers, accessed 11 June 2019.

### Subject-specific professional development for computing teachers

School leadership teams have a key role to play in supporting and valuing their teachers, ensuring they can access the professional development they need[44].

Evidence shows that teachers who undergo subject related CPD are more likely to stay in the classroom for longer[45]. Computing-specific continuous professional development for all teachers of computing is essential in order to refresh subject-specialist knowledge and keep up-to-date with the evolving evidence base. This is especially true in computing, where the pace of technological advancements has implications for school curricula and there is a need for more research into pedagogical practice in computing, which is not so well defined as in more established subjects[46].

Following a commitment in the Industrial Strategy[47], in November 2018, the £84 million National Centre for Computing Education (NCCE) was established to provide computing training for teachers of all key stages across England[48]. It aims to upskill 8,000 computing teachers[49] by offering a range of professional development opportunities for teachers of computer science and other aspects of computing[50], and is establishing a national network of school-led computing hubs[51]. By supporting and equipping computing teachers and their schools, the NCCE can play a vital role in boosting teacher retention, from primary through to sixth form schooling.

In January 2019, the Department for Education published a Teacher recruitment and retention strategy, which included commitment: (i) to a fully-funded 2 year support programme for early career teachers and (ii) to developing a range of specialist qualifications for more experienced teachers, both of which may help encourage higher levels of retention among computing teachers[52].

Ofsted's new inspection framework should help ensure that computing teachers gain access to the professional development and support they need, and thereby help increase and widen participation in computing, particularly among girls, at key stage 4[53, 54].

The success of the Early Career Framework[55] will depend in large part on ensuring that new resources are developed with the help and endorsement of computing teachers. Newly qualified teachers of these subjects need to be supported by discipline-specific mentors[56].

44. See https://royalsociety.org/topics-policy/projects/vision/, accessed 4 April 2019.
45. See https://www.stem.org.uk/system/files/elibrary-resources/2017/09/Improving%20Science%20Teacher%20Retention.pdf, accessed 22 July 2019
46. See https://royalsociety.org/~/media/policy/projects/computing-education/computing-education-report.pdf, p. 88.
47. See https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future, accessed 18 July 2019.
48. See https://www.gov.uk/government/news/tech-experts-to-provide-national-centre-for-computing-education, accessed 13 June 2019.
49. See https://www.computingatschool.org.uk/custom_pages/381-ncce-news, accessed 13 June 2019.
50. See https://teachcomputing.org/offer, accessed 15 May 2019.
51. See https://blog.teachcomputing.org/computing-hubs-announcement/, accessed 5 July 2019.
52. See https://www.gov.uk/government/publications/teacher-recruitment-and-retention-strategy, accessed 26 February 2019.
53. See https://schoolsweek.co.uk/low-uptake-for-computer-science-gcse-spurs-review/, accessed 15 May 2019.
54. See https://royalsociety.org/-/media/policy/Publications/2019/05-04-19-consultation-response-ofsted-education-inspection-framework.pdf, accessed 10 April 2019.
55. See https://www.gov.uk/government/publications/supporting-early-career-teachers, accessed 22 July 2019.
56. See https://royalsociety.org/topics-policy/publications/2018/consultation-response-qts-and-teachers-professional-development/, accessed 22 July 2019.