BCS Landscape Review: Computing Qualifications in the UK

A view of the current state of computing and digital qualifications in the UK

(RQF levels 2/3 and SCQF levels 5/6/7) December 2021

Foreword Dame Professor Muffy Calder, Chair of BCS School Curriculum and Assessment Committee

It would be difficult to spend more than a few hours reading about the future economic wellbeing of the UK without becoming aware of the importance of Computer Science and digital skills. Whether at the heart of the UK's Industrial Strategy and its successors (1, 2), the Scottish Technology Ecosystem Review (3), the 2021 Digital Strategy for Wales (4), or the global views of the Organisation for Economic Co-operation and Development (OECD) (5), the need to equip adults in the workforce with the skills to thrive in a digital world is an ever-present concern.

Further impetus has come from the COVID-19 pandemic, where the contribution and prevalence of computing has become clear as many activities have moved online and/or been supported by software and algorithms.

The administrations that currently govern the UK, each with responsibility for education under the control of their respective parliaments and assemblies, have taken markedly different approaches to computing and digital skills education. This is illustrated in the Royal Society summaries of the overall approach to computing education in schools across the UK; their 2017 'After the reboot' report (6) captures the main philosophies behind curriculum change in each administration, accompanied by a recent snapshot of computing teaching issues and challenges in England, Scotland, and Wales (7). The 2014 work of Brown *et al.* (8) also captured many of these ideas and concerns. In many ways, this variety is helpful as, with at least four flowers blooming, there are plenty of lessons to be learned (robust evidence notwithstanding) of initiatives which have developed and adapted.

What is becoming clearer, is that each administration is dealing with a genuine challenge: a tension between teaching Computer Science and digital skills for all.

Within this range of approaches (and use of terminology) several common issues are evident, whether we are considering academic or vocational options:

- What does a 'good number of students' specialising in Computer Science look like
- The imbalance in uptake of and progression within the subject by male and female students
- The challenge of securing sufficient numbers of and appropriately qualified teachers
- Breadth or depth – should we prioritise universal digital and computing education or curate specialist knowledge
- Specialism versus adaptability
- What should curricula look like

This ambitious report draws together information about participation and achievement by young people across the four nations of the UK. Principally, it covers academic computing and digital skills qualifications accessed by learners at age 16 and 18, which is when most students have to specialise and opt-in to detailed study of the subject. It also covers vocational and technical qualifications (VTQ) at levels 2 and 3 in the Regulated Qualifications Framework (RQF) and levels 5 and 6 in the Scottish Credit and Qualifications Framework (SCQF).

This report offers a comprehensive picture of the varying levels of engagement in Computer Science and closely related qualifications and focuses our attention on continuing challenges

of participation by young women and securing enough teachers to deliver specialist teaching and learning effectively. It also demonstrates how much activity there is to adapt to emerging skill needs, with a growing number of digital awards and qualifications to sit alongside the more typical Computer Science ones.

The data in this report, and it is a decidedly data-led review, sets down a baseline for BCS and its stakeholders. It outlines our thinking about computing education, opportunities for change, and what data needs to be addressed annually. This iterative, data-driven approach highlights evidence and data gaps to be overcome so that we avoid taking leaps of faith as we work with others to support the development of computing and digital skills education across the UK.

Producing this report has presented challenges. Access to comparable data across the four nations is variable, particularly where VTQ's are concerned. This landscape has been described (in England at least) as being 'extraordinarily complex and opaque' (9) and although there has been some positive change in recent years the accompanying engagement and attainment data is similarly so. Over time, the choices available to learners have been streamlined, including a number of information and communications technology (ICT) and digital qualifications where funding approval has been removed – (10). However, it is possible that an increased diversity of courses could play an important role in attracting a more diverse group of learners in the future, so understanding the data behind the VTQs will assume a growing level of importance. It is important to note that the relative importance placed on the VTQs themselves (compared to GCSEs for example) amongst key stakeholders, including school leaders, will also be a critical factor in the availability and ultimately uptake these vocationally focussed qualifications.

Our concerns around female student access and participation may be mirrored by other groups of students such as those from certain ethnic and socioeconomic backgrounds, but we do not currently have the required data publicly available. This is something we urge the relevant authorities and examination bodies to address urgently.

As noted above, different administrations across the UK have taken markedly different approaches; understanding the underlying goals and whether they are achieving their aims will be fascinating. This report offers colleagues across the UK a rich evidence base to draw on when refining approaches or developing new ones.

Understanding the complex Computer Science and digital skills ecosystem across the UK is a critically important activity for BCS, linking directly to our Royal Charter and our vision to make IT good for society. This report, our analysis of the available data and insights as well as calling for more, and better data can only help to ensure that our collective efforts to make computing education and digital skills meaningful and available to all succeeds.

The report and the data

The report takes a nation-by-nation approach, and each section has a common structure, setting out participation and attainment rates in key qualifications and awards and putting this alongside pertinent contextual information (for example, student numbers, teacher supply and policy background documents).

The data used in this report is all publicly available, if sometimes challenging to locate or interpret. It covers a five-year time period (2016/17-2020/21), including the most recent set of awards (2021) where this is available. All of the data sources are cited, including any caveats. Note that awarding approaches differed in 2020 and 2021 due to mitigations for the COVID-19 pandemic, and any comparisons should only be made with full recognition and consideration of the different approaches.

This is a deliberately data-led report, so each section firstly gives prominence to the publicly and easily available data and then sets this in the context of recent education developments in each nation. In a small number of cases, charts display data from fewer than five years. This has been done to improve the clarity of the charts.

Where curriculum levels are referred to, these relate to:

- The Regulated Qualifications Framework (RQF) in England, Northern Ireland and Wales. Level 2 qualifications typically include GCSE awards, whilst Level 3 includes A and AS Levels and their equivalents.
- The Scottish Credit and Qualifications Framework (SCQF) in Scotland. Level 5 qualifications typically include National 5 and equivalent awards, whilst levels 6 and 7 include Highers and Advanced Highers and their equivalents.

About BCS School Curriculum and Assessment Committee

The Committee's aim is to articulate the aspiring vision, goals and principles of Computing Education. This includes:

- To better explain what our subject is
- To help teachers understand what computing is and how they should teach it
- To inform inspectorates and DfE, to support them to ask the right questions, and to know what good practice looks like
- To identify what the ideal set of qualifications is that would offer appropriate pathways for all children, especially at Key Stage 4
- To understand what qualifications are offered and taken across the 4 nations
- To contribute to the increase of Black Afro-Caribbean people and women in computing

This report brings together publicly available data about computing education across the UK and Ireland and provides a comprehensive overview of the current state of the nation.

About BCS, The Chartered Institute for IT

BCS is the Chartered Institute for IT. The purpose of BCS as defined by its Royal Charter is to promote and advance the education and practice of computing for the benefit of the public. As the professional body for the industry we bring together commercial organisations, academics, practitioners and government to share knowledge, inform the design of new curricula, shape public policy and inform the public.

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Key Findings

- There is a growing appreciation amongst employers and policy makers of the role of digital qualifications and awards, complementing specialist Computing Science/Computer Science pathways
- Academic participation rates appear stable or improving, although it is harder to comment in some cases where new curricula and qualifications are being established, such as in Wales (where a new Digital Technology award was made available for first teaching in September 2021 with the first opportunity for certification in summer 2023) and Northern Ireland
- Participation rates in Computing Science in Scotland, which had been falling steadily over recent years, rose in 2021, augmented by the growing uptake of a wider range of new and digitally focused awards
- In all nations, Computer Science (or its equivalent) appears to be the least popular science subject and there are grounds for trying to understand this and to raise its esteem and attractiveness
- Understanding whether qualifications and awards are geographically accessible to all remains a challenge. For example, the Computer Science GCSE is available in around 77% of secondary schools in England (but a higher proportion of students)
- All of the nations in this study have a continuing problem with the balance of male and female participation in whichever variant of the subject is on offer. This can be in excess of 10:1 in some cases, but more regularly around the 5-6:1 level
- In spite of low participation rates, female students typically outperform their male counterparts
- In a small number of VTQs, the male:female ratios reverse the typical participation pattern Computer Science (or its equivalents)
- The supply of appropriately qualified and trained teachers is a common challenge to all nations, although the National Centre for Computing Education (NCCE) is beginning to address this in England
- Uptake of and participation in VTQs is variable across the four nations and generally at levels notably below academic awards
- Overall, participation levels in VTQs appear to be declining, and many of the regulated awards have attracted no participants for several years
- High-quality and comparable data capturing key demographic information in addition to male:female participation and attainment rates is often hard to obtain for both academic and particularly VTQ awards

Key Recommendations

1 A task force to be established with representation from the four UK nations to understand, examine and report on access and participation in Computer Science qualifications of learners across key demographics, with the aim of learning from what works and disseminating best practice

2 That regular reviews to clarify the Computer Science and digital skills ecosystem in the UK are conducted, setting out what characterises different awards and qualifications and what the distinctions are (where these exist and are notable)

3 That administrations, awarding organisations, and regulatory bodies work closely with BCS to monitor and publish data concerning uptake and participation patterns relating to computing and digital qualifications and awards. An independent annual report on

the state of Computer Science education and digital skills across the UK should become the annual benchmark for the sector. BCS is uniquely placed to convene such a report

4 Administrations, awarding organisations, and regulatory bodies should engage closely with BCS to establish more detailed data overviews of Computer Science and digital skills qualifications to explore the impact of other pupil and student characteristics on uptake and attainment

5 An engagement group should be developed to clarify the scale of the digital skills labour market and the nature of the skills required across the UK so that best use can be made of increasingly limited resources.

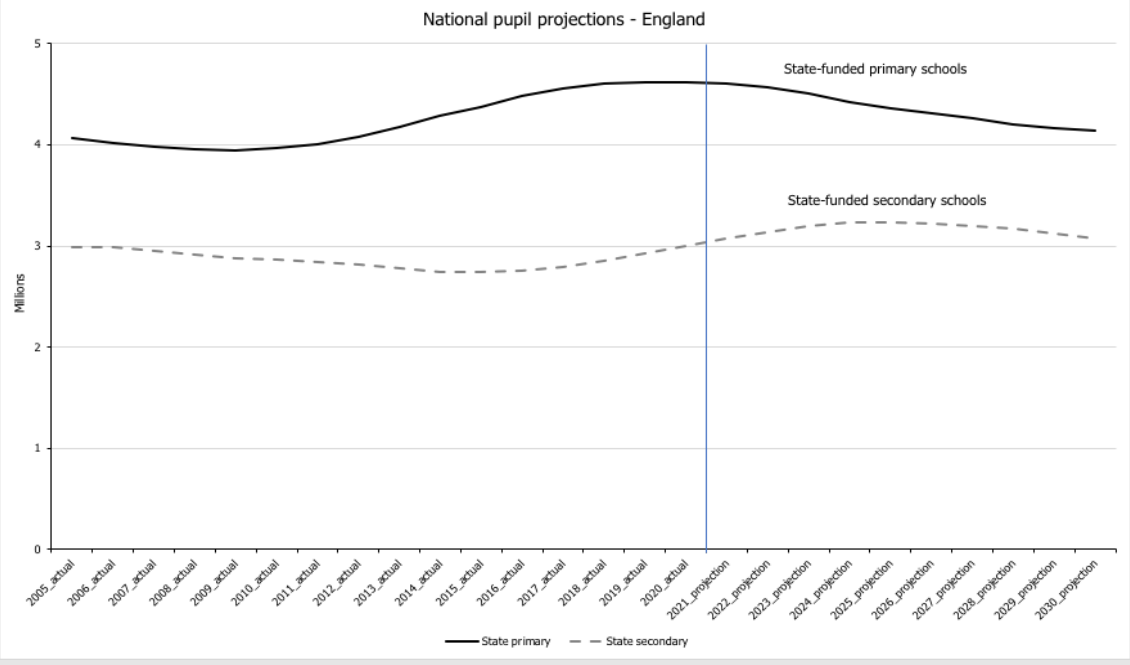
England: Computer Science GCSE, AS, and A Levels

The size and shape of the secondary and primary sector (11)

	Primary (maintained)	Secondary (maintained)
Schools	16,791	3,458
Students	4,660,263	3,493,506
Teachers	221,359	209,824

There are around 620k students in each secondary year band in England.[1]

It is anticipated that primary school numbers will drop across the period to 2030, whilst secondary numbers will peak in around 2025 before the primary decline begins to have an impact.



(12)

Current curriculum and assessment

This section attempts to capture in as summative a form as possible, the key characteristics of the main examinations currently available in England, including the curriculum focus, assessment methodology and coding languages preferred.

[1] Based on UK population estimates https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2019estimates#population-growth-in-england-wales-scotland-and-northern-ireland and https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea21principalprojectionukpopulationinagegroups

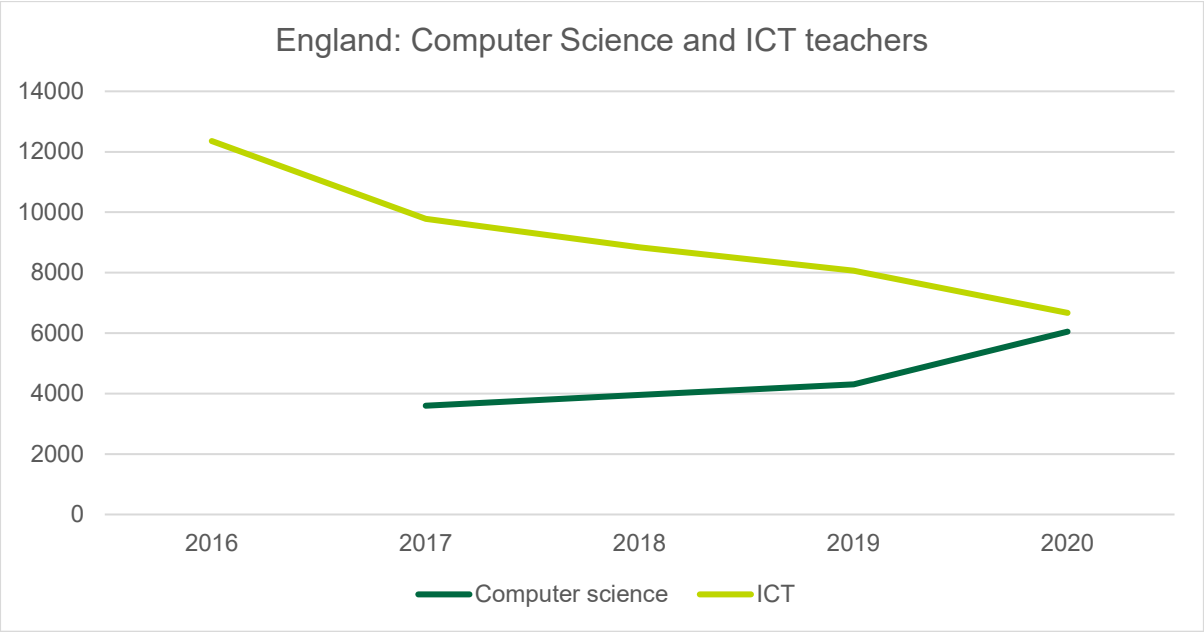
Subject	Award	Level	Awarding body	Curriculum focus	Assessment approach	Language preferred
Computer Science	GCSE	2	AQA	Fundamentals of algorithms Programming Fundamentals of data representation Computer systems Fundamentals of computer networks Fundamentals of cyber security Ethical, legal and environmental impacts of digital technology on wider society, including issues of privacy Aspects of software development Programming project	Written examination and a 20 hour practical project. The project is not assessed.	C#, C++, C, Java, Pascal/Delphi, Python (versions 3 and 2), VB.Net
Computer Science and IT	AS level	3	AQA	Fundamentals of programming Fundamentals of data structures Systematic approach to problem solving Theory of computation Fundamentals of data representation Fundamentals of computer systems Fundamentals of computer organisation and architecture Consequences of uses of computing Fundamentals of communication and networking	Written and on-screen examination, including programme writing in an electronic answer format.	C#, Java, Pascal/Delphi, Python, VB.Net
Computer Science and IT	A level	3	AQA	Fundamentals of programming Fundamentals of data structures Fundamentals of algorithms Theory of computation Fundamentals of data representation Fundamentals of computer systems Fundamentals of computer organisation and architecture Consequences of uses of computing Fundamentals of communication and networking Fundamentals of databases Big Data Fundamentals of functional programming Systematic approach to problem solving Non-exam assessment - the computing practical project	Written and on-screen examination and a practical project. The latter comprises 20% of the overall marks.	C#, Java, Pascal/Delphi, Python, VB.Net

Subject	Award	Level	Awarding body	Curriculum focus	Assessment approach	Language preferred
Computer Science	GCSE	2	Eduqas	Understanding Computer Science: hardware, logical operations, communication, data representation and data types, operating systems, principles of programming, software engineering, program construction, security, authentication and data management and the impacts of digital technology on wider society as well as algorithms and programming constructs. Computer Programming: problem solving, programming languages, data structures and data types, program design, implementation and testing.	Written and on-screen examination. The latter comprises 50% of the overall marks.	One or more high-level programming language with a textual program definition, Python 3 at least.
Computer Science	A level	3	Eduqas	Programming and System Development Computer Architecture, Data, Communication and Applications Programmed Solution to a Problem	Written examination and a practical project. The latter comprises 20% of the overall marks.	Any high-level programming language.
Computer Science	AS level	3	Eduqas	Fundamentals of Computer Science Practical Programming to Solve Problems	Written and on-screen examination. The latter comprises 30% of the qualification.	Python, Visual Basic.NET, Java
Computer Science	GCSE	2	OCR	Systems architecture Memory and storage Computer networks, connections and protocols Network security Systems software Ethical, legal, cultural and environmental impacts of digital technology Algorithms Programming fundamentals Producing robust programs Boolean logic Programming languages and Integrated Development Environment	Written examination.	Either the OCR Exam Reference Language or any other high-level programming language.
Computer Science	A level	3	OCR	The characteristics of contemporary processors, input, output and storage devices Software and software development	Written examination and a practical project. The latter	Python, C family of languages (for example C# C+

Subject	Award	Level	Awarding body	Curriculum focus	Assessment approach	Language preferred
				Exchanging data Data types, data structures and algorithms Legal, moral, cultural and ethical issues Elements of computational thinking Problem solving and programming Algorithms to solve problems and standard algorithms A computing problem to work through according to the guidance in the specification: Analysis of the problem; Design of the solution; Developing the solution; Evaluation	comprises 20% of the overall marks.	etc.), Java, Visual Basic, PHP, Delph
Computer Science	AS level	3	OCR	The characteristics of contemporary processors, input, output and storage devices Software and software development Programming Exchanging data Data types, data structures and algorithms Legal, moral, ethical and cultural issues Elements of computational thinking Problem solving and programming Algorithms	Written examination.	None specified
Computer Science	GCSE	2	Pearson	Computational thinking Data Computers Networks Issues and impact Problem solving with programming	Written and on-screen examination	Programme language subset specified. On-screen tasks using Python 3.

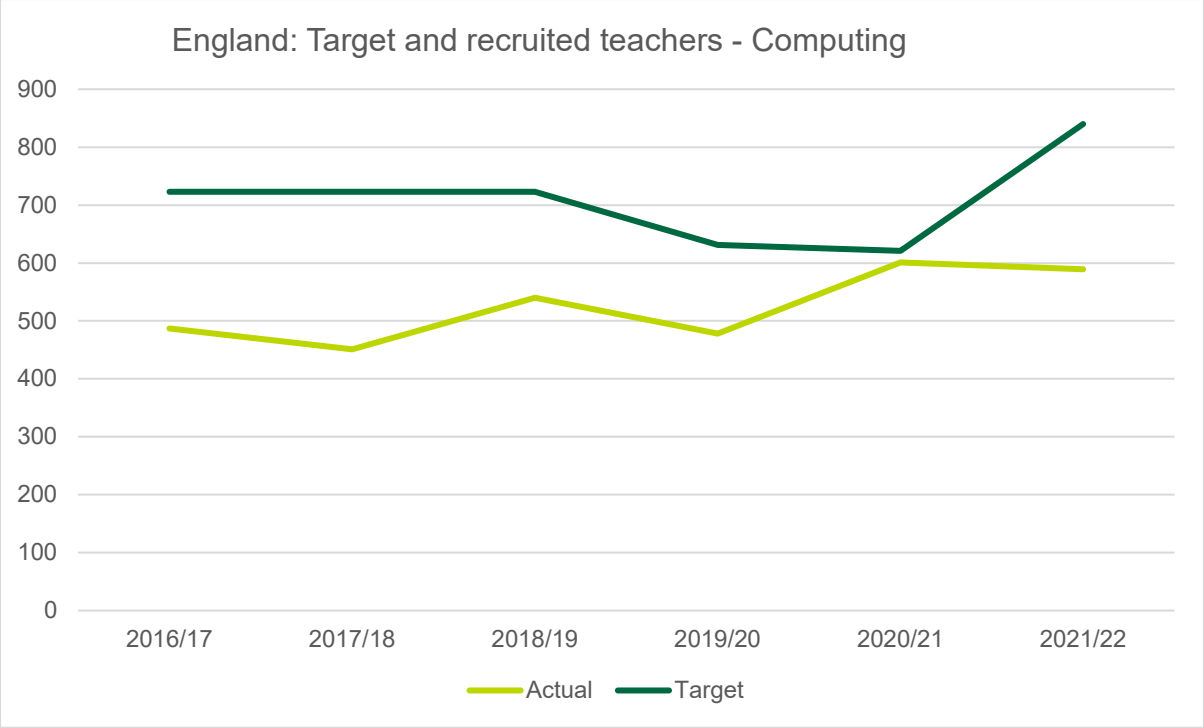
The teaching workforce

The Computer Science teaching workforce in England is growing, as the graph below shows. It also illustrates a relatively similar rate of decline in ICT teachers, with the overall number of Computer Science *plus* ICT teachers remaining similar to the levels of ICT teachers four years previously (13).



There is typically at least one designated Computer Science teacher per secondary school in England, however the available data suggests that not all schools offer the qualification so there may be a higher proportion of these specialists in schools that do offer the qualification, as outlined by Kemp and Berry (14). This shift in teacher designation is unsurprising given the change in the GCSE.

The recruitment of computing teachers to initial teacher training/education remains a challenge, with under 75% of the target figure being met in the past five years (EE).



(15)

The 2021/22 Teacher Supply Model target for postgraduate initial teacher training in computing in England is 840, a notable upwards shift from the 2020/21 target of 621. This target appears to have been missed, as in each of the previous recruitment cycles. Even with 70% recruitment figure (representing 589 trainees) this is still below the previous year's target. The best recruitment year (2020/21) saw 97% of the target being met, but the numbers in this cycle may have been affected by the poor economic outlook and this may have been a single-year phenomenon (16). Amongst STEM subjects, only biology recruited at a better rate, with chemistry, mathematics, and physics still some way short of the target, even though there are no recruitment limits on teacher training or education providers currently.

Recruitment to teacher training is modestly associated with both downturns in an economic cycle and precarious labour markets (*ibid*). Other authors (17) have been tracking the recruitment data since the 2021 cycle began and have also noted the relative upturn in interest in teaching as a career option. Training to teach Computer Science computing appears to have benefitted from this increased labour market uncertainty. However, the signals this sends about the prospects for a stable career as, say, a computer scientist may suffer as a result, influencing young people's views of the attractiveness of the subject.

The upturn may also reflect a 'slow-burn' success of the introduction of incentives such as training bursaries of £24,000 and scholarships of an additional £2,000 which also attract expert support from BCS (18). Bursary support can be a useful way of boosting recruitment, however previous efforts in other priority subjects have sometimes resulted in 'bursary tourism' (where trainees take up a bursary, train, and do not teach, or are recruited to the independent sector) (19). In a further step, highlighting the ongoing challenge involved in securing sufficient new entrants, recruitment to teacher training/education has also been encouraged by offering to repay student loans (20).

Potential trainees can supplement their knowledge by undertaking one of the 27 subject knowledge enhancement courses available across England, prior to starting their initial teacher training/education (ITT/E) programme (21).

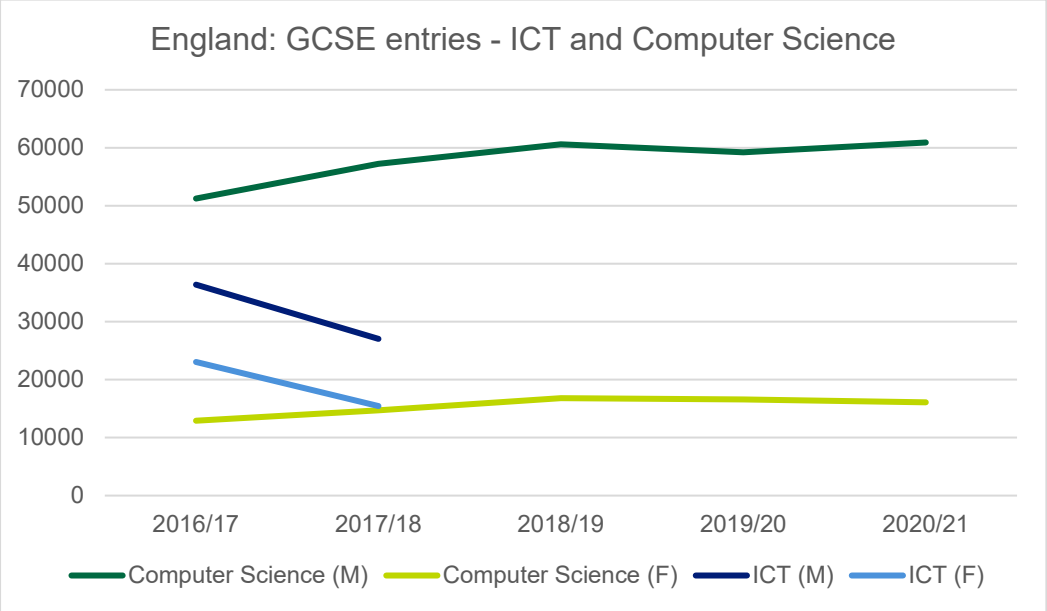
To complement the work carried out by the Computing as School (CAS) network[2] there has been a significant increase in the professional development available for computing teachers in English secondary schools, and for those who wish to develop the specialism as an additional subject.

The launch of the National Centre for Computing Education (NCCE) in 2018 which includes the Teach Computing[3] programme (including bursaries for teachers to support training) offers a way to make up the shortfall in computing teaching skills at every key stage in England. NCCE recently announced that it has supported over 30,000 teachers including over 5,800 secondary specialists to support GCSE Computer Science teaching.[4] The NCCE is currently on track to meet its targeted number of these specialists.

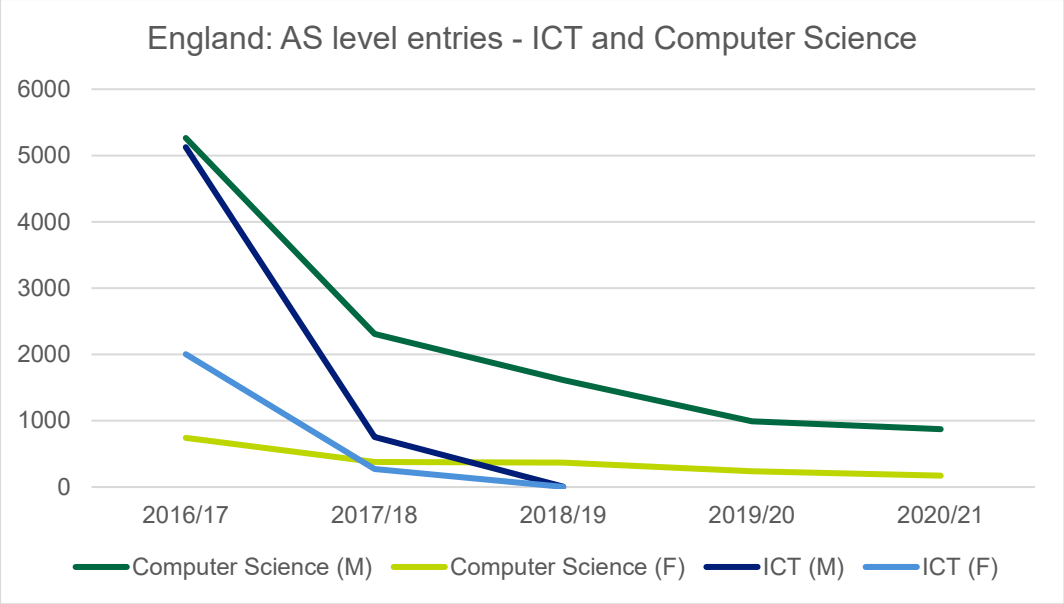
Teacher subject specialism courses were introduced in England in 2016 (22), aimed at non-specialists and returning teachers in secondary mathematics, core maths, physics, and modern foreign languages (MFL). They do not currently include Computing.

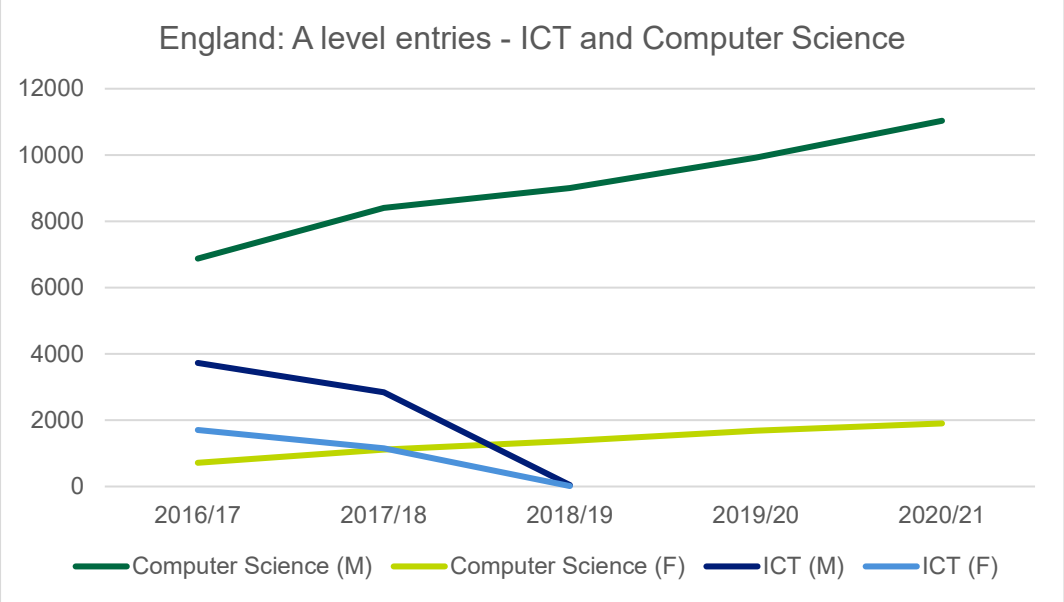
Attainment and participation

The withdrawal of the GCSE in ICT resulted, inevitably, in its decline in the attainment data. There were no entries in 2017/18 and a very small number of entries for AS level and A level in 2018/19. The following charts set out the patterns of participation over the past five years. For the sake of comparison, data for England, Northern Ireland, and Wales is drawn from the Joint Council for Qualifications (JCQ) annual statistical bulletins.

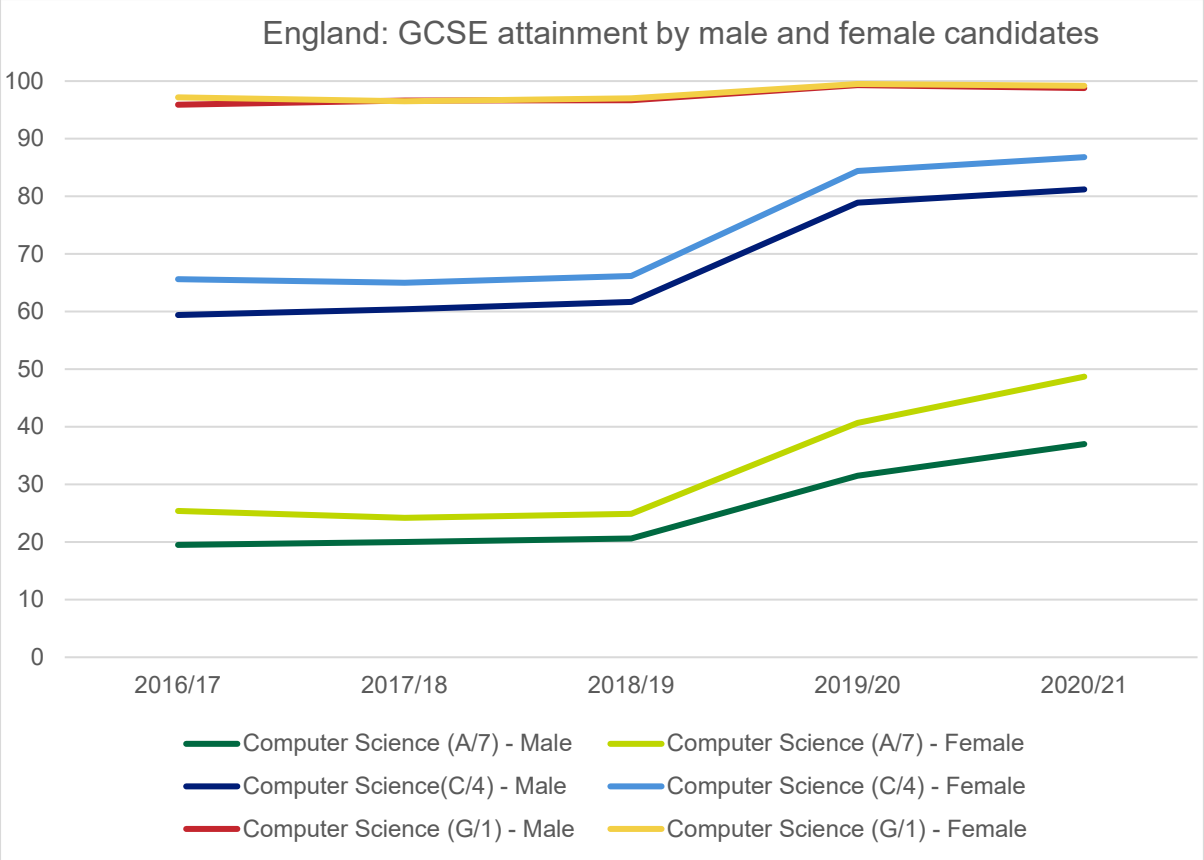


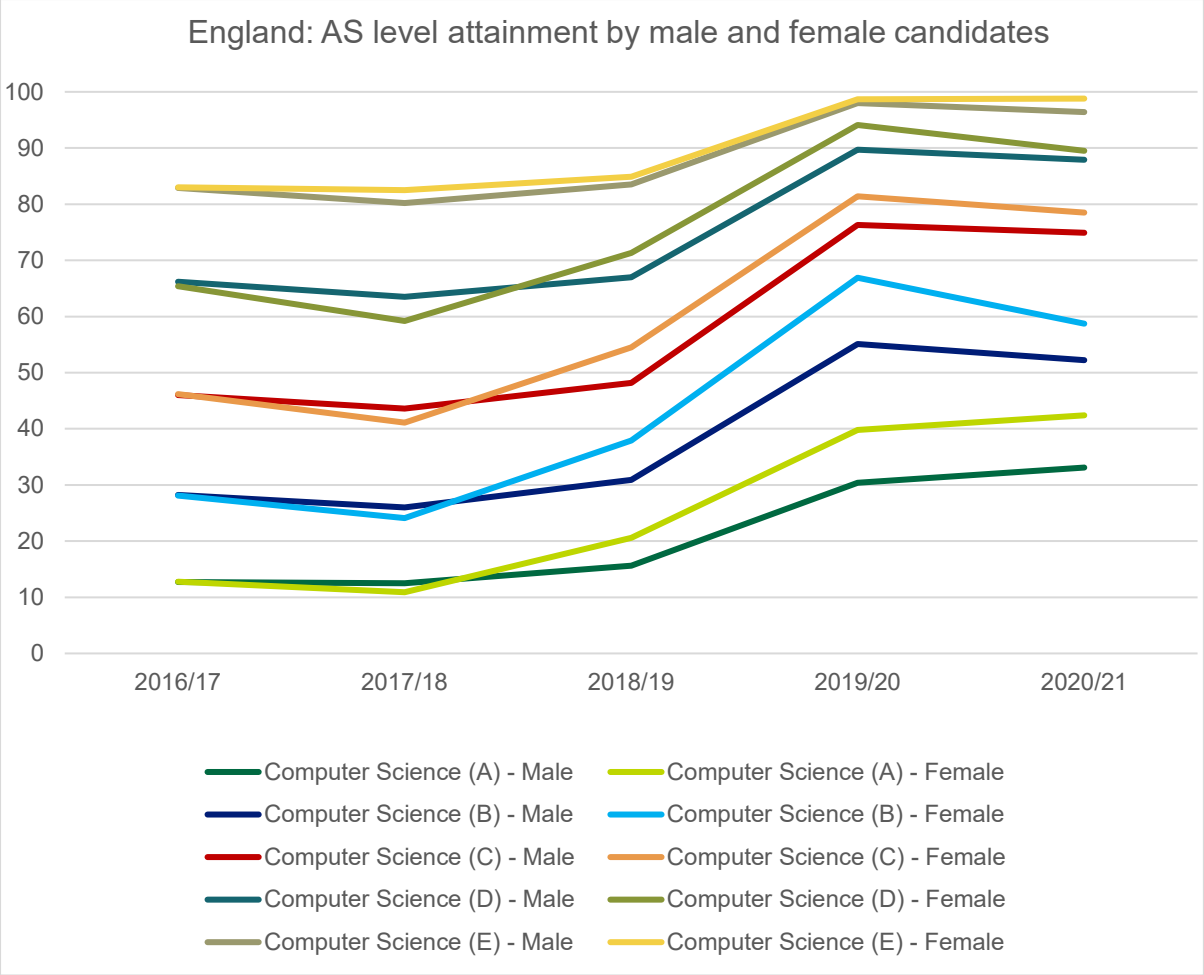
[2] https://www.computingatschool.org.uk/about
[3] https://teachcomputing.org/
[4] https://blog.teachcomputing.org/first-1000-graduates/



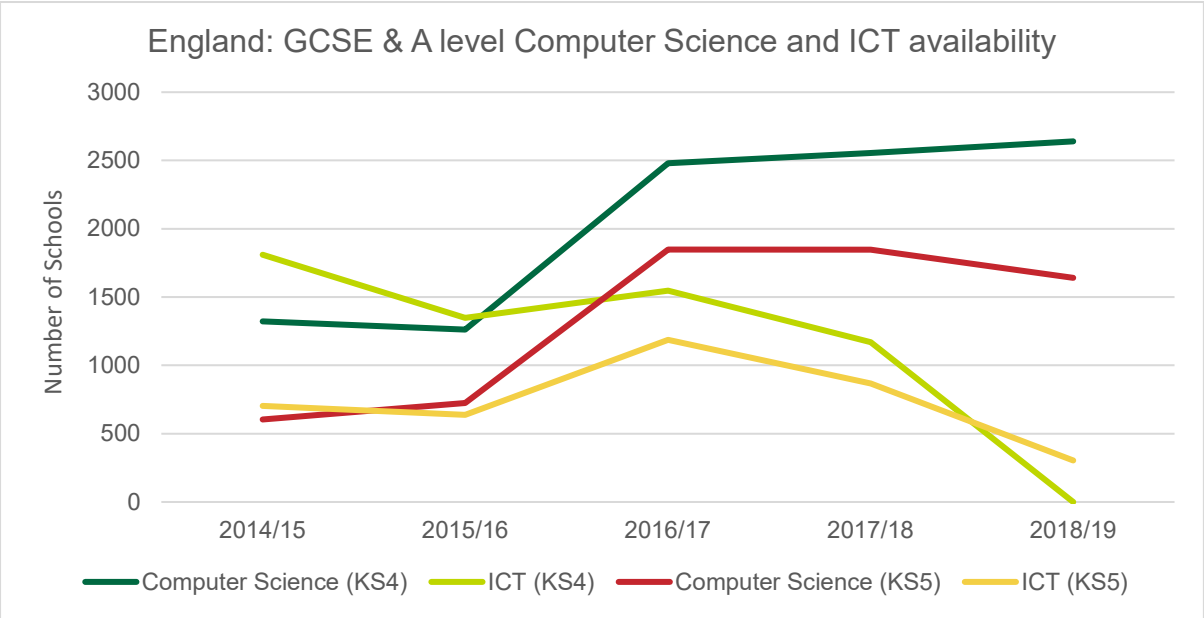


When comparing the attainment of female and male candidates across GCSE, AS and A levels over the past five years (as in the following charts), at the highest grades, female candidates appear to regularly outperform male candidates. However, there appears to be a plateau in entries at GCSE, and a much slower rate of growth in uptake at A level by female candidates compared with males.


England: GCSE attainment by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
2020/21
Computer Science (A/7) - Male
Computer Science (A/7) - Female
Computer Science(C/4) - Male
Computer Science (C/4) - Female
Computer Science (G/1) - Male
Computer Science (G/1) - Female



Studying Computer Science has rapidly increased at KS4 and KS5, but this growth appears to be slowing and about 78% of schools in England offer the GCSE.



The new computing curriculum has been taken up rapidly and more schools now offer GCSE and A level Computer Science than offered GCSE and A level ICT. The position of AS levels in England has changed from being part of a progression to A level to being a stand-alone examination, with a concomitant decline in school and student interest. The inclusion of GCSE Computer Science in the English Baccalaureate (EBacc) measure of school performance may have generated initial interest in the qualification.

In 2020, Computer Science was ranked as:

- 16th most popular GCSE with 13.4% of the cohort taking the examination
- 18th most popular A level with 6% of the cohort taking the examination
- At both A level and GCSE, it is the least popular of the four main sciences, with there being twice as many Physics GCSE entrants and three times as many A level Physics entrants

These patterns conceal some stark disparities in uptake by gender, patterns that were already evident in the previous GCSE participation rates, but which are now more dramatic. Whilst previously the male:female student ratio in ICT participation at GCSE, AS level and A level, ran at 2-3:1, for Computer Science this has remained at 4:1 for GCSE and it has been as high as 10:1 for A level (6:1 in 2019/20).

There is no public and accessible published data regarding uptake by ethnicity, although Kemp, Berry, and Wong (23) used the National Pupil Database (NPD) to examine this and found that the diversity of entrants to Computer Science (compared with ICT) was markedly different and not as representative as would be desired[5]. The same authors have recently reiterated their concerns about the unrepresentative nature of entries for the Computer Science GCSE in England, with particular concerns over female student participation (24).

Some of the uptake challenges appear to be rooted in perception issues, both for students and parents/carers. The Department for Education (DfE) regularly surveys the subject choice views of students and their parents/carers (25).

The latest DfE survey from summer 2019 says:

- GCSE Computer Science was the least popular choice (out of Foreign Languages, Arts, Design and technology, Humanities, and Computer Science).
- 23% of students were aiming to pursue Computer Science, compared with 74% for the Humanities subjects
- Almost three-times as many males students as female students were planning to take the subject. Whilst a substantial element of those rejecting GCSE Computer Science (62%) said that they did not enjoy the subject, male students tended to opt for the subject because they did enjoy it
- Female students reported that they were more likely than their male counterparts to opt for GCSE Computer Science as their schools insisted upon it
- Parents and carers were less likely to discuss careers in Computer Science with their children, however they were enthusiastic about the subject and, when presented with options, were highly likely to recommend it to their children
- Students also recognised that (in spite of overall negative perceptions) that a qualification in Computer Science would be an asset for future career/job prospects (compared with the other subjects listed above) possibly due to gaps in their understanding of what careers are possible

[5] Nesta commissioned a study into this October 2019, but no public report has been produced (https://www.nesta.org.uk/blog/diversity-computer-science-no-gender-parity-sight/)

The involvement of parents and carers in supporting choices was also highlighted in a recent report examining how interventions aimed at altering behaviour relating to subject choices influenced A-level selection (26). The interventions were targeted at improving the participation of high-attaining female students in STEM subjects (including Computer Science) prior to finally selecting their A levels. Whilst there was little evidence of an impact at individual subject level, students in the intervention group whose parents or carers were 'nudged' were more likely to select a second STEM subject.

There is currently no published data illustrating uptake by students by socioeconomic status, ethnicity or other relevant demographic. This can only be accessed via the NPD.

England: Vocational and Technical Qualifications in Computing at the end of Key Stage 4 and 5

Background and context

There are 599 VTQ's at Level 2 and 3 registered in England with Ofqual (27) although only 97 of these (46 Level 2 and 51 Level 3) are currently operational. These are offered by 12 awarding organisations. There are a further 26 registered awarding organisations with qualifications that are no longer operational.

In 2020, the most popular award at Level 2 was the Pearson Edexcel Level 2 Certificate in Digital Applications (1,024 awards) and at Level 3 it was the City & Guilds Level 3 Award in Business Processes (405 awards). 45 VTQs had no students being awarded a qualification – almost half of the number registered. The current Level 2 and 3 awards that are still eligible for entry and assessment are included at Annex 3.

The DfE recognises three types of vocational awards for reporting purposes. These are described below:

Technical awards

These broad level 1 and level 2 qualifications are designed to provide students with applied knowledge and associated practical skills which may not be available in a more general educational option. It is possible at key stage 4 to take up to three technical awards, often in combination with at least five academic GCSEs from the list of EBacc subjects (28). Technical Awards in the Information and Communication Technology category are subject to a no-overlap rule with the Computing KS3 Programme of Study and the Computer Science GCSE subject specification.

Technical certificates

These level 2 qualifications provide post-16 students with the skills and knowledge required to advance to skilled employment and/or further study.

T levels

These level 3 T-levels follow GCSEs and are designed as equivalent to 3 A-levels, they have their origins in the 2016 Sainsbury Review of Technical Education (29). They have been developed with employer support and are aimed at post-16 students wishing to specialise in a specific industry, occupation, or technical role. They had a phased introduction started in September 2020 which included digital production, design and development with first certifications in Summer 2022. The digital business services and digital support and services T-levels began in September 2021.

Knowing what counts and what does not in the Department for Education performance tables is important. In the 2019 versions of the tables and subsequently, the European Computer Driving Licence (ECDL, BCS) has been dropped from inclusion at Levels 2 and 3. Many other vocational qualifications have been discontinued since the Wolf report of 2011 (30).

Understanding and interpreting the uptake and attainment data regarding VTQs in England is challenging and requires greater support from the DfE for this to happen .

There are two main issues with the current VTQ data:

- Relevant demographic information isn't captured effectively restricting policy makers' ability to make informed decisions around such issues as socioeconomic status and ethnicity

- Inconsistency in the existing data sets across years. For example, Level 2 data has been produced with a female and male breakdown in the past two years, but not beyond that. At Level 3, subject level data is aggregated at a very high level, but there is inconsistency over reporting results by gender

The college sector, of course, includes general further education and there are qualifications and data that allow us to examine what level of uptake of qualifications there is in this sector. As this information is drawn from the FE sector, it is not immediately clear that it excludes school-level information set out in the performance tables.

In the school and college sector, the most reliable source of data is the DfE's performance tables data. Currently, these reports at KS4 and 16-18 include a range of VTQ's. These include the Technical Awards, Technical Certificates, and T Levels (31) described earlier.

The awards included currently in the DfE performance tables (and part of this analysis) are set out in Annex 3 and the data presented here is in the public domain and can be accessed at the sources listed in Annex 4. These datasets are current up to and including academic year 2019/20.

There are other computing related vocational technical awards such as OCR Level 1/2 Cambridge National Certificate in Creative iMedia which are not categorised by DfE as Information and Communication Technology and therefore fall out of the scope for this report. However, a significant number of candidates take related qualifications such as these, in 2021 more than 42,000 candidates took OCR Level 1/2 Cambridge National Certificate in Creative iMedia, which is categorised in Arts, Media and Publishing. Schools' reasons for offering these alternative qualifications warrants further investigation.

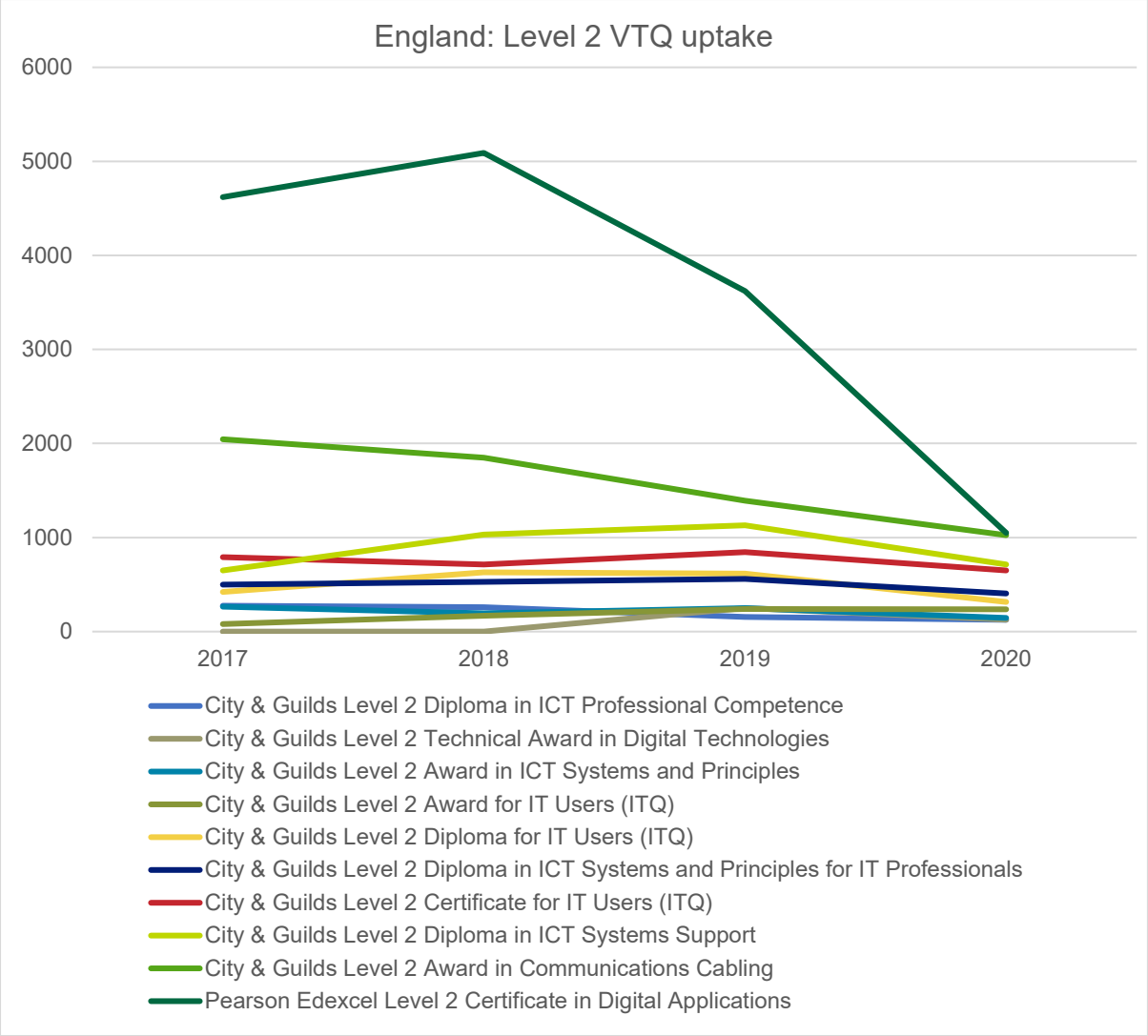
Participation and attainment

The data presented below comes from a variety of sources. Some of this is drawn from DfE school and college performance data, whilst some is drawn from the Ofqual qualifications records. The overlap and comparability of the data sets requires further investigation, and there is a distinct lack of consistent public reporting by simple measures such as male:female participation.

The patterns of uptake over the last five years for these qualifications is erratic with no clear trends and some unexplained declines in some areas – Level 2 digital applications or Level 3 Coding and logic for example. These declines may simply be a reflection of the market currency of VTQs and the possible greater volatility of qualification uptake when they are closely linked to employer needs. The 2020 data may also reflect a loss of engagement as a result of the COVID-19 pandemic and the data may include adult learners reiterating the need for much better quality data.

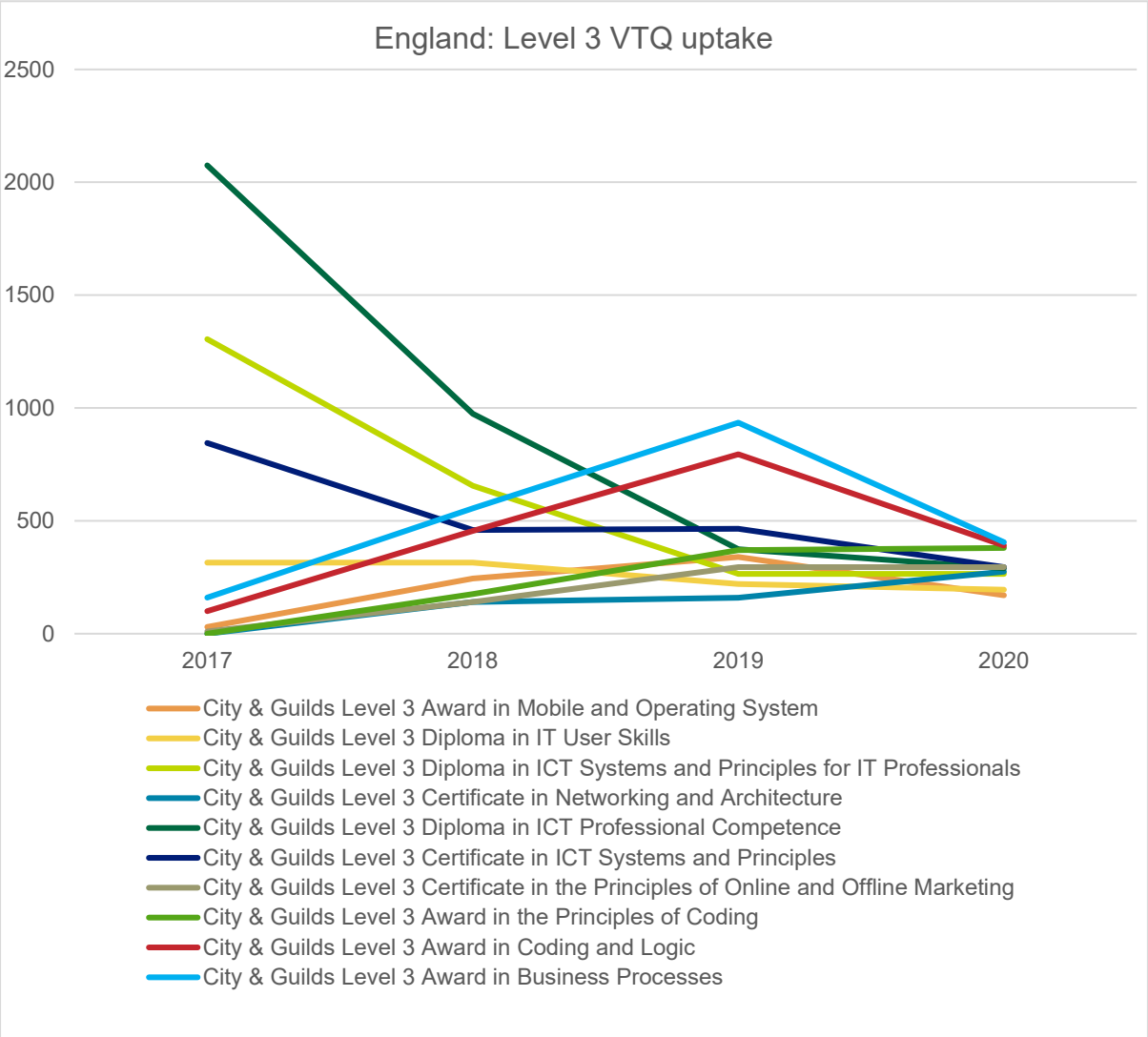
VTQ data from Ofqual

The following charts show the VTQ uptake across five years in Level 2 and 3 qualifications. It is not possible to determine any patterns in the uptake separately by males and females.



In 2020, the equivalent GCSE and A-level entries (for Computer Science) were 75,791 and 11,608 respectively in England. None of the VTQs examined here are in any way comparable in terms of size of uptake to their academic equivalents. The low numbers of VTQ entrants is very likely a reflection of the removal of a number of extremely popular qualifications from the

Performance Tables following the Wolf Review.



In 2020, the three most popular Level 2 and Level 3 awards were as follows:

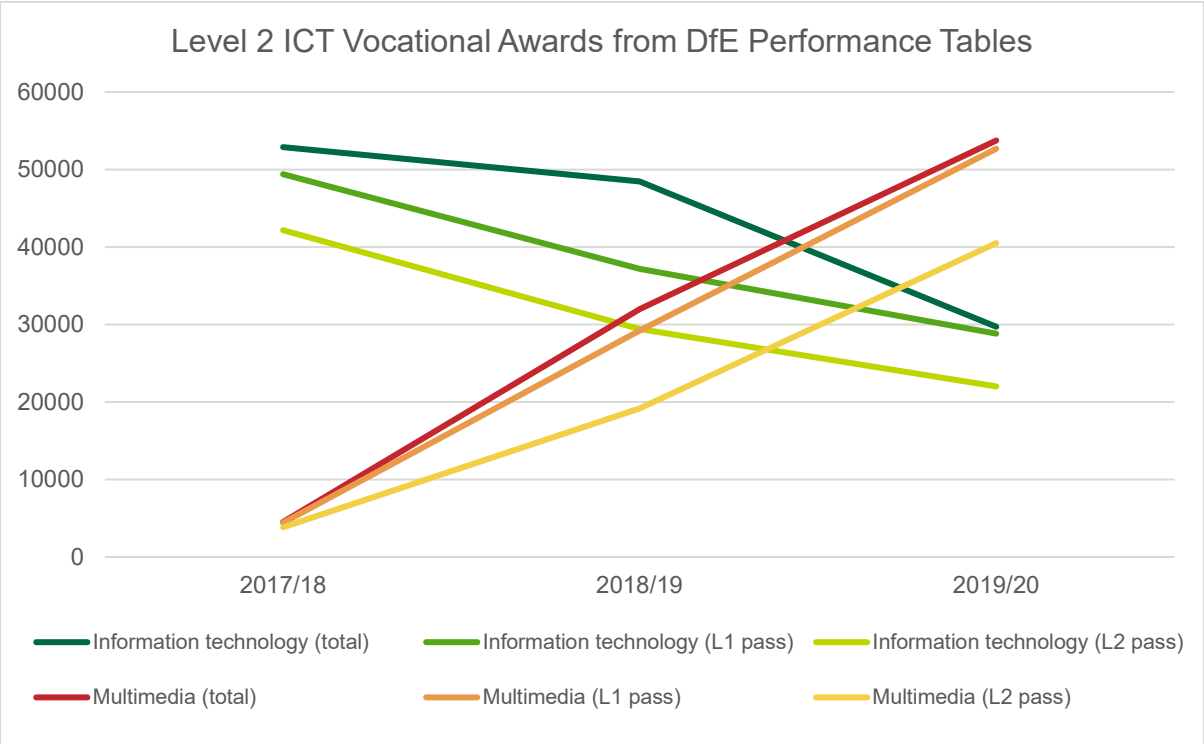
Award	Number
Pearson Edexcel Level 2 Certificate in Digital Applications	1050
City & Guilds Level 2 Award in Communications Cabling	1025
City & Guilds Level 2 Diploma in ICT Systems Support	715
City & Guilds Level 3 Award in Business Processes	405
City & Guilds Level 3 Award in Coding and Logic	390
City & Guilds Level 3 Award in the Principles of Coding	380

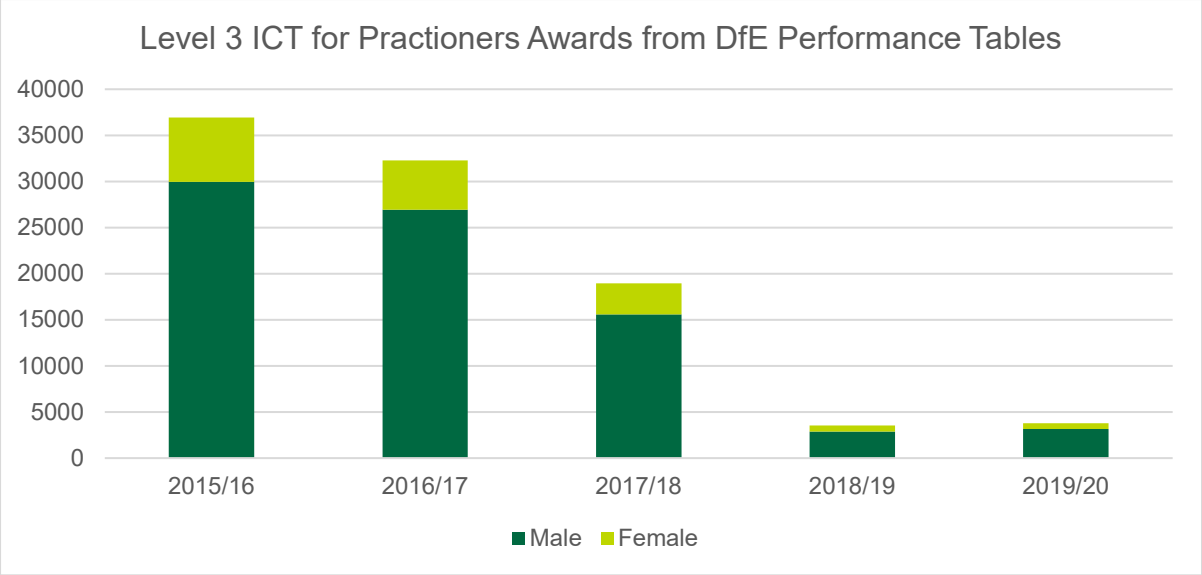
In 2020, the equivalent GCSE and A-level entries (for Computer Science) were 75,791 and 11,608 respectively in England. None of the VTQs examined here are in any way comparable in terms of size of uptake to their academic equivalents.

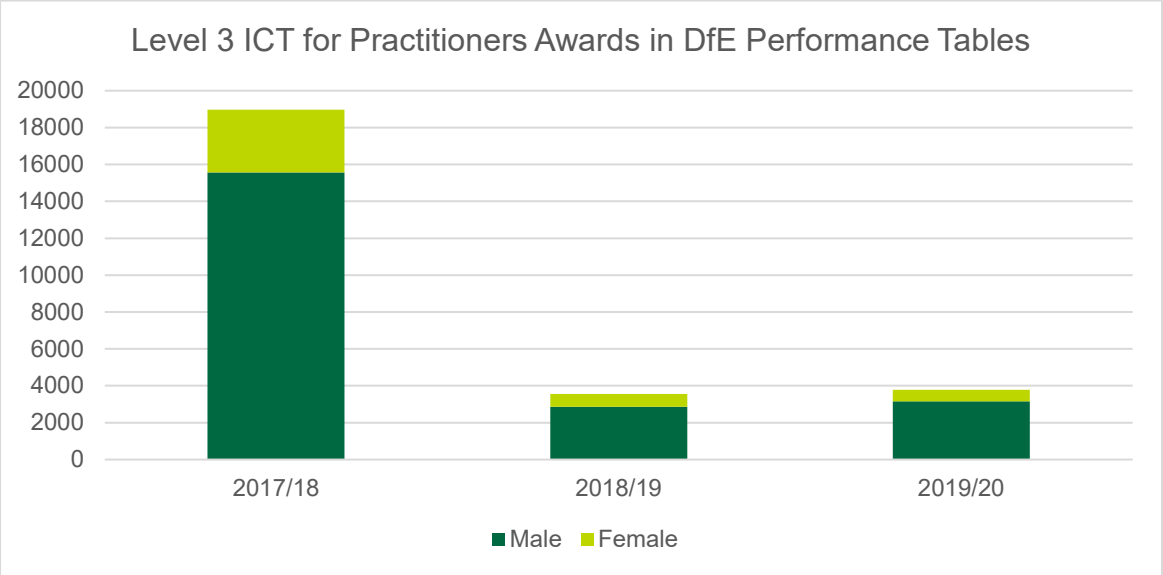
It has not been possible to aggregate data across the Level 2 or Level 3 qualifications to identify the number of unique students who gain a computing or digital qualification at the end of key stage 4 or 5.

Vocational awards from the Department for Education data

The following charts show the uptake of vocational qualifications that can be discerned from the School and College Performance tables and related statistical first releases. The sudden drop in 2017/18 is a result of the plan to remove the ECDL from the DfE Performance Tables.







Typically, at Level 2, the ratio between male: female participation and awards is 1.9:1.0, whilst at Level 3 it is around 5.0:1.0, suggesting a strong decline in female student engagement post-16.

Some context

The Computer Science A-level was reformed in 2015 and from 2016, the DfE replaced the GCSE in Information and Communications Technology (ICT) with the GCSE in Computer Science. The UK Government's 2017 Digital Skills Strategy (32) celebrated this change and drew attention to the support being offered to underpin the new curriculum, including the contributions being made by providers of informal support and enrichment activities. This was followed up by the autumn 2017 budget (33) announcement of an £84m investment in Computer Science teachers, with the aim of upskilling 8,000 individuals (to become qualified Computer Science teachers).

The loss of any computing-rich options beyond key stage 3 (KS3) in England other than GCSE Computer Science causes concern and there is little to suggest that VTQs are currently seen as alternatives being effectively promoted as options or complements to the current system[6]. Of particular concern is the shift in male and female student participation highlighted by studies such as (24), something which may not be helping with diversity in higher education Computer Science (where the ratio of male and female undergraduates in is over 4:1) (34).

The Royal Society (7) points to concerns about teacher supply. The shift from ICT to computing placed demands on existing teachers to deliver a new curriculum, prior to any new supply of dedicatedly trained teachers. Whilst dedicated teachers are entering the system, and CAS and the NCCE address upskilling, there continue to be issues with the spread of the subject across schools and with the supply of skilled practitioners. If computing teacher supply bears any relationship to that of other STEM subjects, then there is evidence of persistent supply issues in schools serving disadvantaged communities (35). Improved data quality on the supply of computing and digital teaching skills in the further education sector is needed before accurate conclusions can be made.

The NCCE recently released its first impact report (36), setting out the scale and range of the programme and achievements. In two years, it has developed a comprehensive suite of learning materials and development opportunities for teachers in England across the primary and secondary phases. School participation rates tell us that 78% of secondary schools and just over 50% of primary schools have engaged with the NCCE.

[6] The ratios are more favourable where vocational options are offered. There are a number of Progress 8 vocational and technical qualifications (VTQs) awards that cover broader computing. They attract ~125k students each year and have a better male to female ratio.

Northern Ireland: Digital Technology and software systems GCSE, AS, and A Levels

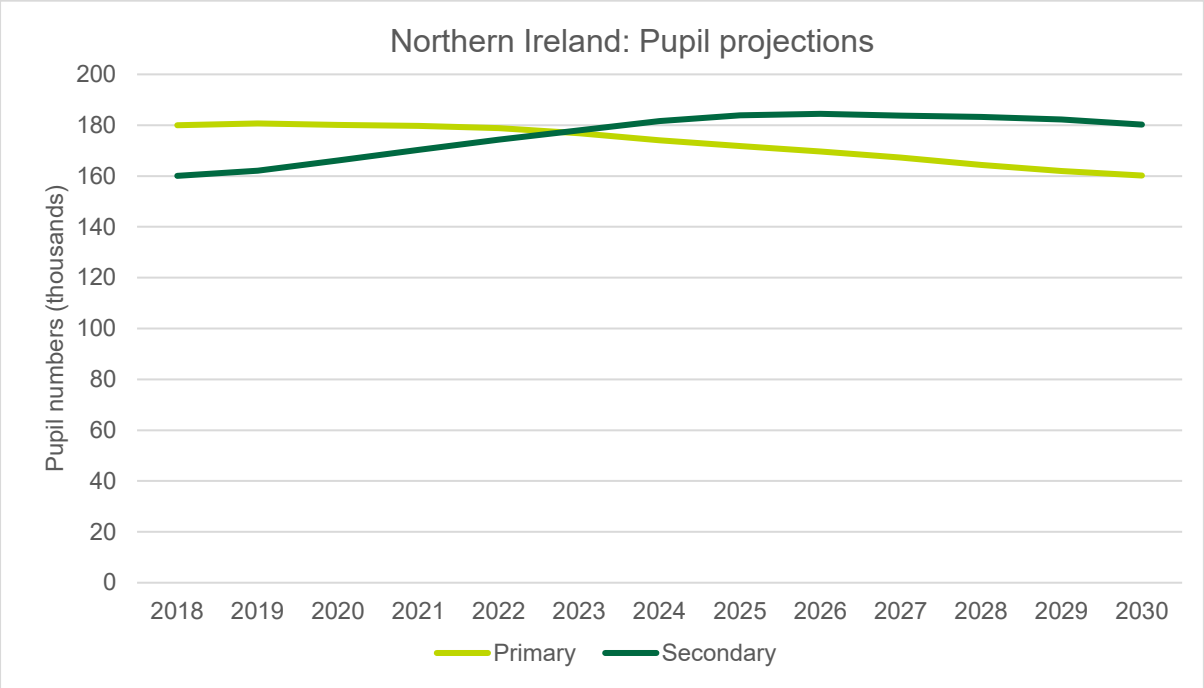
The size and shape of the secondary and primary sector (11)

	Primary*	Secondary*
Schools	791	193
Students	183,079	148,918
Teachers	8,340	9,429

**Non-independent*

There are around 20,700 students in each secondary year band in Northern Ireland.

The most recent student projections (in the context of an overall growing Northern Irish population) suggest that primary numbers are set to fall towards 2030, as secondary numbers rise to a peak at around 2025.



(QQ)

The current curriculum and assessment

This section attempts to capture in as summative a form as possible, the key characteristics of the main examinations currently available in Northern Ireland, including the curriculum focus, assessment methodology and coding languages preferred.

Subject	Award	Level	Awarding body	Curriculum focus	Assessment approach	Language preferred
Digital technology	GCSE	2	CCEA	Digital Authoring Concepts - multimedia route Digital Authoring Practice - multimedia route Digital Development Concepts - programming route Digital Development Practice - programme route Digital Technology - both routes	Written exam and a controlled assessment task that is worth 60 marks - 30% of the total.	Python, Java, C#
Digital technology	GCE (A/AS)	3	CCEA	Approaches to Systems Development Fundamentals of Digital Technology Information Systems Application Development (Case Study)	Written examinations and portfolio development.	None specified - SQL and HTML for particular cases.
Software systems development	GCSE (A/AS)	3	CCEA	Introduction to Object Oriented Development Event Driven Programming Systems Approaches and Database Concepts Implementing Solutions.	Written examinations and portfolio development.	None specified - SQL and HTML for particular cases.

The teaching workforce

Data on the teaching workforce by subject specialism in secondary education is not readily available for Northern Ireland. The Statistics & Research Branch (Tertiary Education) of the Department for the Economy currently provide information about the number of entrants to teacher training/education in the past five years who had a first degree in Computer Science. This is set alongside a science and mathematics for comparison.

Subject		2014/15	2015/16	2016/17	2017/18	2018/19
Computer Science	Enrolments	10	10	10	15	10
	Qualifications	10	10	10	15	10
Biological Sciences	Enrolments	30	25	25	25	40
	Qualifications	30	25	25	25	40
Physical Sciences	Enrolments	25	15	20	20	20
	Qualifications	25	15	20	20	15
Mathematical Sciences	Enrolments	25	20	20	15	20
	Qualifications	25	20	15	15	20
Total	Enrolments	245	220	225	210	240
	Qualifications	225	210	215	200	225

Personal communication, Department for the Economy, Northern Ireland.

This shows that the scale of teacher supply being addressed by initial teacher training education is modest with one university (Queen's University Belfast) responsible for the majority of post-primary Computer Science teacher supply (37).

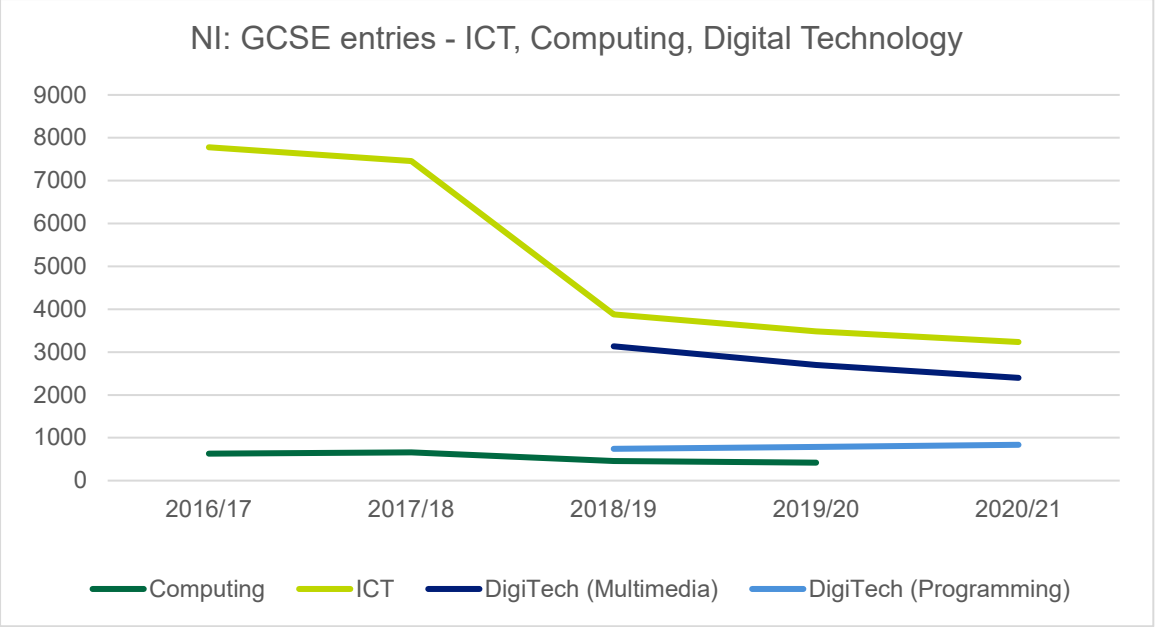
The current number of teachers in post-primary settings in Northern Ireland with responsibility for Computing and or ICT, are provided by the General Teaching Council for Northern Ireland– the teacher registration authority. There are indications Northern Ireland may be (overall) training too many teachers (38) but that there is a major shortfall in people trained to work in the information technology sector in Northern Ireland.

There are currently no initiatives to incentivise people to train as a computing or ICT teacher in Northern Ireland, or supplementary training to support new entrants to teaching or to offer existing teacher additional specialisms.

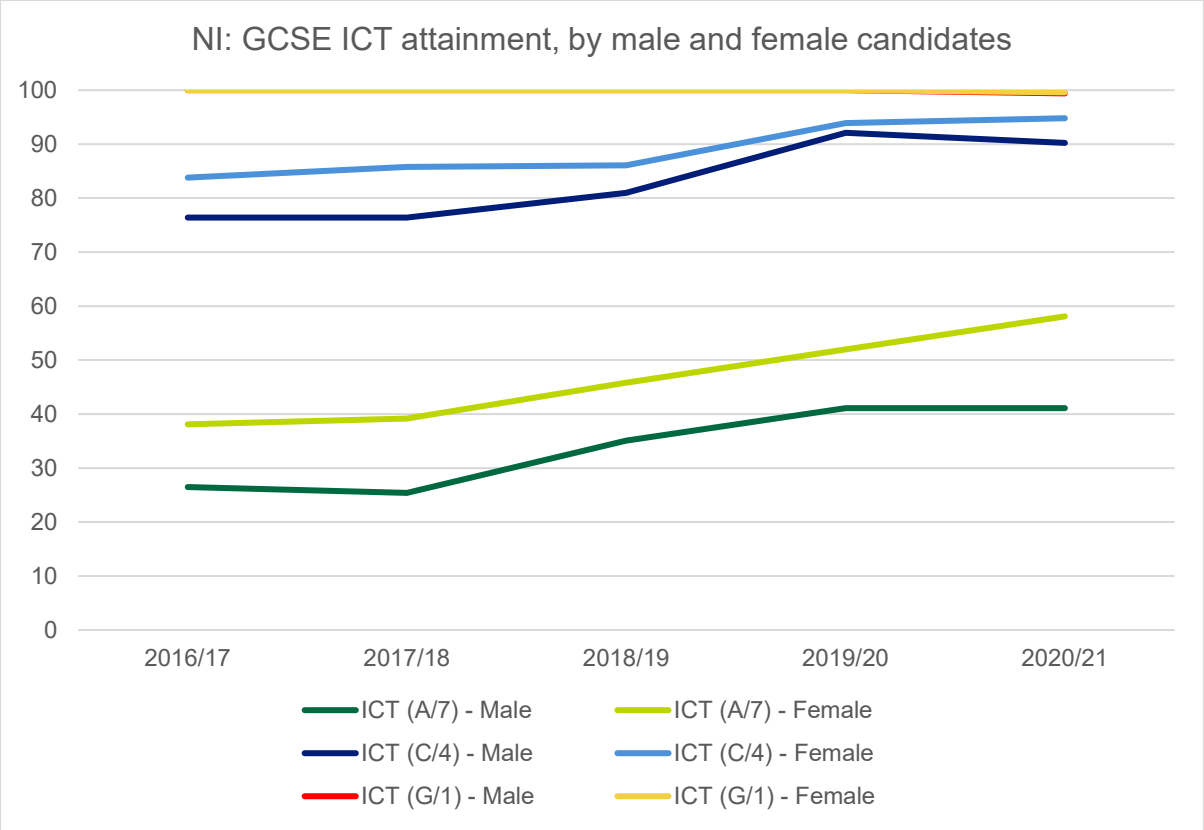
Attainment and participation

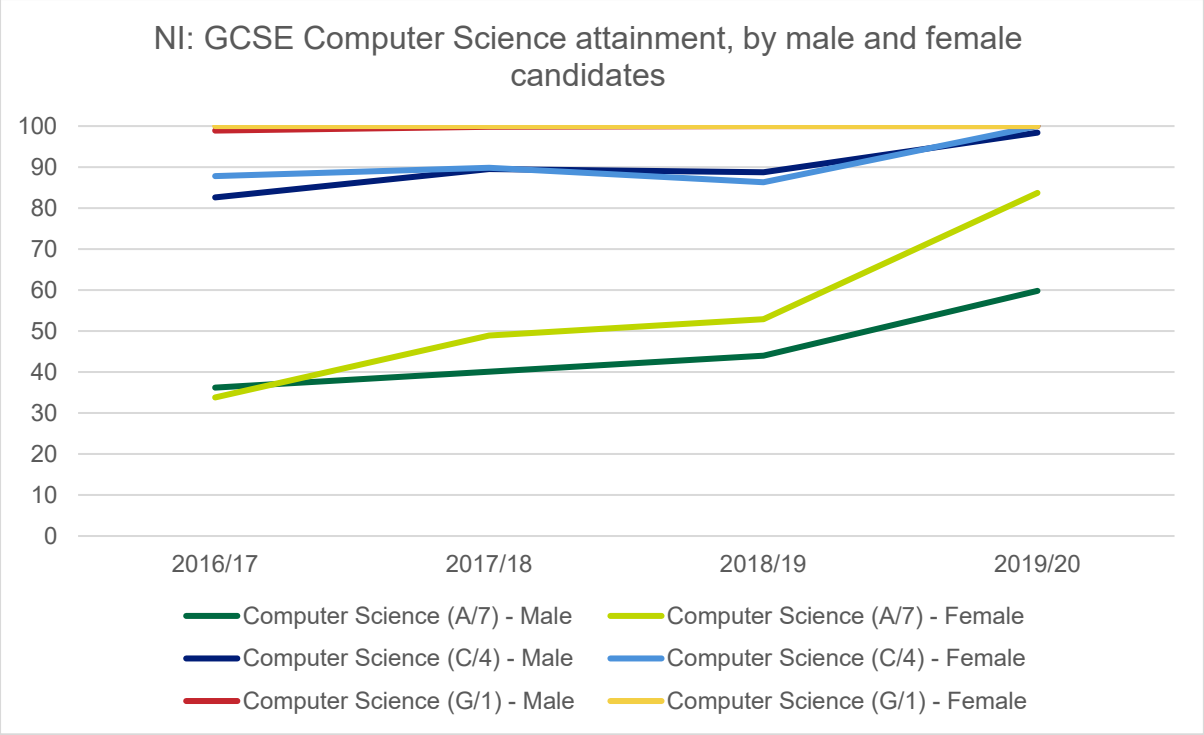
The mainstay of computing education in Northern Ireland has been ICT. Uptake of A Level Computing has been growing, but ICT is the dominant qualification. There has been a drop of around 50% in ICT entries for all levels across the last five years, but growth in Digital Technology, which has largely replaced this subject. The A/AS level in Software Systems Development (introduced in 2015/16) has seen a decline in uptake since it became part of the curriculum, with just over 200 students taking this in 2020/21.

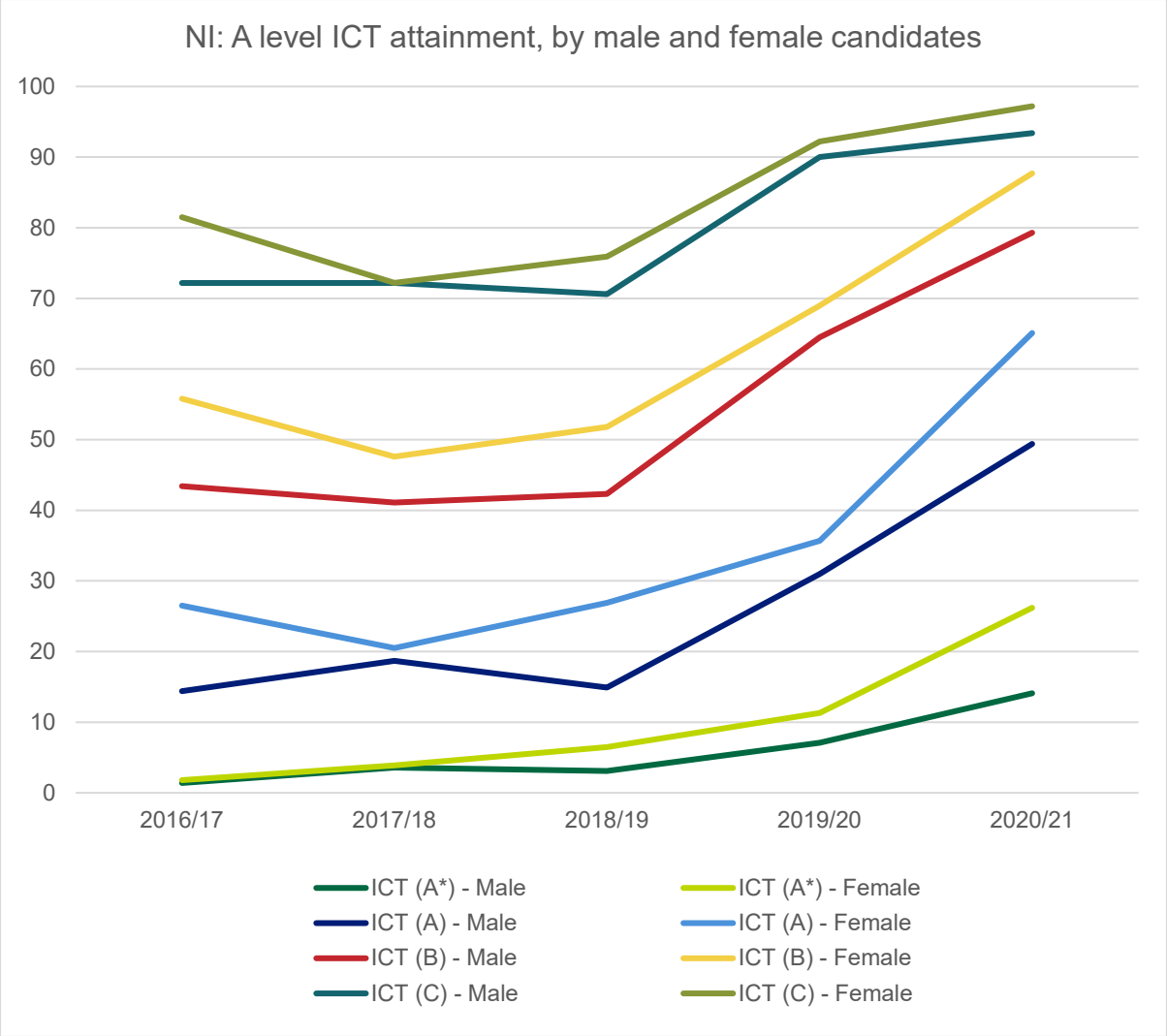
Data for England, Northern Ireland, and Wales is drawn from JCQ annual statistical bulletins. Council for the Curriculum, Examinations & Assessment (CCEA) data is used to augment this. JCQ data on Computing includes the CCEA Software Systems Development course (A/AS level) whilst the JCQ data on ICT includes the CCEA Digital technology options.

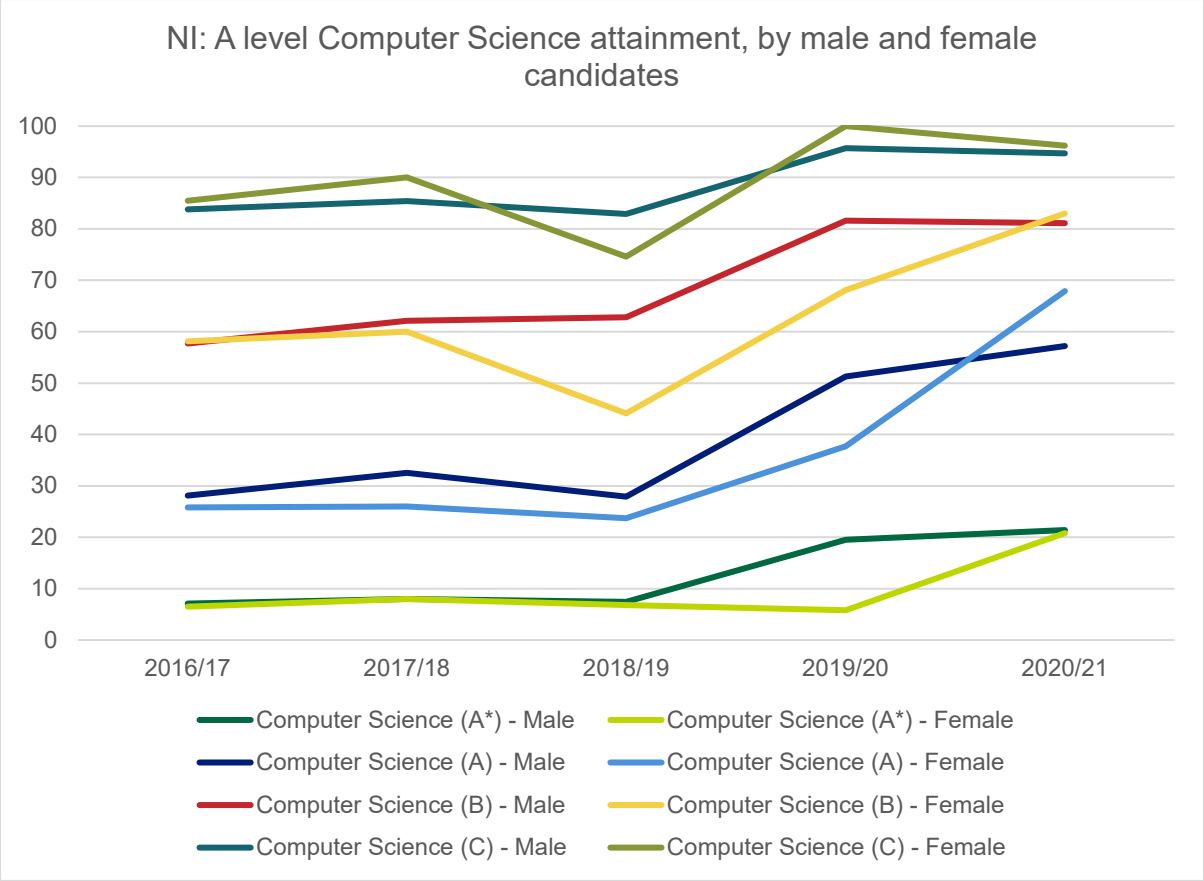


The following charts compares the performance of female and male candidate's attainment in GCSE Computing and Digital Technology over the past five years (cumulative percentages).




NI: GCSE Computer Science attainment, by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
Computer Science (A/7) - Male
Computer Science (A/7) - Female
Computer Science (C/4) - Male
Computer Science (C/4) - Female
Computer Science (G/1) - Male
Computer Science (G/1) - Female


NI: A level ICT attainment, by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
2020/21
ICT (A*) - Male
ICT (A) - Male
ICT (B) - Male
ICT (C) - Male
ICT (A*) - Female
ICT (A) - Female
ICT (B) - Female
ICT (C) - Female



The participation rates show a ratio of 1:2 female:male students studying ICT. In Computing, this rises to 1:9 for GCSE in 2019/20 and 4:1 at A level.

The introduction of Digital Technology appears to be producing more favourable participation ratios between males and females, reflecting the uptake of ICT to a greater degree than Computing. CCEA data for the Software System Development AS and A levels show that the male to female ratio has improved for the former (moving from 5:1 to 3:1) and deteriorated for the latter (moving from 3:1 to 5:1).

Out of nine STEM subjects, Computing was the second least popular A level subject in 2018/19. Over three-times as many students opted for Physics at A level. Digital technology and ICT were behind Physics, Chemistry, Biology, and Mathematics (39). Small numbers of students took up A levels in closely related subjects such as Software Systems Development and Moving Image Arts (all part of the Digital Skills Framework (40)). 338 students took Computing A level in NI in 2020/21 representing 3% of the cohort.

There is currently no published data illustrating uptake by young people from relatively advantaged and disadvantaged backgrounds, or by ethnicity.

Northern Ireland: Vocational and Technical Qualifications in Computing at the end of Key Stage 4 and 5

Northern Ireland uses the same regulatory framework as England (Ofqual), there are 215 vocational qualifications related to ICT and digital skills currently registered. These are offered

by 23 different awarding organisations. Of the 215 registered awards, only 28 registered one or more student receiving that award in 2020. The currently active awards are set out in Annex 5.

All of the relevant data can be accessed here:

- Department for the Economy, Further education sector activity in Northern Ireland: 2015/16 to 2019/20: https://www.economy-ni.gov.uk/publications/further-education-sector-activity-northern-ireland-201516-201920
- Council for the Curriculum, Examinations & Assessment, Technical and Professional Qualification Bulletins: https://ccea.org.uk/regulation/reports-statistics/technical-and-professional-qualification-bulletins

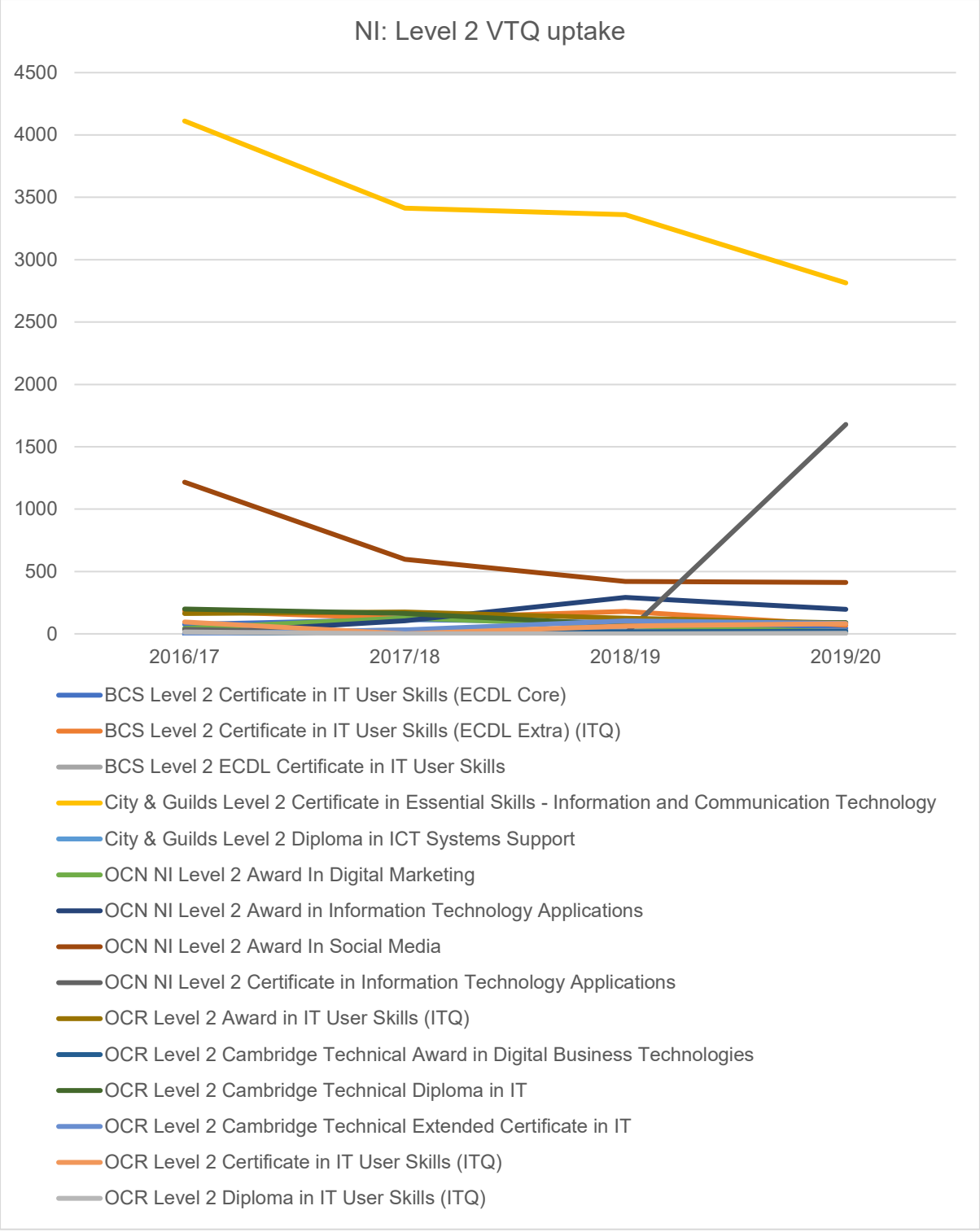
In 2020, the three most popular Level 2 and Level 3 awards were as follows:

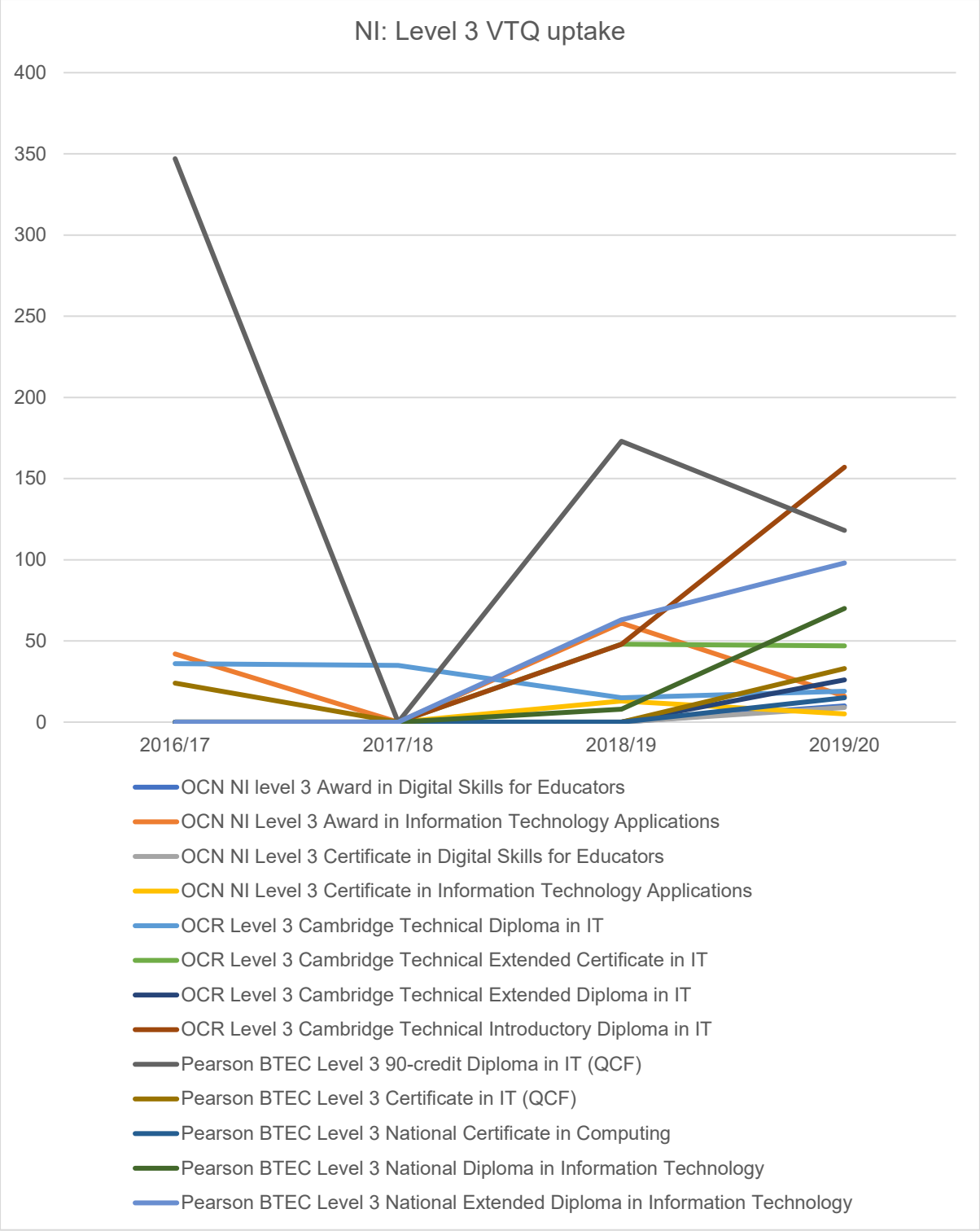
Award	Number
City & Guilds Level 2 Certificate in Essential Skills - Information and Communication Technology	2814
OCN NI Level 2 Certificate in Information Technology Applications	1679
OCN NI Level 2 Award in Social Media	412
OCR Level 3 Cambridge Technical Introductory Diploma in IT	157
Pearson BTEC Level 3 90-credit Diploma in IT (QCF)	118
Pearson BTEC Level 3 National Extended Diploma in Information Technology	98

Further education data suggests that in 2019/20, 10,245 students also took a qualification (all levels) in ICT. This figure is 29% lower that the figure in 2015/16.

In 2020, the equivalent GCSE and A-level entries were 7,381 and 2,255 respectively in Northern Ireland.

The following charts show the VTQ uptake across five years in Level 2 and 3 qualifications. It is not possible to determine any patterns in the uptake separately by males and females.


NI: Level 2 VTQ uptake
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2016/17
2017/18
2018/19
2019/20
BCS Level 2 Certificate in IT User Skills (ECDL Core)
BCS Level 2 Certificate in IT User Skills (ECDL Extra) (ITQ)
BCS Level 2 ECDL Certificate in IT User Skills
City & Guilds Level 2 Certificate in Essential Skills - Information and Communication Technology
City & Guilds Level 2 Diploma in ICT Systems Support
OCN NI Level 2 Award In Digital Marketing
OCN NI Level 2 Award in Information Technology Applications
OCN NI Level 2 Award In Social Media
OCN NI Level 2 Certificate in Information Technology Applications
OCR Level 2 Award in IT User Skills (ITQ)
OCR Level 2 Cambridge Technical Award in Digital Business Technologies
OCR Level 2 Cambridge Technical Diploma in IT
OCR Level 2 Cambridge Technical Extended Certificate in IT
OCR Level 2 Certificate in IT User Skills (ITQ)
OCR Level 2 Diploma in IT User Skills (ITQ)



Some context

As in the other nations of the UK, young people gain experience of digital skills and digital making in their earlier years to provide a platform that supports specialisation at key stage 4 and beyond. The publication of the Lords Select Committee report on the UK's digital future in 2015 (41) informed the reform of the curriculum offer and associated qualifications in Northern Ireland (42).

This appears to have driven a shift from using software and applications to 'more technical aspects of computing' (*ibid*). The variety of VTQs on offer is extensive, although few receive substantial entries and add little to the numbers pursuing similar qualifications in school. The notable exception is the ICT-based level 2 award, which although declining over the period examined, still attracts almost 3,000 students, possibly indicating a resilient interest in digital skills applied to a range of work settings.

CCEA has analysed the issue of low female participation in computer-focused choices at key stage 4 and beyond (43), concluding that many of the reasons are common to STEM subjects in general and that lessons should be looked for and adopted from other outside of Northern Ireland. These findings are reflected in the recent work of Cavaglia et al (44), who emphasise how important role modelling (peers, mentors, and teachers) can be.

At the time of writing, both the Department for the Economy is preparing a new skills strategy for Northern Ireland that will emphasise the place of digital skills in the education and training system and in the economy.[7]

[7] https://consultations.nidirect.gov.uk/dfe/skills-strategy-for-northern-ireland/

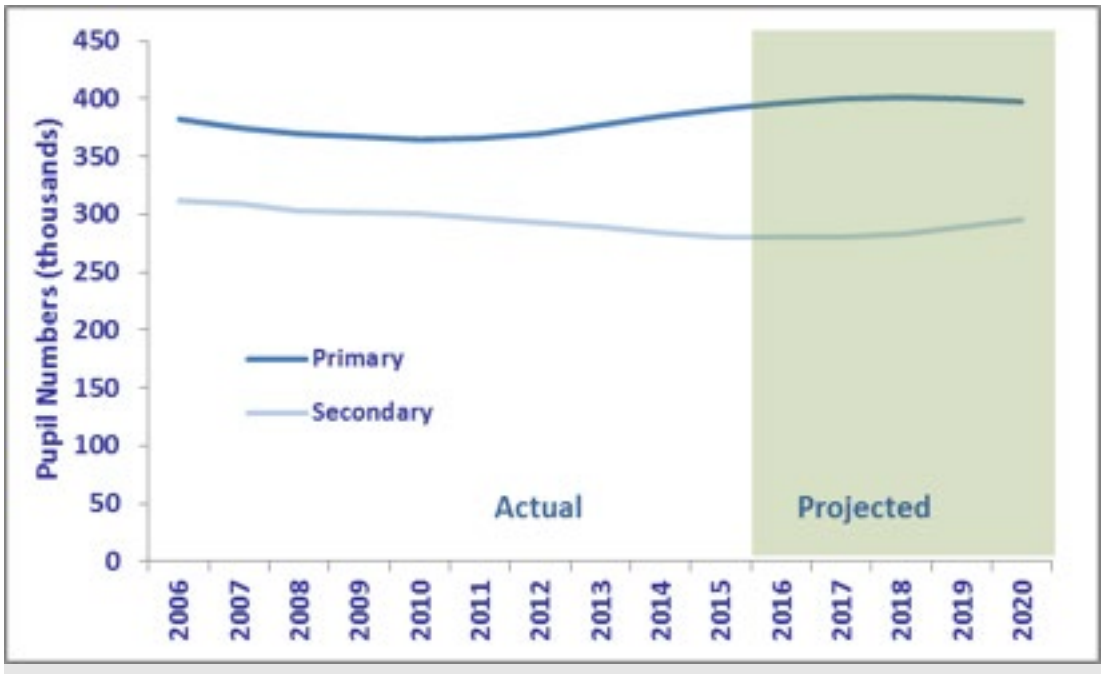
Scotland: Computing Science National 5, Highers and Advanced Highers

The size and shape of the secondary and primary sector (11)

	Primary (maintained)	Secondary (maintained)
Schools	2,005	357
Students	393,957	300,954
Teachers	25,651	24,077

There are around 50,000 students in each secondary school year band in Scotland.

The most recent student projections from the Scottish Government date from 2016 and indicate that primary numbers are stable and dropping from 2020, with a related slow rise in secondary numbers.



(45)

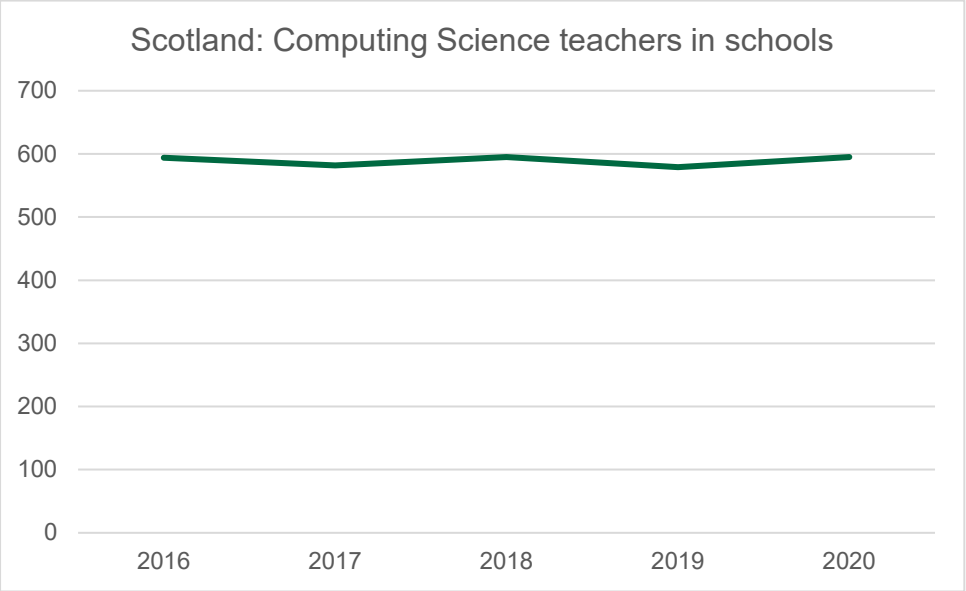
The current curriculum and assessment

This section attempts to capture in as summative a form as possible, the key characteristics of the main examinations currently available in Scotland, including the curriculum focus, assessment methodology and coding languages preferred.

Subject	Award	Level	Awarding body	Curriculum focus	Assessment approach	Language preferred
Computing Science	National 5	5	SQA	Software design and development Computer systems Database design and development Web design and development	Written examination and an assignment worth 50 out of 160 marks.	Any programming code that meets the course requirement (Python, Live Code, Visual Basic, True Basic, Java, Xojo (formerly real basic)) including SQA's standardised reference language
Computing Science	Higher	6	SQA	Software design and development Computer systems Database design and development Web design and development	Written examination and an assignment worth 50 out of 160 marks.	Any programming code that meets the course requirement (Python, Live Code, Visual Basic, True Basic, Java, Xojo (formerly real basic)) including SQA's standardised reference language
Computing Science	Advanced Higher	7	SQA	Software design and development Computer systems Database design and development Web design and development	Written examination and an assignment worth 80 out of 160 marks.	Any programming code (Python, Live Code, Visual Basic, Java) and SQA's standardised reference language

The teaching workforce

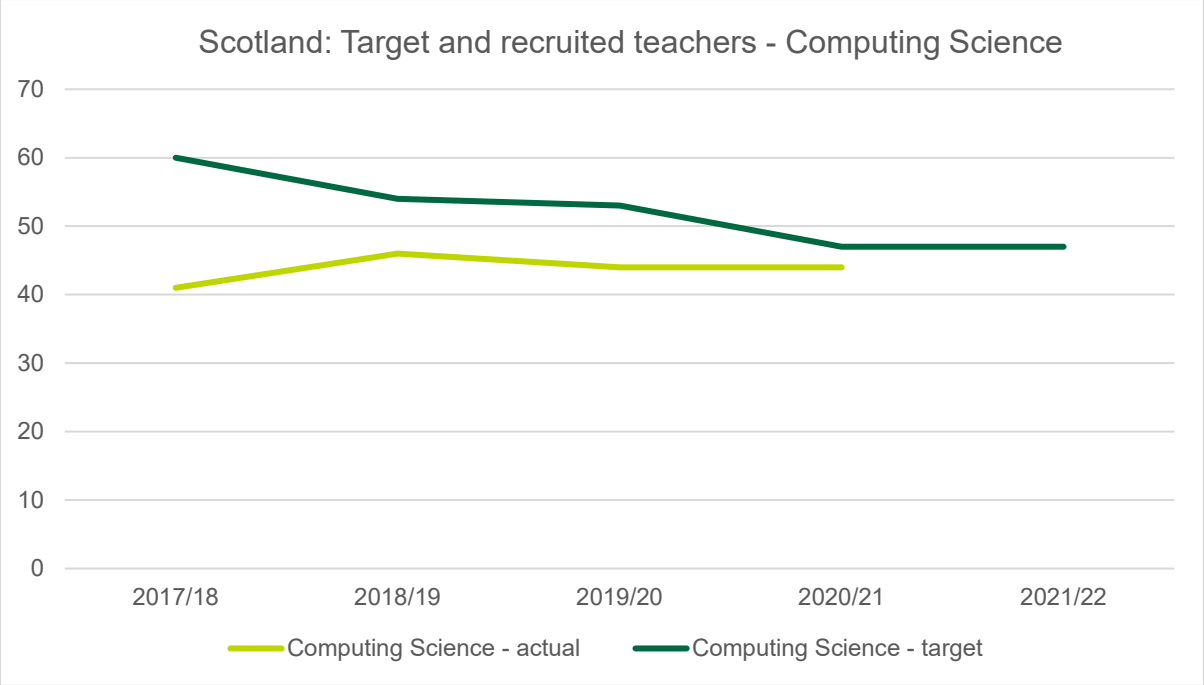
There are currently at least 595 teachers in Scottish secondary schools delivering Computing Science, little changed from the number in 2016 (594). Interestingly, in 2008, there were 766 Computing Studies teachers (46) indicating a 22% decline in teaching capacity in just over a decade, across a period when student numbers were relatively stable.



(47)

Recruitment to initial teacher education/training for Computing Science (as with many STEM subjects) remains a challenge in Scotland and is concentrated in four of the 11 initial teacher education/training providers. Over two thirds of the places are in two providers in Glasgow, which although the central belt is home to approximately 70% of the Scottish population, this regional consolidation may limit supply for the rest of the country. To address the need for teachers, there are now bursaries in place to encourage recruitment[8], in 2021/22 the aim is to recruit 47 new entrants to the profession. This is still a difficult target to meet; at best, recruitment has only managed to get to a maximum 94% of the target in one year in the past five (from a low point of 68%) with the increased proximity to the target figure largely a result of it being steadily reduced.

[8] https://teachinscotland.scot/news/stem-teacher-education-bursaries/



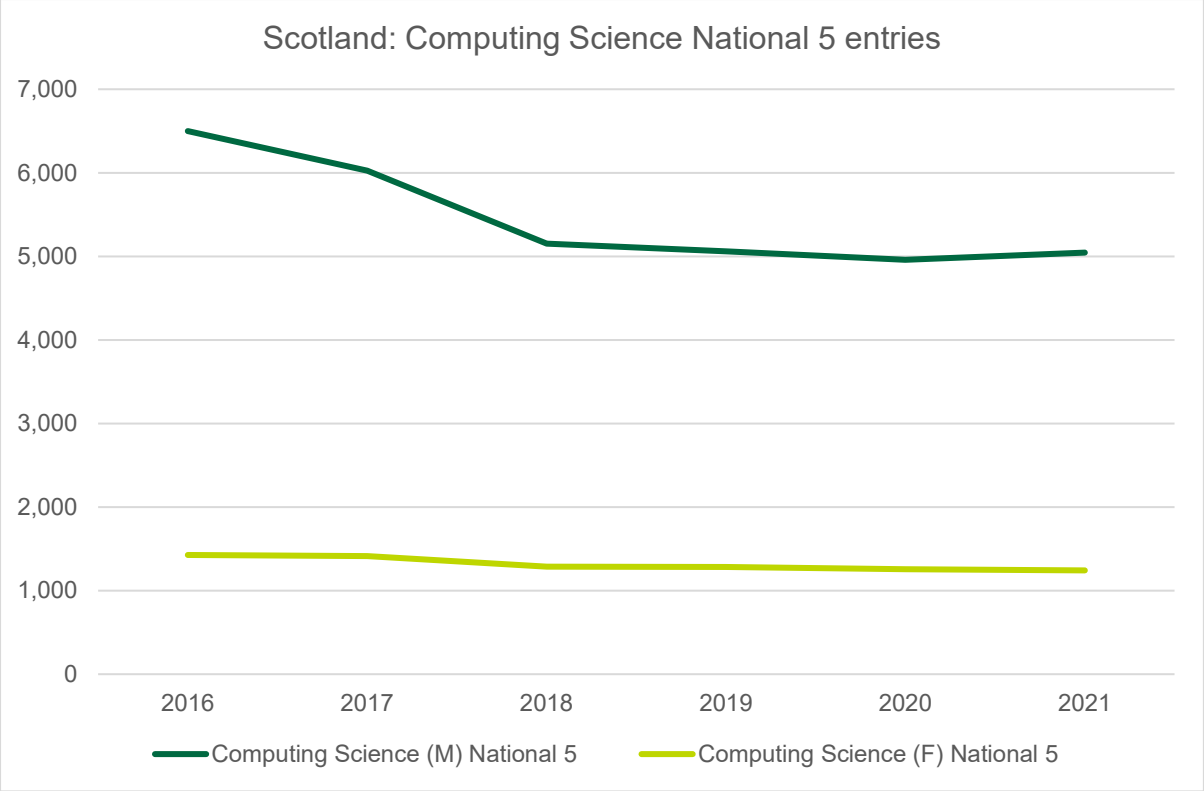
(48, 49)

The General Teaching Council for Scotland encourages professional development for all teachers, teachers must demonstrate that they have updated their professional skills every five years (50). They also only permit teachers to add additional subjects if they can demonstrate that they have the competence to teach a new subject at secondary level.

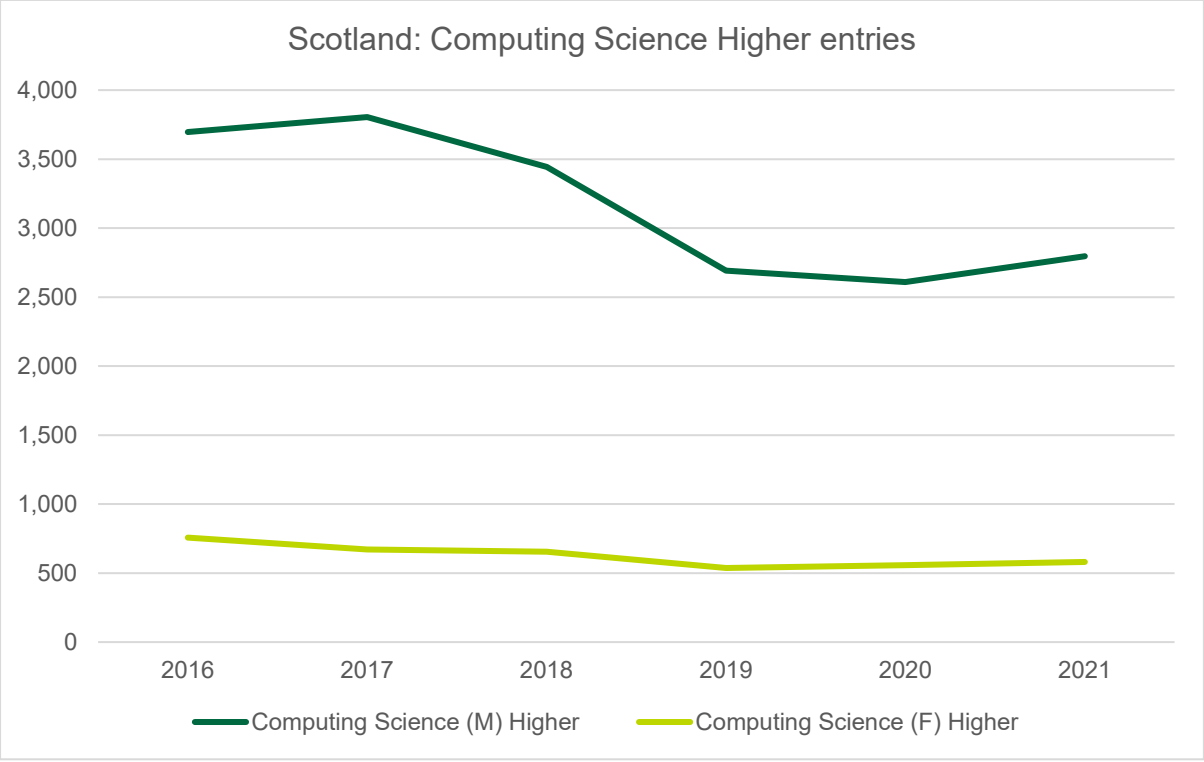
BCS, with funding from Microsoft, has supported The University of the Highlands and Islands (UHI) to develop an additional teaching qualification award in Computing Studies leading to BCS certification to support teachers wishing to add this subject to their portfolio (51). A 2014 initiative to create a teacher professional learning network for Computer Science teachers (Professional Learning and Networking in Computing - PLAN C) produced promising outcomes such as engaging over 300 teachers, gaining positive feedback on their proposed pathways to change model and identifying lessons for future professional development (52).

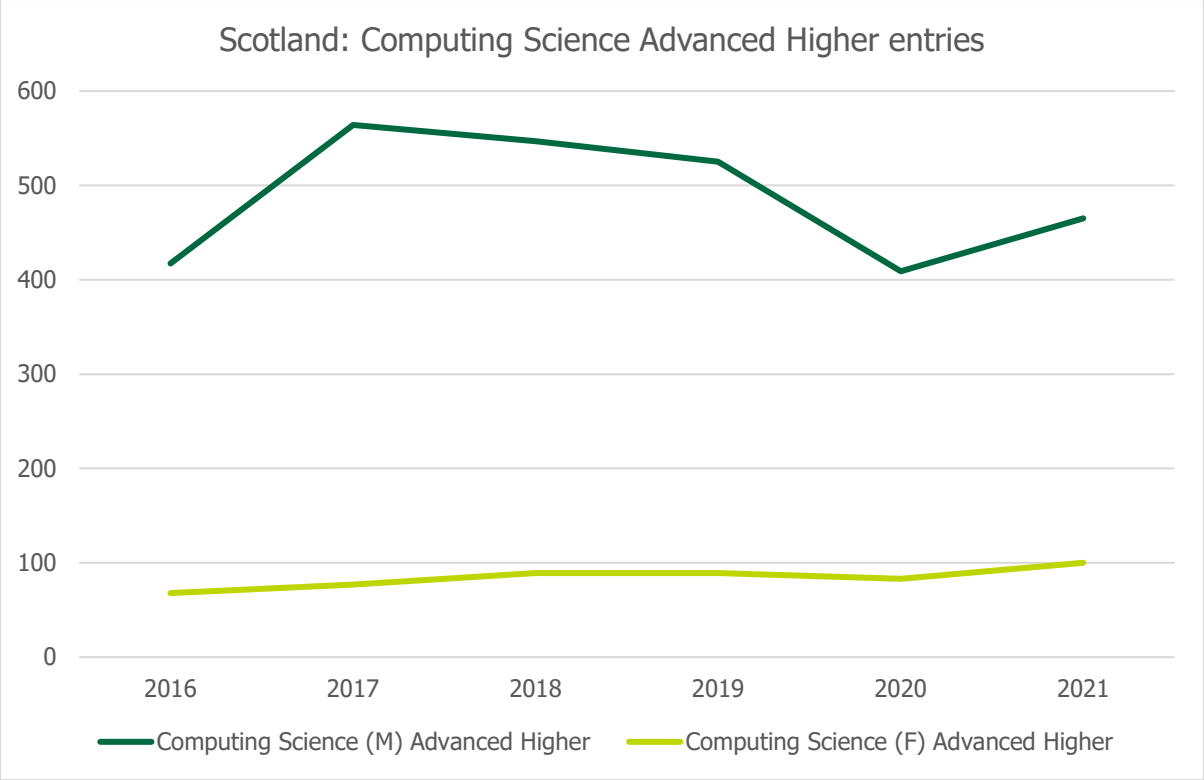
Attainment and participation

The pattern of participation in Scotland shows a drop of over 20% participation at National 5 across five years (likely contributing factors may include staffing in schools, changes in course and assessment and the narrowing of subject choices in some schools), although the most recent data shows an upturn at all levels. The SQA has also been offering a wider and more diverse range of employment-focused digital skills awards (such as National Progression Awards - NPA) which are beginning to be taken up in schools (in 2021, 634 students took an NPA in Computer Games development at Scottish Credit and Qualifications Framework (SCQF) level 5).

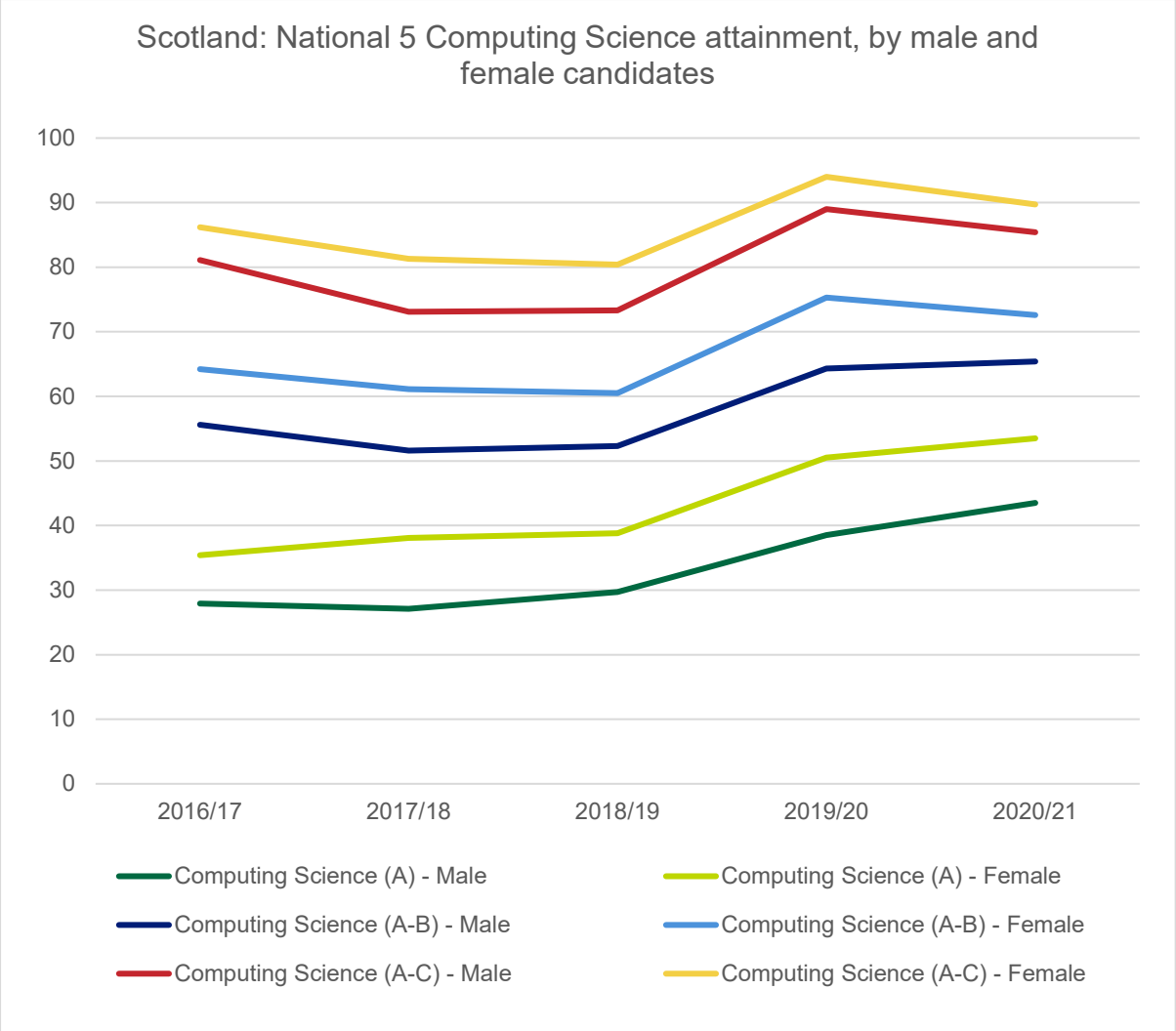


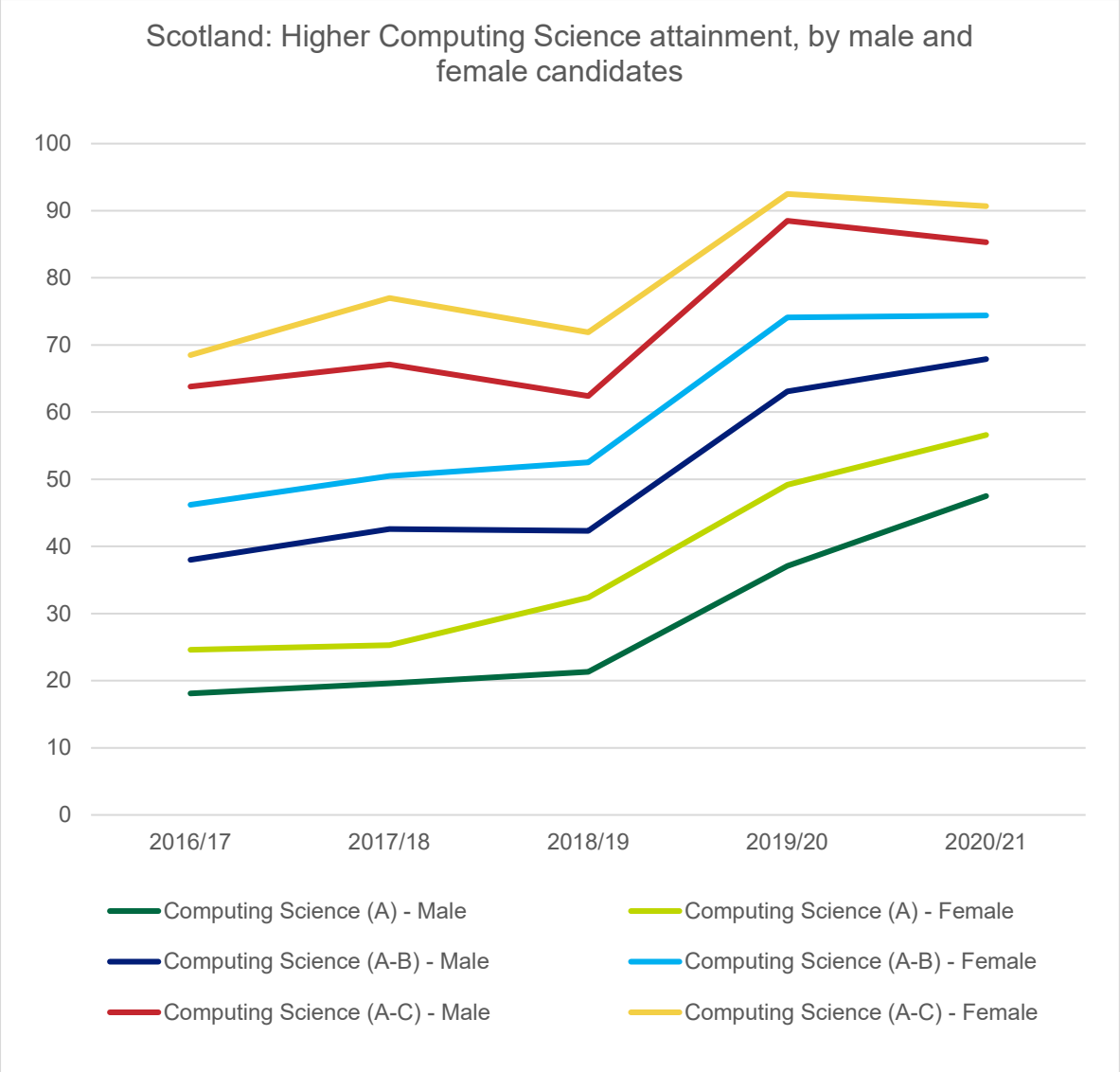
In 2015, schools could offer an old Computing Higher or a new Computing Science Higher. In this year, entries represent 1,182 students taking Computing Science plus 3,008 taking the original Computing Higher (with a male:female ratio of 6:1).

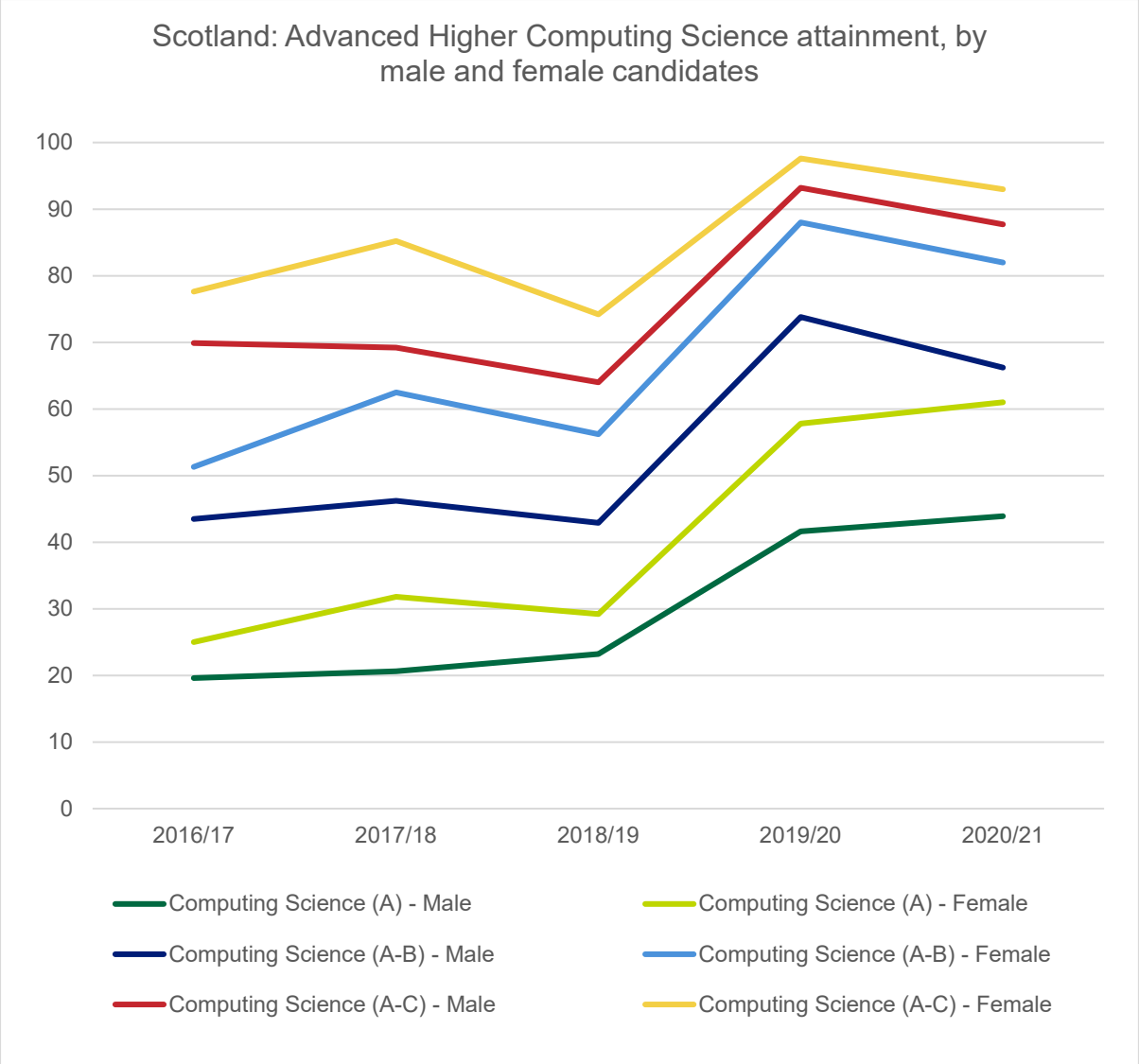




The following charts set out Computing Science attainment by male and female candidates over the past five years (cumulative percentages).


Scotland: National 5 Computing Science attainment, by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
2020/21
Computing Science (A) - Male
Computing Science (A) - Female
Computing Science (A-B) - Male
Computing Science (A-B) - Female
Computing Science (A-C) - Male
Computing Science (A-C) - Female


Scotland: Higher Computing Science attainment, by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
2020/21
Computing Science (A) - Male
Computing Science (A) - Female
Computing Science (A-B) - Male
Computing Science (A-B) - Female
Computing Science (A-C) - Male
Computing Science (A-C) - Female



In common with England, at the higher grades, female candidates are regularly outperforming male candidates.

The participation patterns reflect those in other parts of the UK, with at most (National 5) 20% of entrants being female and at worst 12% (Advanced Higher). Total numbers of female participants in Computing Science qualifications have broadly held up, but they are notably out of step with male participation.

In Scotland, the 2020 data (latest year for which there are detailed cohort sizes) indicates that National 5 participation was 12% of the cohort, with 7% and 2% respectively taking the Higher and Advanced Higher options. These data have been consistent over five years, so it is unlikely that it will have been very different in 2021.

In 2021, National 5 Computing Science was the 15th most popular N5 award, by entries. It was the least popular science and physics (the next most popular science) attracted almost three-times as many entries.

Higher Computing Science was the 18th most popular Higher award, by entries. It was the least popular science and human biology (the next most popular science) attracted almost twice as many entries (physics, almost three-times).

Advance higher Computing Science was the 16th most popular Higher award, by entries. It was the least popular science and physics (the next most popular science) attracted over three-times as many entries.

There is currently no published data illustrating uptake by young people from different socioeconomic backgrounds, or by ethnicity.

Scotland: Vocational and Technical Qualifications in Computing Science at Level 5 and 6

VTQs are regulated and awarded by the SQA and can be delivered in schools or colleges. There are 39 awards that have been identified as being relevant to this analysis, covering IT/ICT, computing, and digital skills.

All of the data presented here is in the public domain and has been accessed here:

- Scottish Qualifications Authority, Statistics and information: ttps://www.sqa.org.uk/sqa/78673.html

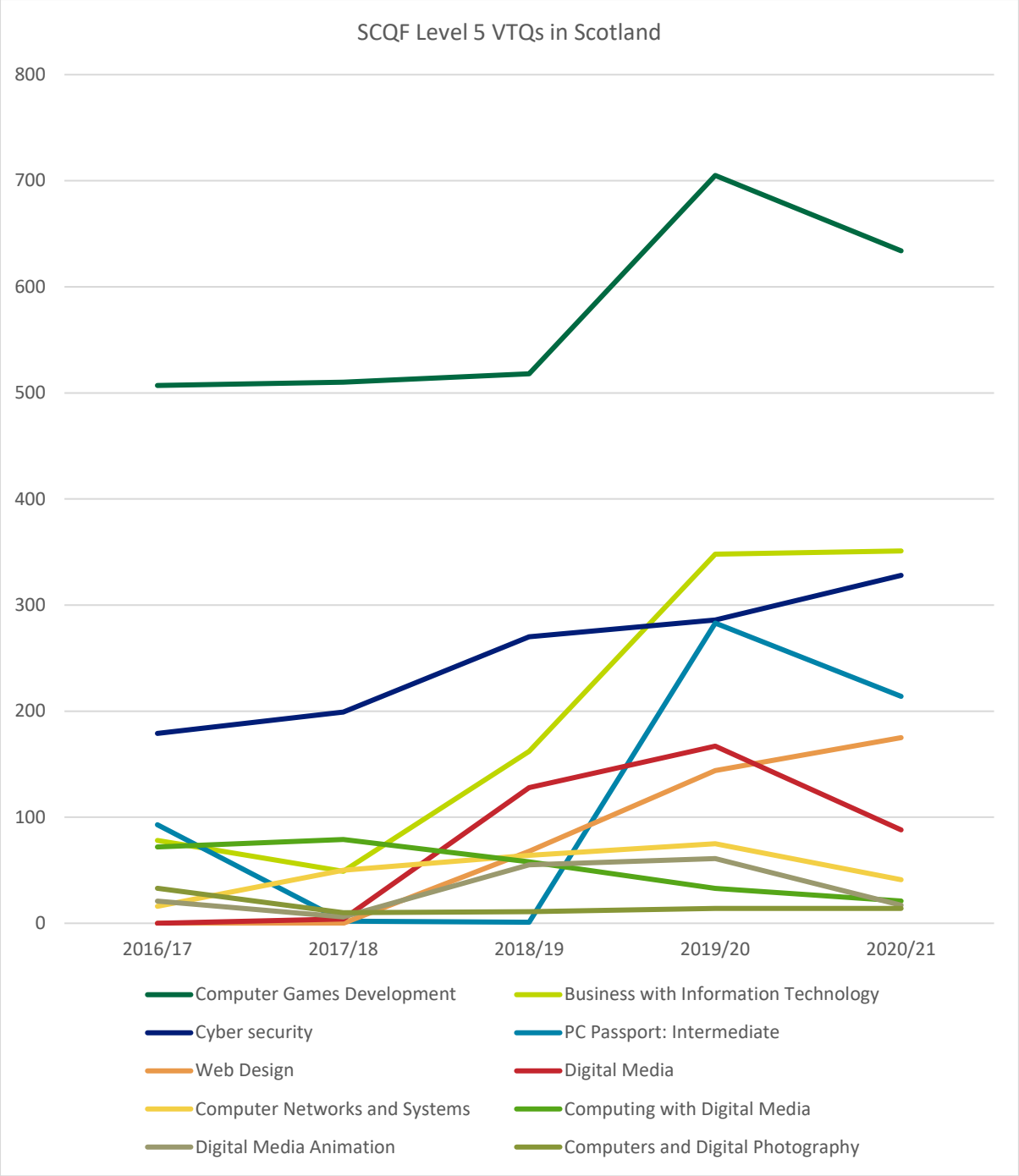
The currently active awards are set out in Annex 6 and the definitions of what the discrete types of award are as follows:

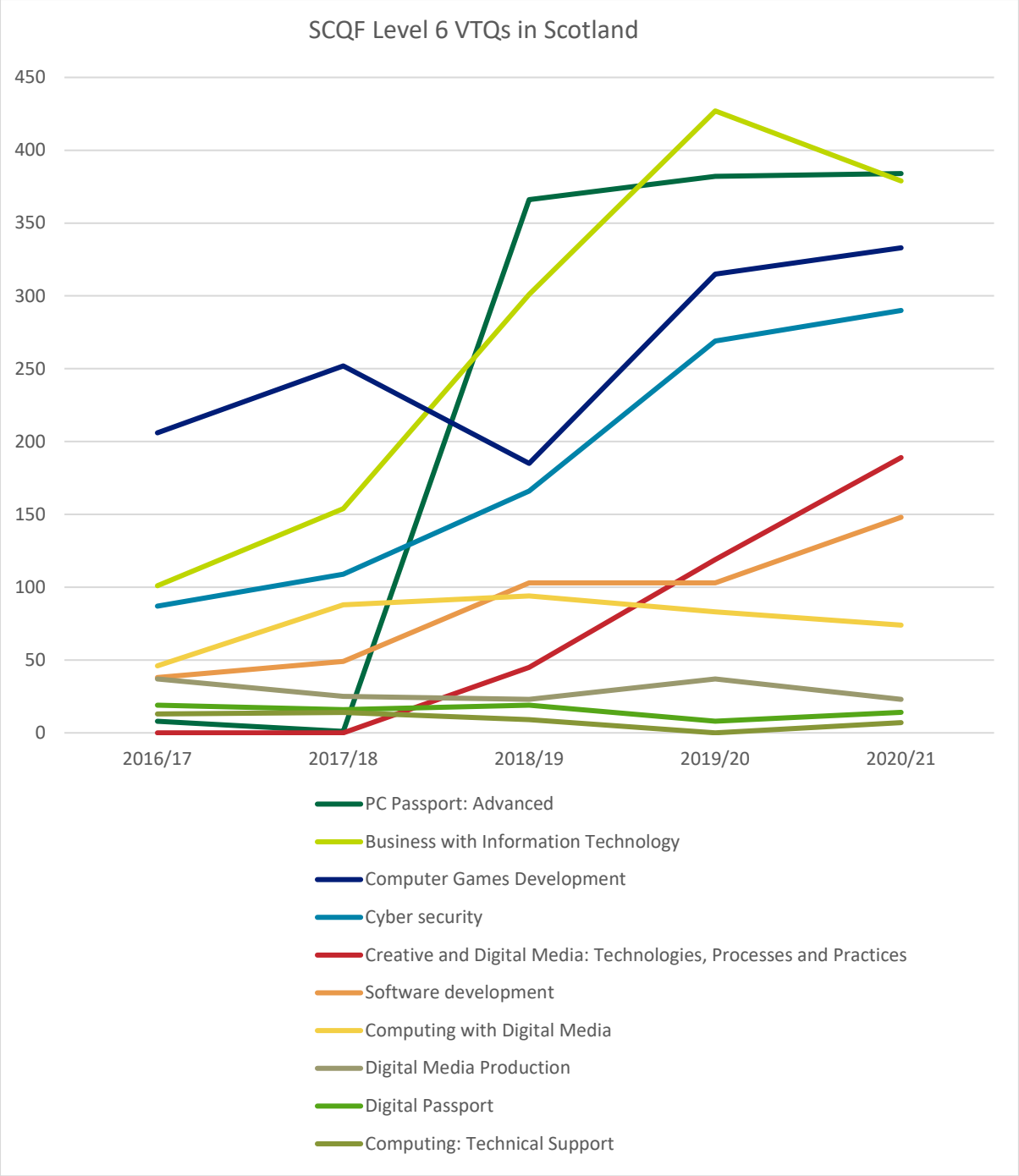
National certificates are directed at 16-18 year olds and aim to help prepare individuals for the world of work, or to support career development. They can also act as stepping stones towards further study.

National progression awards can be delivered by partnerships of schools, colleges and employers. They identify a discrete set of sector-specific skills (drawing on the National Occupational Standards that underpin Scottish and National Vocational Qualifications – S/NVQs).

Higher national units are the building blocks of Higher National Certificates and Diplomas (HNC/HND), awards that are employer-focused and can be taken at college or university.

The data, showing awards (which offers the most detailed data perspective) made to students, over a five-year period, is set out in the charts below.


SCQF Level 5 VTQs in Scotland
800
700
600
500
400
300
200
100
0
2016/17
2017/18
2018/19
2019/20
2020/21
Computer Games Development
Business with Information Technology
Cyber security
PC Passport: Intermediate
Web Design
Digital Media
Computer Networks and Systems
Computing with Digital Media
Digital Media Animation
Computers and Digital Photography



In 2021, the three most popular SCQF Level 5 and Level 6 awards (by attainment) were as follows:

Award	Number
Computer Games Development	634
Business with Information Technology	351
Cyber security	328

PC Passport: Advanced	384
Business with Information Technology	379
Computer Games Development	333

The data for awards in SCQF Level 6 'IT in Business: Word Processing, Spreadsheets and Databases: An Introduction' is not available for 2020 or 2021 at present. It has been in decline since 2015/16, but still saw 610 students gain the award in 2018/19 (easily placing it in the top three awards).

For the sake of comparison of scale, in 2021, the equivalent National 5 and Higher entries were 6,286 and 3,377 respectively in Scotland.

The ratio of male to female candidates follows some familiar patterns. For the most part male candidates predominate in these vocational awards, with some very strikingly high ratios of males:females (see SCQF 5, National Certificate, Computer Games Development for example). There are, out of the 39 awards, a small number (seven) awards where the pattern is reversed:

- SCQF Level 5, National progression awards, Business with Information Technology;
- SCQF Level 5, National progression awards, Computers and Digital Photography;
- SCQF Level 6, National progression awards, PC Passport: Advanced;
- SCQF Level 6, Higher national unit, IT in Business: Word Processing, Spreadsheets and Databases: An Introduction;
- SCQF Level 6, National certificate, Computer Arts and Animation;
- SCQF Level 6, National progression awards, Business with Information Technology;
- SCQF Level 6, National progression awards, Creative and Digital Media: Technologies, Processes and Practices.

It may be worth considering what characteristics of these awards (possibly, the potential for them to offer opportunities that are not tied to careers in computing) are that make them more attractive to female students than other digital skills options.

One additional observation concerns the pattern of awards made versus entries. If we look at the three most popular National Progression Award subjects by entry at SCQF level 5 in 2020 (Computer Games Development, Cyber Security, and PC Passport), the overall entries amount to 2,344. However, the awards (which are based on a pass/fail basis) range from 42% for males taking Cyber Security to 66% for females taking the PC Passport award. The success rate for females in these subjects, even though the male to female ratio can be as high as 9:1 for Cyber Security, is higher than for their male peers.

Some context

The Scottish Curriculum for Excellence (CfE) was introduced in 2010 after a long period of national consultation and its effectiveness was reviewed by the OECD in 2015 (53) and a second appraisal by the OECD has recently been published (54).

The CfE sets out to offer a broad, general, education and does so via a thematic curriculum, in which digital skills and Computing Science are located, with the latter being a specialist choice at age 14 and above. A recent review of how young people experience technologies within the broad, general education has noted that the use of the concept that ICT was present in the curriculum 'to enhance learning' had outlived its usefulness. Education Scotland will now

describe their approach as placing 'digital technologies at the heart of learning' (55) with an emphasis on the development of computational thinking.

There has been a decline in the number of teachers qualified to teach the more specialised qualifications, similarly a drop in the number of students taking such qualifications. Some argue that curriculum choices at National 5 and above are narrowing as a result of structural changes to the way in which the curriculum is mandated to operate (56), also pointing out that this may be to the detriment of young people in schools serving disadvantaged communities. Some have observed that this is a particular issue for the delivery of Computing Science (57) as well as for STEM subjects more broadly (58).

Responding to the needs of industry and to create qualifications that develop relevant skills, the SQA introduced Cyber security and Data Science National Progression Awards (NPA) in 2015 and 2019 respectively at Scottish Credit and Qualifications Framework (SCQF) levels 4, 5, and 6.[9] Typically NPAs focus on skills for employment and would generally feature in the curriculum offered by the further education sector, but in this case the SQA have been keen to promote it to schools too, to be studied alongside other National 5, Higher and Advanced Higher qualifications to complement the Computing Science curriculum. In 2020, the first year of assessment, 8 students took this (Data Science) award at SCQF level 5 (equivalent to National 5).

There is a clear development of a digital skills agenda in schools and colleges in Scotland, flowing from the 2011 and 2017 Digital Strategies (59 and 60) and the 2016 'Enhancing learning and teaching through the use of digital technology' report (61). However, the recent Scottish technology ecosystem review (3) was highly critical of the progress made, the framing of Computer Science in the curriculum and the stark under-representation of young women taking up the subject. Nevertheless, looking across the entire range of computing and digital qualifications and awards, it is possible to see the number of entries at least stabilising, although there is still a challenge in the way that the newer awards are viewed compared with Computer Science, in particular the parity of esteem between vocational awards and graded national courses. This is linked to the ways schools measure and compare their attainment (insight points) and the perceived value of courses with no exam.

It is likely that the ramifications of the recent OECD review of the CfE (54) will continue to influence the shape of the curriculum, its reach across subjects to all pupils and students, and the way learning outcomes are assessed for some time to come. This may provide an opportunity to revisit Computing Science and digital skills in Scotland and address some of the concerns set out by the Scottish technology ecosystem review (3).

[9] https://www.sqa.org.uk/sqa/91458.html NPAs do not attract as many SQCF credit points as graded national courses at the same level.

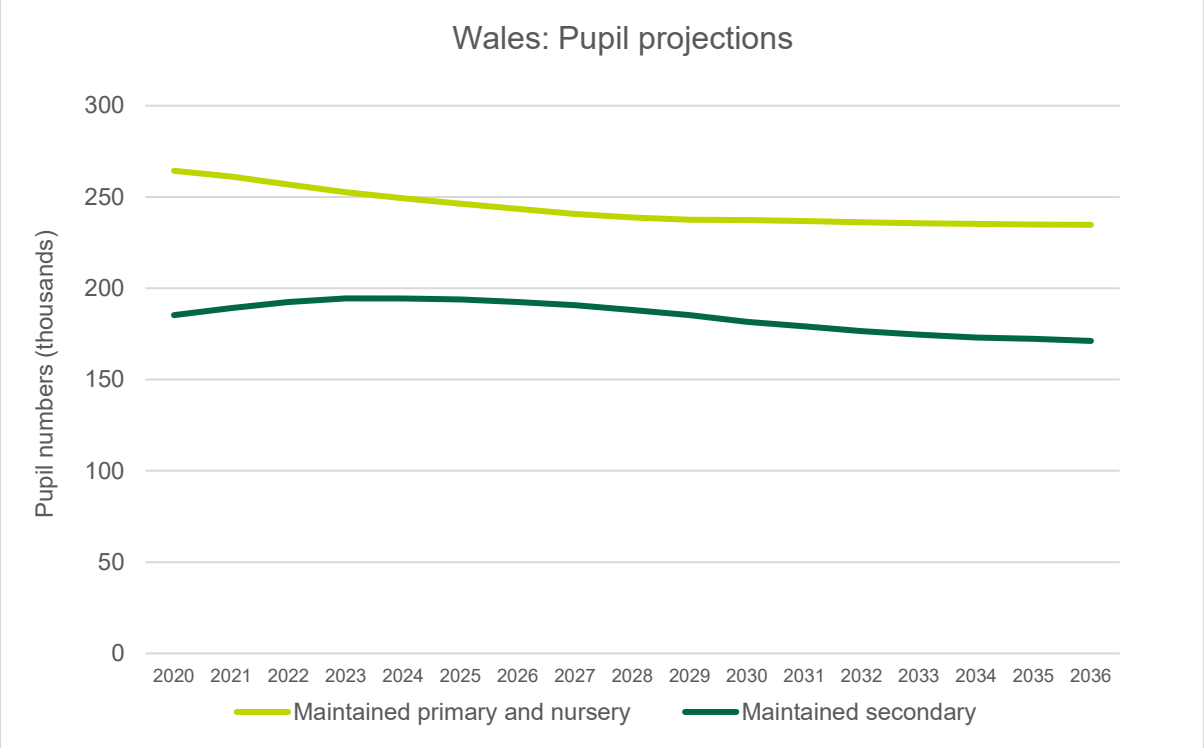
Wales: Computer Science GCSE, AS, and A Levels

The size and shape of the secondary and primary sector (11)

	Primary (maintained)	Secondary (maintained)
Schools	1,219	182
Students	272,339	174,133
Teachers	11,789	10,138

There are around 32,055 students in each secondary year band in Wales

Pupil projections for Welsh schools suggest that primary numbers are slowly declining, and secondary student numbers will follow suit around 2025.



(62)

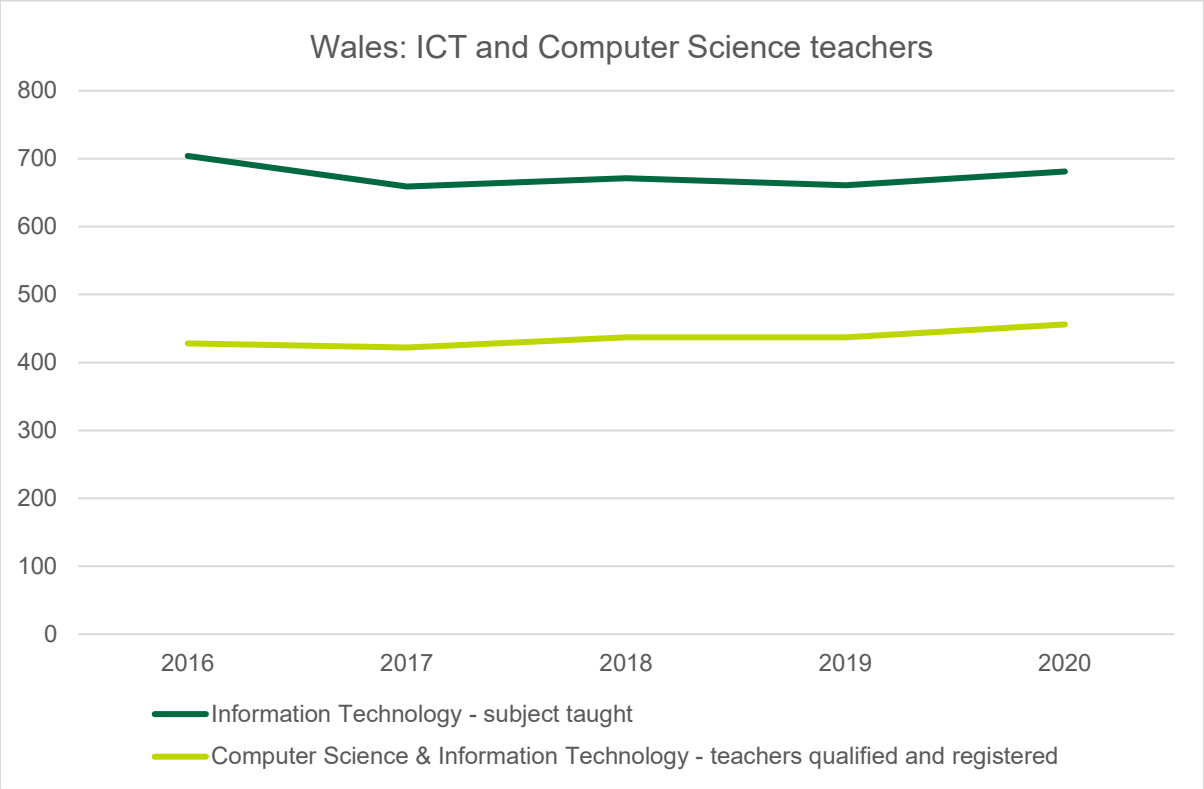
The current curriculum and assessment

This section attempts to capture in as summative a form as possible, the key characteristics of the main examinations currently available in Wales, including the curriculum focus, assessment methodology and coding languages preferred.

Subject	Award	Level	Awarding body	Curriculum focus	Assessment approach	Language preferred
Computer Science	GCSE	2	WJEC	Understanding Computer Science Computational Thinking and Programming Software Development	Written and on-screen examination and a practical project. The latter comprises 20% of the overall marks.	Basic derived languages (e.g. VB.NET, Small Basic, QBasic), C derived languages (e.g. C, C++, C#, PHP, Python, Pascal/Delphi
Computer Science	AS	3	WJEC	Fundamentals of Computer Science Practical Programming to Solve Problems	Written and on-screen examination.	Visual Basic.NET, Python, Java
Computer Science	A level	3	WJEC	Programming and System Development Computer Architecture, Data, Communication and Applications Programmed Solution to a Problem	Written and on-screen examination, plus a project that contributes 30% of the overall A level marks.	Visual Basic.NET, Python, Java

The teaching workforce

The most recent teaching workforce statistics from the Education Workforce Council (EWC) – the teacher registration authority in Wales (63) – offers a picture of relative workforce stability in computing and ICT although it is perhaps the case that ICT is being handled by non-specialists in many schools.



(52)

This data does reveal a particularly interesting phenomenon, which may be a result of the different definitions used to capture staff information on the EWC register. As the chart shows, there appears to be notably more teachers teaching ICT on the register than qualified to do so.

The recruitment of new Computer Science teachers continues to be a priority (it has been since 2013/14), with incentives offered (up to £20,000) to those who can train to teach Computer Science (64). It has been especially challenging recruiting and retaining Welsh language Computer Science teachers, to support high-quality provision in Welsh medium schools. The ITT/E targets for 2020/21 include 50 places for Information Technology, down from 54 in 2019/20. Initial teacher training/education targets in Wales are missed regularly, particularly in priority subjects such as STEM; this is a particular challenge in preparation for the new Curriculum for Wales, which will phase in from September 2022.

There are currently no formalised ways of developing additional skills qualifications for secondary teachers in Wales. The EWC promotes professional development for teachers, including signposting subject support. Teachers in Wales may also access training and development via a wide range of bilingual initiatives in computer science such as through the pan-Wales Technocamps[10] project

There have been changes to the way in which ITT/E recruitment data is presented recently (65 and 66). The intake targets show only Information Technology teachers for 2020/21 and

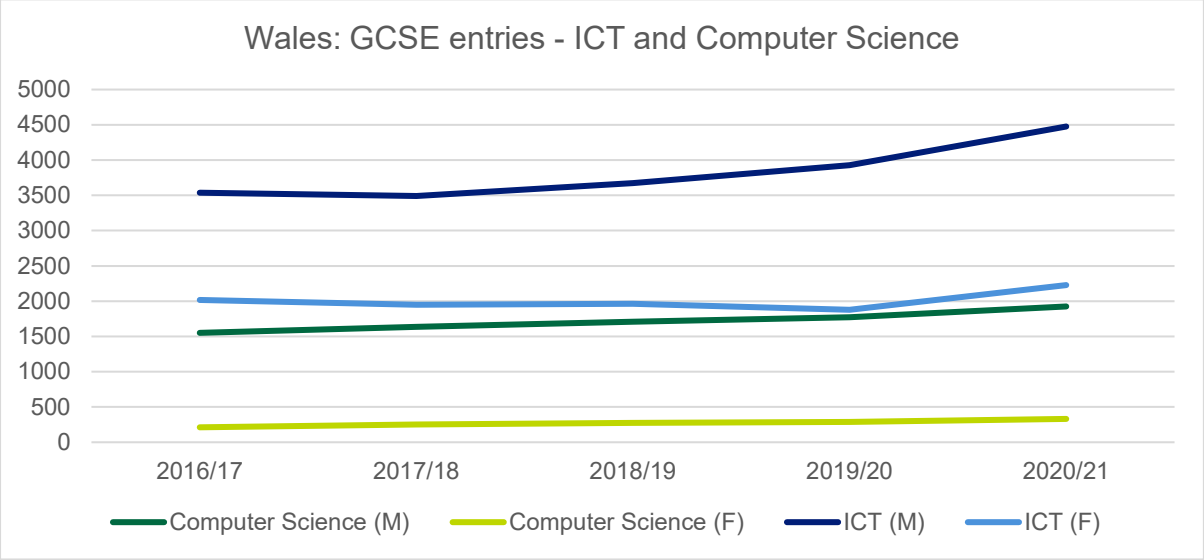
[10] See: https://www.technocamps.com/en/

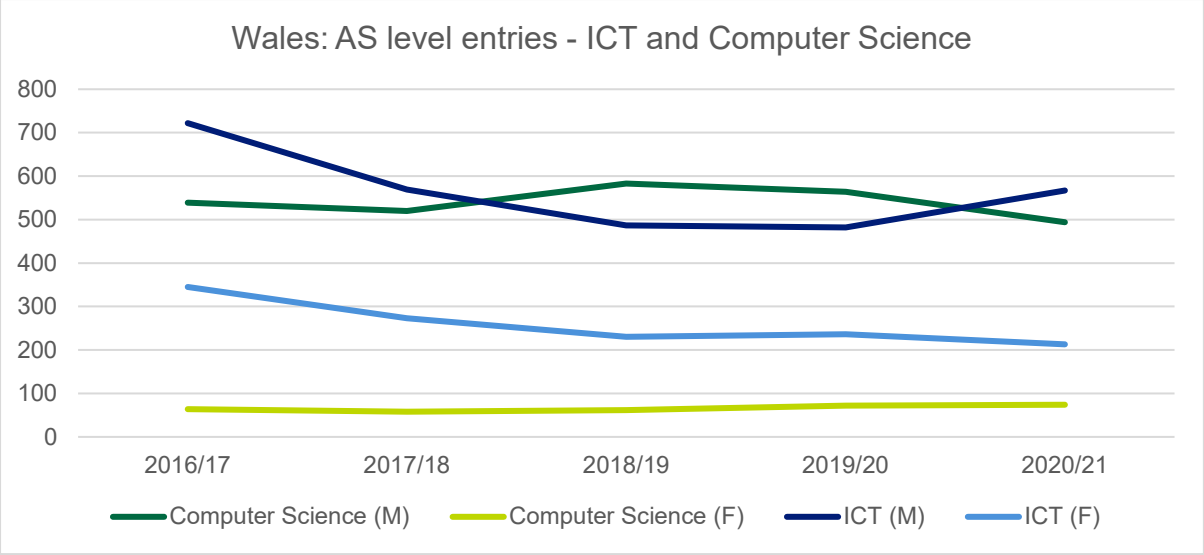
2021/22 (50 in each year). The recruitment data (actual intake) for 2020/21 is split into Information Technology (18 students) and Computer Science (9 students). This looks notably below the ambition set out for recruitment. It is currently not possible to present a coherent time series.

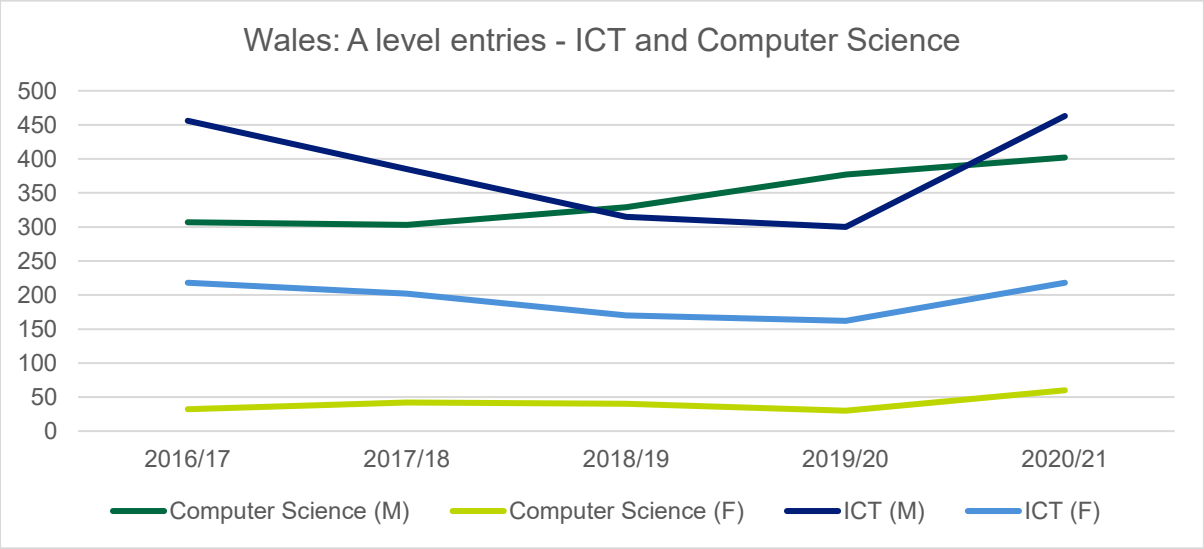
Attainment and participation

Uptake of ICT and Computer Science in Wales is mixed. The GCSE and A level interest in Computer Science is growing, and it is almost as popular as ICT at A level. ICT is dropping away at AS and A level, whilst uptake remains relatively stable at GCSE. The Welsh Government data for GCSE and A-level outcomes merges Computer Science and ICT entry and attainment data and it is difficult to untangle the impact on the uptake figures of further education colleges and the independent sector. Furthermore, with the proposed significant changes to the assessment and qualifications regime in Wales as part of the wider Curriculum for Wales reform (as per Qualifications Wales' "*Qualified for the Future*" (67) work), there will be a wide offering of new Level 2 qualifications ready for learners from 2025 onwards.

For the sake of comparison, data for England, Northern Ireland, and Wales is drawn from JCQ annual statistical bulletins.

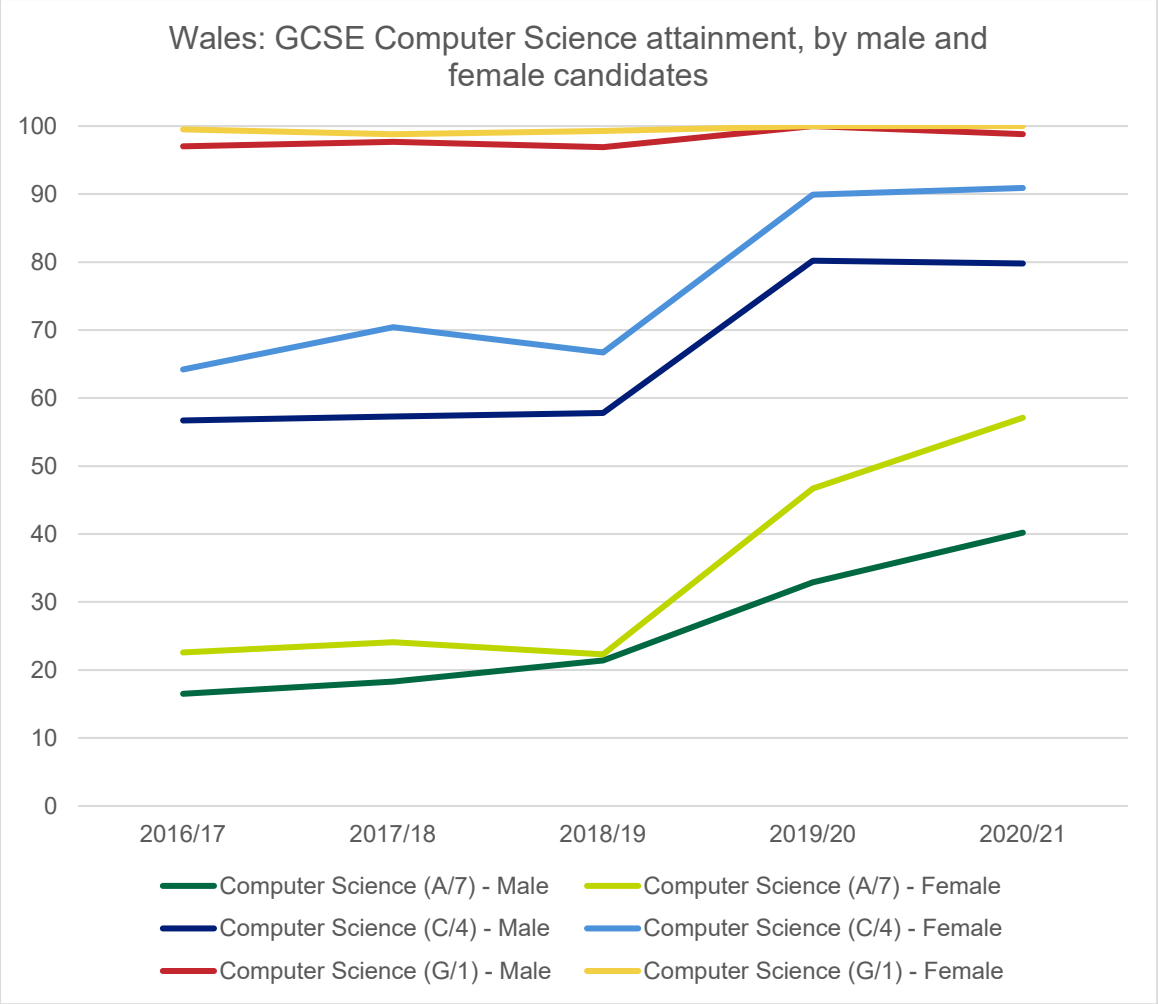


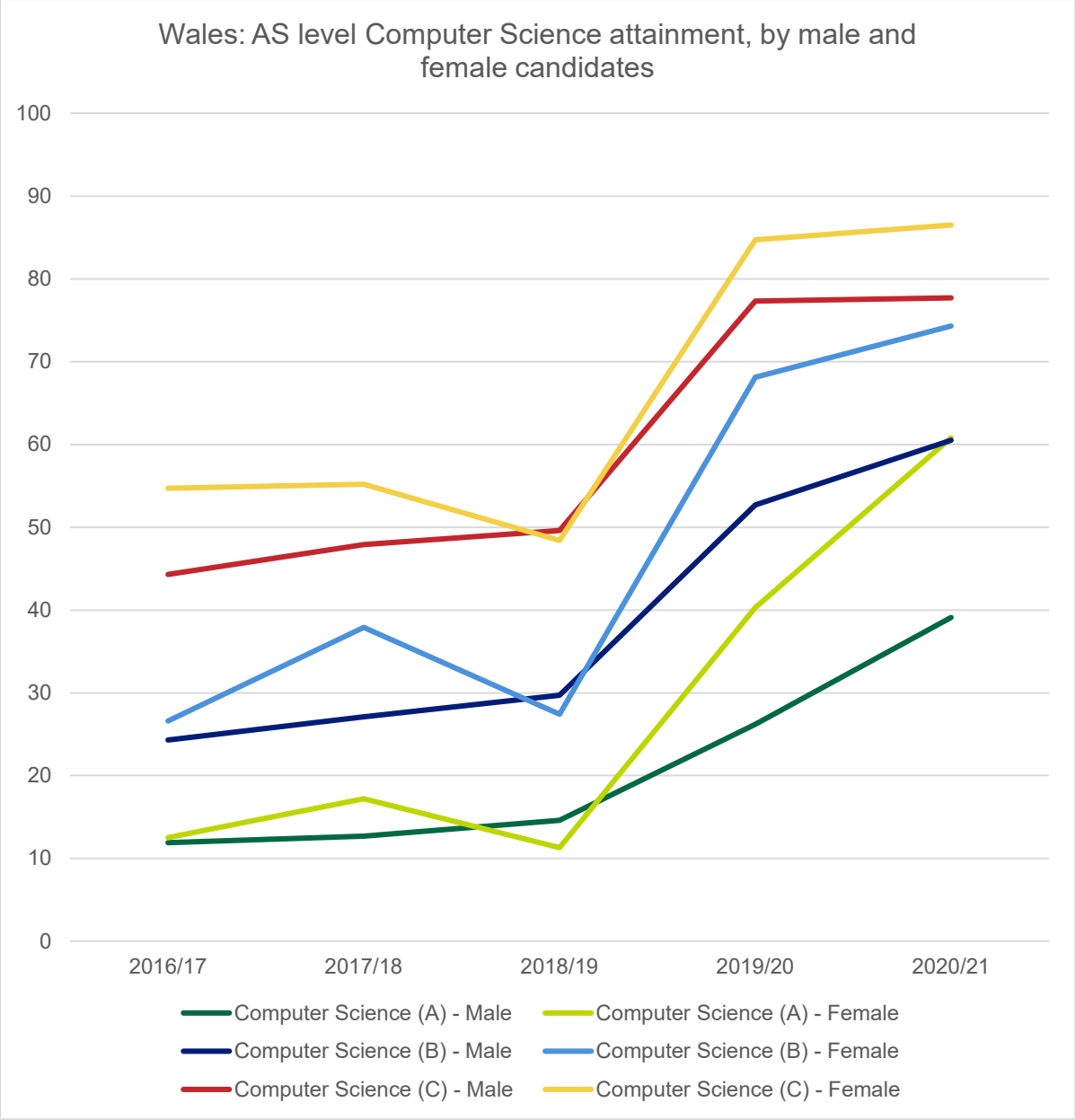


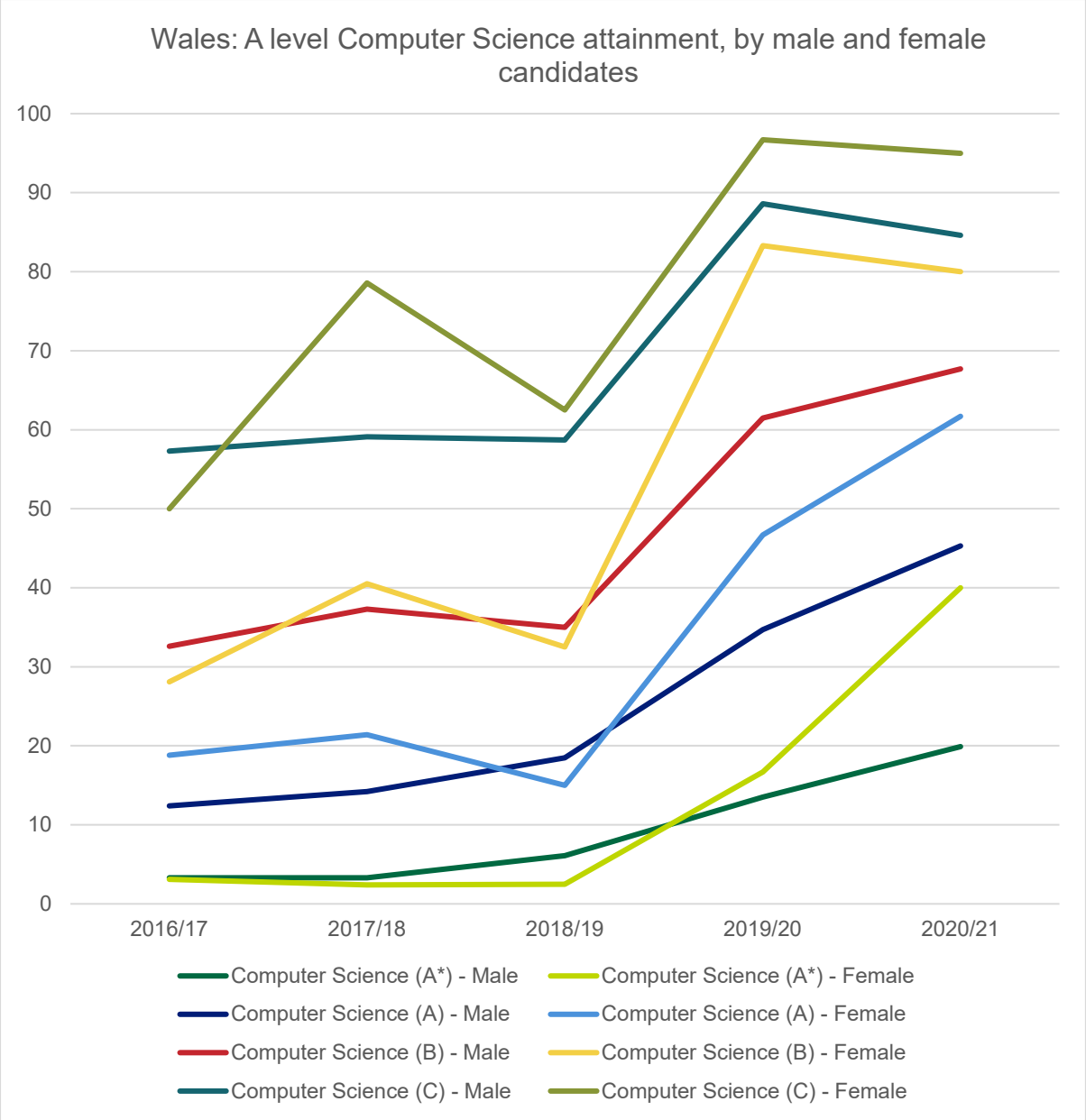


In 2021, JCQ reporting merged Applied A/AS levels into the main A/AS levels tables for data in Wales (68). This may have contributed to the small increases in ICT in the most recent year.

The following charts set out Computer Science attainment by male and female candidates over the past five years (cumulative percentages).


Wales: GCSE Computer Science attainment, by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
2020/21
Computer Science (A/7) - Male
Computer Science (A/7) - Female
Computer Science (C/4) - Male
Computer Science (C/4) - Female
Computer Science (G/1) - Male
Computer Science (G/1) - Female


Wales: AS level Computer Science attainment, by male and female candidates
100
90
80
70
60
50
40
30
20
10
0
2016/17
2017/18
2018/19
2019/20
2020/21
Computer Science (A) - Male
Computer Science (A) - Female
Computer Science (B) - Male
Computer Science (B) - Female
Computer Science (C) - Male
Computer Science (C) - Female



The male and female rates of interest are starkly different, with as many as 13 male participants to every female one for Computer Science A level whilst it is broadly two to one for ICT. Clearly, there is some strong signalling about the subject that is either galvanising or suppressing interest.

Computing GCSE accounts for 7% of the cohort (2,256 candidates), ICT GCSE for 20% if the cohort (6,704 candidates). Overall, ICT/Computing was the 10th most popular GCSE (19% of the cohort).

ICT/Computer Science was the 13th most popular A level in Wales in 2018/19 (5% of the cohort (462 Computing candidates, 681 ICT candidates)) with almost twice as many students taking Physics.

There is currently no published data illustrating uptake by young people from relatively advantaged and disadvantaged backgrounds, or by ethnicity.

Wales: Vocational and Technical Qualifications in Computing at end of Key Stage 4 and 5

In Wales, according to the *Qualifications in Wales* database (69), there are currently 70 regulated awards available in subject related to ICT at Levels 2 and 3 (21 Level 2 and 49 Level 3). These awards are overseen by eight awarding organisations:

- Agored Cymru
- Ascentis
- BCS, The Chartered Institute for IT
- City & Guilds
- OCR
- Pearson Education Ltd
- TLM - The Learning Machine
- WJEC-CBAC

The currently active awards are set out in Annex 7.

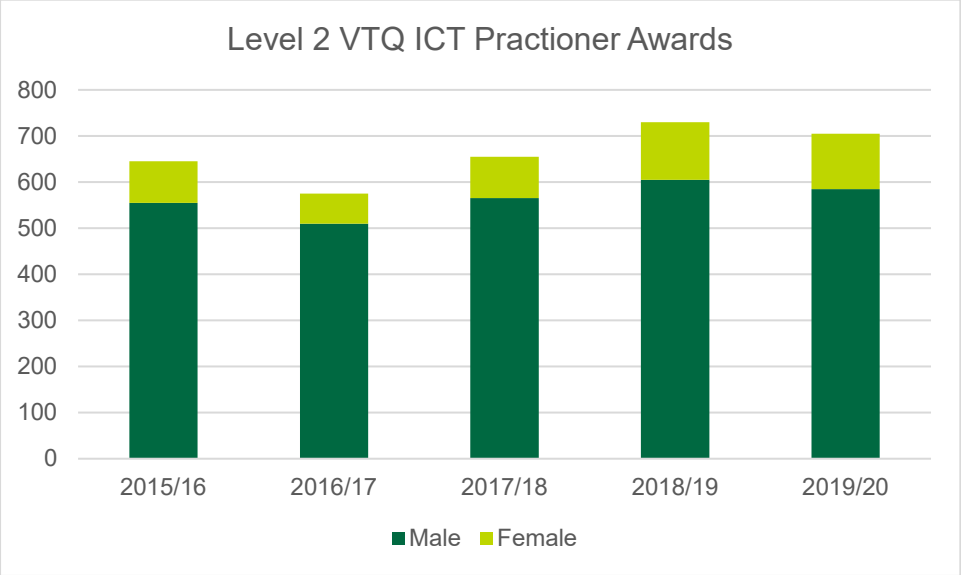
All of the data presented here is in the public domain and can be accessed here:

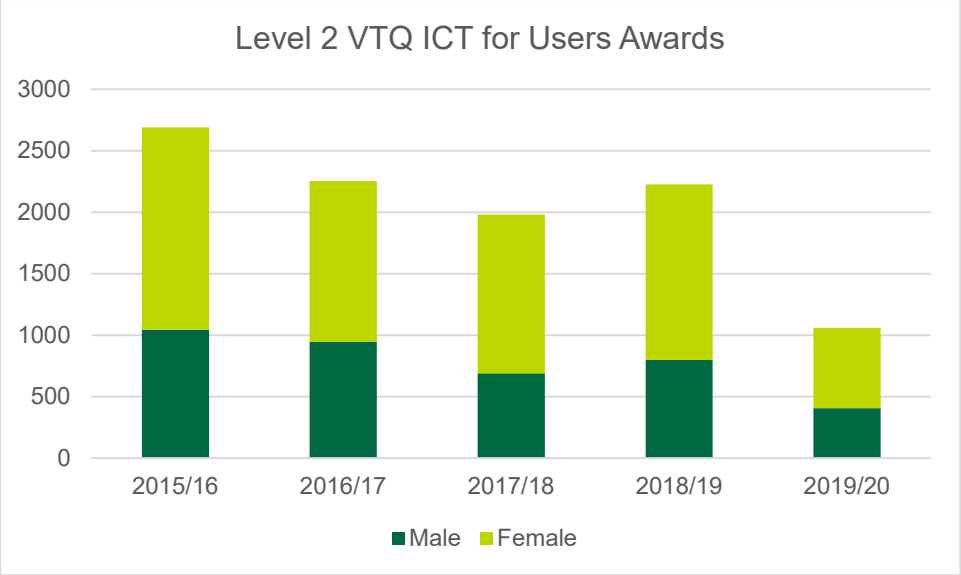
- StatsWales, Learning activities at further education institutions by subject and credit level: https://statswales.gov.wales/Catalogue/Education-and-Skills/Post-16-Education-and-Training/Further-Education-and-Work-Based-Learning/Learners/Further-Education/learningactivitiesfurthereducationinstitutions-by-subject-creditlevel

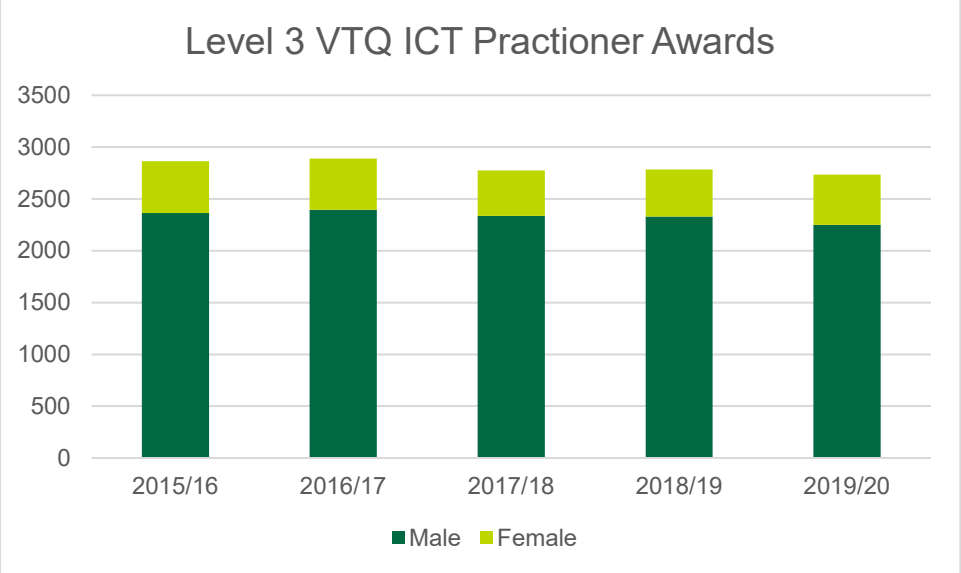
The data set may include awards taken in the further education system by adult learners.

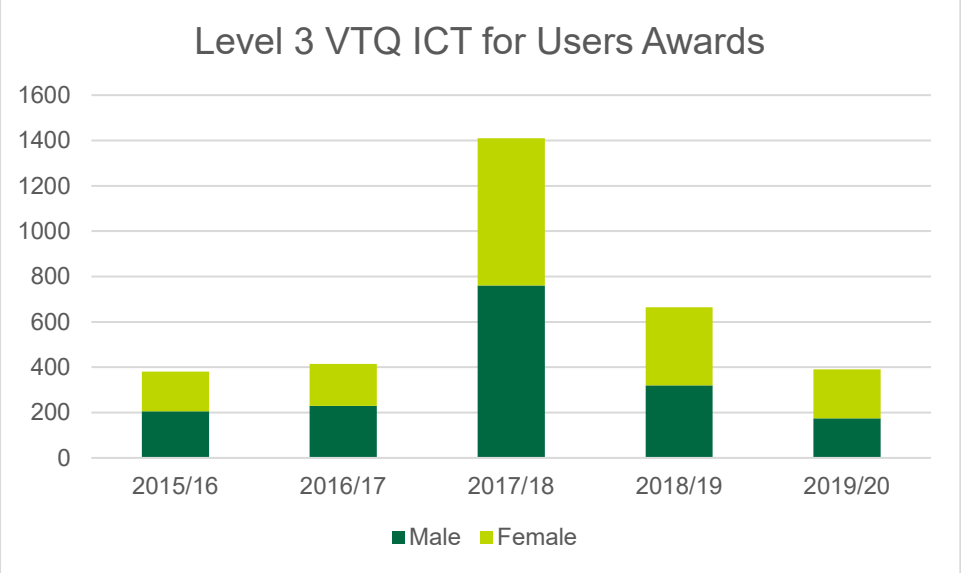
Whilst it is possible to identify many different qualifications, reporting is an aggregate level – ICT for practitioners and ICT for users.

The following charts show the VTQ awards made across five years in Level 2 and 3 qualifications, separately by males and females.









In 2020, the equivalent GCSE and A-level entries were 7,867 and 869 respectively in Wales.

The ratio of male to female students has been closing at Level 2 across five years – from 6.2 down to 4.9. The ICT for users Level 2 course has always had more female students that males – 1:0.6.

	M:F	M:F	M:F	M:F	M:F
Subject	2015/16	2016/17	2017/18	2018/19	2019/20
ICT Practitioners	6.2	7.8	6.3	4.8	4.9
ICT for Users	0.6	0.7	0.5	0.6	0.6

At Level 3, the pattern is similar, albeit with consistently more male students taking the ICT for practitioners option (around 5:1), there are now more female students gaining the ICT for users awards.

	M:F	M:F	M:F	M:F	M:F
Subject	2015/16	2016/17	2017/18	2018/19	2019/20
ICT Practitioners	4.7	4.8	5.3	5.1	4.6
ICT for Users	1.2	1.2	1.2	0.9	0.8

Some context

The computing curriculum has evolved over at least a decade in Wales, with a far-reaching and influential review of ICT in 2013 (70) which set the ball rolling for an overhaul of the curriculum. A principal recommendation was the separation of ICT into Computing (with Computer Science and Information Technology covered) and attention given to creating a digital literacy framework which would be woven into education from the Foundation phase and sit alongside numeracy and literacy as statutory cross-curricular skills. The 2015 independent *Successful Futures* review of curriculum and assessment in Wales (71) took up and endorsed these messages.

A bilingual Digital Competence Framework (to be the responsibility of all teachers, as the 2015 review advised) and covering up to and including Year 11 was developed and made available to schools in 2016 (72). Alongside this, there has been a detailed review (by Qualifications Wales) of the qualifications and assessments that are currently available to young people (73). This has, as per the Scottish technology ecosystem review (3), noted the limitations of an existing curriculum that is often delivered by non-specialists and set a clear direction towards a suite of qualifications that are current, relevant to the future, and assessed in ways that are credible, relevant, and challenging yet engaging. Qualifications Wales approved new GCSE and AS/A level qualifications in Digital Technology (launched in 2021 and 2022 respectively).

The WJEC awarding body will concurrently review the existing GCSE and AS/A level awards. There is a separate but linked digital strategy for non-school post-16 provision (74).

Informal and extra-curricular activity

A common theme for all of the jurisdictions examined here has been the need to attract young people to computing and coding, with female students a particular focus. In some cases, there has been a deliberate attempt to link schools' endeavours to informal and extra-curricular work (see, for example, in Wales – 75)). The Northern Ireland Assembly also noted the potential usefulness of such activities (42).

Several authors ((3) for example) reflect on the need to position computing as one of the sciences, standing as part of the STEM community. This is an apt comparison to make, as the teaching and learning challenges in school that have faced the STEM community for several decades are also reflected in engagement and participation in computing and related activities.

STEM enrichment and engagement interventions are many and various. In 2004, the National Audit Office estimated that there were 470 different activities with an associated expenditure of £35m (76). These typically aspire to positively interest children and young people in STEM but are all too often not set up to be evaluated or their impact understood. This really limits our ability to understand what works (and, indeed, what does not work).

The number and range of informal and extra-curricular activities concerning computing and coding is extensive[11] and there are some high-level interests in them, and there is a growing interest in getting below the surface of these and appraising their effectiveness.

For example, Code Club commissioned the National Foundation for Educational Research (NFER) to study their impact, finding that it worked well in developing coding skills (77) but had no discernible impact on computational thinking. CoderDojo Scotland have looked at ways of encouraging female students to participate in one of their 23 Scottish clubs and established, almost counter-intuitively that female-only clubs did not help to increase participation whereas using the right language (amongst other things) to describe the clubs did (78). Digital Schoolhouse work closely with schools and have presented a very honest appraisal of where they are able to make a difference and the barriers they might face when trying to blend their offer with what happens in schools (79). Technocamps works with schools across Wales in both English and Welsh, engaging with learners of all ages to change perceptions of computer science, as well as supporting the professional development of teachers.

There are very few of the many, many, activities and groups that are setting out to increase diversity in the computing and digital communities that have clearly identifiable objectives that can help to understand whether or not they are having they effect they wish. They should be encouraged to do so, as they may be genuinely making a difference and others may learn from this. The National Centre for Computing Education has launched a series of research trials, one of which is focused on non-formal learning. Each four-year trial is aimed at generating evidence to help improving the gender balance in computing (80).

The importance of role-modelling, mentoring, and signalling has been identified time and again as a factor in encouraging under-represented groups to participate in STEM activities and study (81). Tackling these issues is not something that often results in an instant result, so policy and practical work may require long-term engagement and good alignment between the aims of schools and the informal sector.

[11] See for example https://www.digitalxtrafund.scot/directory-of-resources/

Conclusions and full recommendations

There is a host of information and many perspectives to be gleaned from looking at how computing education is handled in the latter stages of secondary education in the four nations of the UK. There are different definitions and approaches, for example Northern Ireland aiming for a digital technology space, recognising the technical and creative tracks this may lead to. Others seem to be tackling the issue from the perspective of a tighter definition of Computer Science/Computing Science, with the curriculum and qualifications in England looking more tightly linked to this approach than elsewhere.

Participation rates appear to be holding up or growing, although it is harder to comment in some cases — such as Wales and Northern Ireland — where new curricula and qualifications are bedding in. In England, Computer Science entries have grown to replace the older ICT qualification but may have reached a plateau and are still below the 2014/15 peak of 98,908. The Computer Science GCSE is available in around 77% of secondary schools in England, but this figure can mislead as, we know that the percentage of pupils that the qualification is available to is actually far higher. Scotland could until 2021 be seen as an outlier here, with entries for Computer Science falling at all levels. However, this may, to some degree, be being offset by uptake of a wider range of newer and digitally-focused awards and an upturn in mainstream entries.

This is important, as many young people have to make choices that do not involve typical A level or Higher routes (for example) and their potential presence in a digitally-skilled workforce (or in apprenticeships, or further and higher education) could be notable. However, obtaining a clear, longitudinal and comparable set of VTQ perspectives is challenging. What we can see is that there appear to be very few consistent patterns or trends in the data relating to uptake and awards across to four nations:

- England – declining popularity of ICT/digital VTQs at RVQ Levels 2 and 3. Some interest in coding-based options and business-related approaches. The ratio of male:female participation/awards worsens markedly from level 2 to Level 3.
- Northern Ireland – no areas of sustained increase. No perspective on male:female participation.
- Scotland – some interest growing in computer games development and business-related ICT awards, and a narrowing of the gulf between male and female uptake of these options (although this is not the case for the increasingly popular cyber security).
- Wales – generally declining participation in ICT/digital VTQs, possibly underpinned by the move away from the ECDL options. ICT for practitioners at RQF Level 3 is growing a little, but there is still a poor balance between male and female participation.

The scale of uptake of VTQs across the four nations is, by and large, small (and reducing) by comparison with the numbers taking more academic options and many of the large number of awards available are arguably quite niche.

All of the UK nations in this study have a long-standing problem with the balance of male:female participation in whichever variant of the subject they are teaching and whether in academic or vocational domains. Whilst male:female ratios of 2:1 were not untypical of the older ICT curricula, the move to a more computing-focused (even digital technology-led) approach has seen the imbalance grow: in excess of 10:1 in some cases, but more regularly around the 5-6:1 level. In subjects such as physics and economics, there is a greater emphasis on role-modelling to try to address long-established participation imbalances, and many of the informal Computer Science endeavours are working very hard to make an impression in this space.[12] There may be lessons to be learned from some of the VTQs where a small number of

[12] https://dresscode.org.uk/ and https://linktr.ee/codingblackfemales for examples

topics show a better balance or, indeed, from the Computer Science developments in Ireland. This may be linked both to the way the subjects are still perceived and even their status alongside other STEM subjects.

The recent World Skills UK report on the digital skills gap (82) also resonated with what arose from the VTQ analysis presented here: declining uptake[13] and a strong gender imbalance. This report also intimated concerns with a mis-match between what the system might offer and what employers and learners want and need. In the analysis presented here, this may be seen as a relatively strong uptake of digital skills related to business and applications, with less interest in creating digital systems.

It is, of course, difficult to compare 2021 and 2020, and with the previous years, as in each case the way in which assessment outcomes have been derived has been different. However, as GCSE at 7 or Grade C (including National 5) and above is often seen as the gateway to study at the next level (A level, AS level, Higher), it will be interesting to see if (as more students in 2021 have these grades) more students and their teachers feel able to tackle Computer Science and its equivalents beyond age 16.

A further issue, which is exemplified by the data from Scotland but is common to all jurisdictions (although the picture in Northern Ireland is less clear), is the relative absence of qualified teachers in schools and the difficulties in recruiting enough new teachers. In England, in spite of the presence of generous bursaries, only 70% of the target from teacher recruitment has been met across the past five recruitment cycles, and the recent uplift may be a one-off response to the pandemic and economic uncertainty.

If, as in other STEM subjects such as mathematics, the shortages are concentrated on schools serving disadvantaged communities, then the issue of equity of access may compound the lack of female participation in the subject. The Scottish technology ecosystem review (3) has noted the curriculum on offer in Scotland could be seen as being designed to be delivered by non-specialist teachers, something that may limit the appeal of the subject and send an off-putting signal to students. It is hard to see how the subject can prosper in the absence of a sufficiency of appropriately qualified teachers.

These issues matter regardless of the scale of Computer Science education in the UK, but that statement alone raises two key, and as yet not easy to answer, questions:

- How much is enough?
- Is the drive for digital skills about specialists (for example, coders) or more generally applicable digital skills?

The desire to grow the subject in schools, to accord it status with the other sciences, to make it attractive as a way into careers that might appeal to a good cross-section of young people is self-evident in any of the country-level and UK-wide policy documents. Indeed, in recent years BCS has been promoting the idea that there is a need to triple the number of young people taking up the Computing qualifications at Key Stage 4 in England (with concomitant changes to teacher supply and professional development).[14] Growth of this scale may well be necessary, but as this report notes, there are some common issues with male:female participation that will need to be addressed whether or not numbers develop from their current levels at GCSE, National 5 and beyond.

There may be several issues that limit growth (the relative absence of female students being a major limiting factor), for example the attractiveness of the subject (and an understanding of

[13] They also note the relative paucity of appropriate apprenticeship options.
[14] BCS, The Chartered Institute for IT submission for Budget representation, September 2017

where it can lead to) – its relevance to 'people like me'. It is also possible that the route between subject levels is seen as more forbidding or challenging than it should be.

The participation (by cohort) in England has remained quite static at around 13% over the past five years – broadly typical of the other nations, with the exception of Wales where the proportion of the cohort taking ICT remains almost three times than that taking Computer Science (7%). Equally, the ratio of GCSE:A level or National 5:Higher entries is quite revealing in terms of 'conversion' of an initial qualification into a higher award. This has averaged about 7:1 in England in recent years whilst in Scotland it is about 2:1 over the same five year period.

There are some indications that young people, armed with good information about the potential for choosing some subjects over others, change their perceptions of subjects and amend their choices (83) so even at the current GCSE/National 5 engagement levels, there may be more to be done (especially in England) to show the career and study options that open up to those taking a higher level computing qualification.

Interestingly, the latest public data concerning uptake of Computing in UK higher education institutions (2019/20) shows that it is the 6th most popular degree group (and second only to Engineering in terms of the suite of STEM subjects) with 34,945 first year undergraduates. This is considerably more than the 22,699 students who emerged from UK schools that year with higher-education-relevant computing qualifications. However, as in the school sector, the male:female student ratios have been stable at around 4:1 since 2014/15 (84).

Overall, whilst there are still questions about what sufficiency looks like, and how to make the supply of students grow and diversify within the school sector, there are also ongoing challenges in addressing the balance between school, and further and higher education supply (let alone apprenticeships). Addressing these issues of attractiveness, scale and aim, particularly with regard to the evolving labour market, are questions BCS and a range of partners and stakeholders may wish to return to.

Gaining a useful perspective on the size and shape of the academic, vocational and technical qualifications market is challenging. For example, posing what are superficially straightforward questions about the number of students applying to take any of the vocational awards, and understanding how representative the students are, has unearthed a number of difficulties that will need to be addressed for any future analysis. The VTQ datasets, in England, Northern Ireland and Wales cover potentially different age groups of students and rarely offer any data more granular than the total number of students taking each award in any year. This is less problematical with access to academic outcomes data but examining issues beyond male:female participation (for example, access across regions) is still challenging with publicly available data. This makes understanding equity of access, diversity and inclusion issues problematical.

Recommendation 1: In terms of equality, diversity, and inclusion (EDI), a task force should be established with representation from the four UK nations to understand, examine and report on access and participation in Computer Science qualifications of learners across key demographics, with the aim of learning from what works and disseminating best practice. Administrations, awarding organisations, and regulatory bodies should work with BCS to monitor whether headline qualifications and awards are available to all pupils and students.

Across the four nations, there is an emerging diversity of terminology used to describe qualifications and awards. Looking across the curricula of (say) the Computer Science GCSE and the National 5 Computing Science qualification reveals some subtle distinctions in structure, coverage and assessment. This is further complicated by newer awards covering

subjects such as Digital Technology. It is a recurrent challenge for students, their parents and carers, employers and others to understand the qualifications landscape and know what terminology really means and what to expect from differently titled awards.

Recommendation 2: That regular reviews to clarify the Computer Science and digital skills ecosystem in the UK are conducted, setting out what characterises different awards and qualifications and what the distinctions are (where these exist and are notable)

Looking at access and attainment by (say) socioeconomic status or ethnicity (or, indeed, consider the intersectionality of factors such as these) requires access to more sensitive and granular data but understanding this is critical to developing digital skills for young people. This – access to reliable, comparable, granular data – is perhaps the most pressing issue that the development of this field faces. In order to reform, develop and critique policy there is a need to understand as openly as possible what the data tells us. To support this, BCS should set out its data goals and use this to take forward a regular and rolling 'state of play' perspective.

Recommendation 3: That administrations, awarding organisations, and regulatory bodies work closely with BCS to monitor and publish data concerning uptake and participation patterns relating to computing and digital qualifications and awards. It is anticipated that this report becomes an annual mark of progress and representation in Computer Science education and digital skills and that it can iterate and build as new data sets become available.

Recommendation 4: Administrations, awarding organisations, and regulatory bodies should engage closely with BCS to establish more detailed data overviews of Computer Science and digital skills qualifications to explore the impact of other pupil and student characteristics on uptake and attainment

Recommendation 5: An engagement group should be developed to clarify the scale of the digital skill labour market and the nature of the skills required so that best use can be made of increasingly limited resources.

Annex 1 Terminology

Any discussion of computing skills (wherever these are developed – in school, in work, at university) should take care to be precise, where possible, about what terminology is employed. In a 2016 international review for the National Council for Curriculum and Assessment (NCCA) the authors noted that it as critical to be clear about 'distinguishing between Computer Science and Information Communications Technology, when establishing a Computer Science programme to purposely cultivate a better understanding about the nature of Computer Science' (85).

The Royal Society tackled the lack of clarity in use of nomenclature in 2013, observing how the National Curriculum in England National Curriculum in England 'lumps together a range of aspects of Computing including Computer Science, Information Technology and digital literacy under the heading 'ICT'' (86). Their 2017 review of computing education (6) helpfully set out some good definitions of terms that can often be used interchangeably:

Information technology means the assembly, deployment and configuration of digital systems to meet user needs for particular purposes.

Digital literacy means the basic skill or ability to use a computer confidently, effectively and safely, including the ability to use office software such as word processors, email and presentation software, and the ability to use a web browser and internet search engines. Digital literacy also includes understanding the morality and ethics of the personal and societal implications of digital technologies. These are the skills that secondary school teachers of other subjects should be able to assume that their pupils have, as an analogue to being able to read and write.

Computer science should be interpreted as referring to the scientific discipline of computer science, covering principles such as algorithms, data structures, programming, systems architecture, design and problem-solving.

Digital literacy is often also described as **digital competency** (87 and 88), whilst the European commission (89) notes that computer science can also be described as **computing education** or **informatics**.

The International Telecommunication Union (ITU) defines the wider realm of '**digital skills**' as: The ability to use ICTs in ways that help individuals to achieve beneficial, high-quality outcomes in everyday life for themselves and others… [and to] reduce potential harm associated with more negative aspects of digital engagement.[15]

[15] https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2018/MISR-2018-Vol-1-E.pdf

Annex 2 Qualifications frameworks in the UK and the EU

Scottish Credit and Qualifications Framework (SCQF)	Qualifications in England & Wales (RQF/CQFW)	European Qualifications Framework (EQF)
12	8	8
11	7	7
10/9	6	6
8/7	5/4	5
6	3	4
5	2	3
4	1	2
3	E3	1
2	E2	
1	E1	

(Source: https://www.sqa.org.uk/sqa/64561.html)

Annex 3 Current VTQ awards in England

Title (Level 2)	53
AIM Qualifications Level 2 Award in IT User Skills	
AIM Qualifications Level 2 Certificate in IT User Skills	
AIM Qualifications Level 2 Diploma in IT User Skills	
Ascentis Level 2 Award in IT User Skills	
Ascentis Level 2 Award in IT User Skills	
Ascentis Level 2 Certificate in IT Skills for Employment	
Ascentis Level 2 Certificate in IT Skills for Employment	
Ascentis Level 2 Certificate in IT User Skills	
Ascentis Level 2 Certificate in IT User Skills	
Ascentis Level 2 Diploma in IT Skills for Communications Specialists	
Ascentis Level 2 Diploma in IT Skills for Communications Specialists	
City & Guilds Level 2 Award for Broadband Technicians	
City & Guilds Level 2 Award for IT Users (ITQ)	
City & Guilds Level 2 Award in Communications Cabling	
City & Guilds Level 2 Award in ICT Systems and Principles	
City & Guilds Level 2 Certificate for IT Users (ITQ)	
City & Guilds Level 2 Certificate in Essential Skills - Information and Communication Technology	
City & Guilds Level 2 Certificate in ICT Systems and Principles - Bowman Operators	
City & Guilds Level 2 Certificate in ICT Systems Support	
City & Guilds Level 2 Certificate in Telecommunication Systems (VTQ)	
City & Guilds Level 2 Diploma for IT Users (e-Quals) - Standard	
City & Guilds Level 2 Diploma for IT Users (ITQ)	
City & Guilds Level 2 Diploma in ICT Professional Competence	
City & Guilds Level 2 Diploma in ICT Systems and Principles for IT Professionals	
City & Guilds Level 2 Diploma in ICT Systems Support	
City & Guilds Level 2 Diploma in IT User Skills	
City & Guilds Level 2 Technical Award in Digital Technologies	
City & Guilds Level 2 Technical Certificate in Digital Technologies	
DAO Level 2 Certificate in Specialist CIS Fundamentals	
ETCAL Level 2 Certificate in Digital Technologies	
IAO Level 2 Diploma in IT User Skills (ITQ)	
NCFE Level 2 Certificate in ICT Systems and Principles	
NCFE Level 2 Diploma in Professional Competence for IT and Telecoms Professionals	
OCN NI Level 2 Award in Cyber Security	
OCN NI Level 2 Award in Digital Marketing	
OCN NI Level 2 Award in Digital Skills for Life and Work	
OCN NI Level 2 Award in Digital Skills for Life and Work. Being Safe and Responsible Online	
OCN NI Level 2 Award in Digital Skills for Life and Work. Communicating and Collaborating Using Technology	
OCN NI Level 2 Award in Digital Skills for Life and Work. Using Devices and Handling Information	
OCN NI Level 2 Award in Digital Skills for Life and Work. Using Technology to Carry Out Online Transactions	
OCN NI Level 2 Award in Digital Skills for Life and Work. Using Technology to Create and Edit Information	
OCN NI Level 2 Award in Geographical Information Systems	
OCN NI Level 2 Award in Information Technology Applications	
OCN NI Level 2 Award in Social Media	
OCN NI Level 2 Certificate in Essential Skills - ICT	

Title (Level 2)	53
OCN NI Level 2 Certificate in Information Technology Applications	
OCR Level 2 Diploma in IT User Skills (ITQ)	
Pearson Edexcel Level 2 Certificate in Digital Applications	
Pearson Edexcel Level 2 Certificate in Essential Skills - ICT	
Pearson Edexcel Level 2 Diploma in Digital Applications	
ProQual Level 2 Certificate in Using Business Technologies in the Workplace	
TQUK Level 2 Award in ICT Systems and Principles for Practitioners (RQF)	
TQUK Level 2 Diploma in ICT Professional Competence (RQF)	

Title (L3)	60
AIM Qualifications Level 3 Award in IT User Skills	
AIM Qualifications Level 3 Certificate in IT User Skills	
AIM Qualifications Level 3 Diploma in IT User Skills	
AQA Level 3 Foundation Technical Level IT: Cyber Security	
AQA Level 3 Foundation Technical Level IT: Scripting and App Programming	
AQA Level 3 Foundation Technical Level IT: Technical Support	
AQA Level 3 Technical Level IT: Cyber Security and Security Administration	
AQA Level 3 Technical Level IT: Networking	
AQA Level 3 Technical Level IT: Programming	
AQA Level 3 Technical Level IT: User Support	
Ascentis Level 3 Award in Digital Learning Design	
BIIAB Level 3 Award in ICT Systems and Principles for Professionals	
City & Guilds Level 3 Advanced Technical Certificate in Digital Technologies	
City & Guilds Level 3 Advanced Technical Extended Diploma in Digital Technologies (720)	
City & Guilds Level 3 Award for IT Users (ITQ)	
City & Guilds Level 3 Award in Business Processes	
City & Guilds Level 3 Award in Cloud Services	
City & Guilds Level 3 Award in Coding and Logic	
City & Guilds Level 3 Award in Mobile and Operating System	
City & Guilds Level 3 Award in the Principles of Coding	
City & Guilds Level 3 Certificate for IT Users (ITQ)	
City & Guilds Level 3 Certificate in Designing and Planning Communications Networks	
City & Guilds Level 3 Certificate in Digital Marketing Business Principles	
City & Guilds Level 3 Certificate in ICT Systems and Principles	
City & Guilds Level 3 Certificate in ICT Systems and Principles - Advanced Bowman Operators	
City & Guilds Level 3 Certificate in Networking and Architecture	
City & Guilds Level 3 Certificate in the Principles of Online and Offline Marketing	
City & Guilds Level 3 Diploma for IT Users (ITQ)	
City & Guilds Level 3 Diploma in ICT Professional Competence	
City & Guilds Level 3 Diploma in ICT Systems and Principles for IT Professionals	
City & Guilds Level 3 Diploma in ICT Systems Support	
City & Guilds Level 3 Diploma in Information Security (QCF)	
City & Guilds Level 3 Diploma in IT User Skills	
City & Guilds Level 3 Diploma in Telecommunication Systems (VTQ)	
DAO Level 3 Award in Defence Information Support Administrator	
FAQ Level 3 Diploma in IT User Skills (ITQ)	

Title (L3)	60
NCFE Level 3 Certificate in ICT Systems and Principles	
NCFE Level 3 Diploma in ICT Systems and Principles	
NCFE Level 3 Diploma in Professional Competence for IT and Telecoms Professionals	
NCFE Level 3 Extended Diploma in IT	
OCN NI level 3 Award in Digital Skills for Educators	
OCN NI Level 3 Award in Geographical Information Systems	
OCN NI Level 3 Award in Information Technology Applications	
OCN NI Level 3 Certificate in Digital Skills for Educators	
OCN NI Level 3 Certificate in Information Technology Applications	
OCN NI Level 3 Diploma in Information Technology Applications	
OCR Level 3 Diploma in IT User Skills (ITQ)	
Pearson BTEC Level 3 Award for IT Users (ITQ)	
Pearson BTEC Level 3 Diploma in Information Security (QCF)	
Pearson BTEC Level 3 Extended Diploma in ICT Systems and Principles	
Pearson BTEC Level 3 National Diploma in Business Information Systems	
Pearson BTEC Level 3 National Diploma in Computer Science	
Pearson BTEC Level 3 National Diploma in Computer Systems and Network Support	
Pearson BTEC Level 3 National Diploma in Computing for Creative Industries	
Skillsfirst Level 3 Certificate in ICT Systems and Principles (QCF)	
Skillsfirst Level 3 Diploma in ICT Professional Competence (QCF)	
SQA Level 3 Certificate in ICT Support in Education for Practitioners (QCF)	
TLM Level 3 Diploma in Open Systems Computing	
TQUK Level 3 Certificate in ICT Systems and Principles (RQF)	
TQUK Level 3 Diploma in ICT Professional Competence (RQF)	

Annex 4 VTQ data sources: England

Ofqual, Vocational qualifications dataset: https://www.gov.uk/government/statistical-data-sets/vocational-qualifications-dataset

Department for Education, Statistics: further education and skills: https://www.gov.uk/government/collections/further-education-and-skills-statistical-first-release-sfr

Department for Education, Statistics: performance tables: https://www.gov.uk/government/collections/statistics-performance-tables

Department for Education, Statistics: 16 to 19 attainment

https://www.gov.uk/government/collections/statistics-attainment-at-19-years

Department for Education, A level and other 16 to 18 results: https://explore-education-statistics.service.gov.uk/find-statistics/a-level-and-other-16-to-18-results/2019-20

Department for Education, Key stage 4 qualifications, discount codes and point scores: https://www.gov.uk/government/publications/key-stage-4-qualifications-discount-codes-and-point-scores

Department for Education, Key stage 4 performance 2019 (revised): https://www.gov.uk/government/statistics/key-stage-4-performance-2019-revised

Department for Education, 2018 performance tables: technical and vocational qualifications: https://www.gov.uk/government/publications/2018-performance-tables-technical-and-vocational-qualifications

Annex 5 Current VTQ awards in Northern Ireland

Title (L2)	15
BCS Level 2 Certificate in IT User Skills (ECDL Core)	
BCS Level 2 Certificate in IT User Skills (ECDL Extra) (ITQ)	
BCS Level 2 ECDL Certificate in IT User Skills	
City & Guilds Level 2 Certificate in Essential Skills - Information and Communication Technology	
City & Guilds Level 2 Diploma in ICT Systems Support	
OCN NI Level 2 Award in Digital Marketing	
OCN NI Level 2 Award in Information Technology Applications	
OCN NI Level 2 Award in Social Media	
OCN NI Level 2 Certificate in Information Technology Applications	
OCR Level 2 Award in IT User Skills (ITQ)	
OCR Level 2 Cambridge Technical Award in Digital Business Technologies	
OCR Level 2 Cambridge Technical Diploma in IT	
OCR Level 2 Cambridge Technical Extended Certificate in IT	
OCR Level 2 Certificate in IT User Skills (ITQ)	
OCR Level 2 Diploma in IT User Skills (ITQ)	

Title (L3)	13
OCN NI level 3 Award in Digital Skills for Educators	
OCN NI level 3 Award in Digital Skills for Educators	
OCN NI Level 3 Award in Information Technology Applications	
OCN NI Level 3 Award in Information Technology Applications	
OCN NI Level 3 Certificate in Digital Skills for Educators	
OCN NI Level 3 Certificate in Information Technology Applications	
OCR Level 3 Cambridge Technical Diploma in IT	
OCR Level 3 Cambridge Technical Extended Certificate in IT	
OCR Level 3 Cambridge Technical Extended Diploma in IT	
OCR Level 3 Cambridge Technical Introductory Diploma in IT	
Pearson BTEC Level 3 90-credit Diploma in IT (QCF)	
Pearson BTEC Level 3 Certificate in IT (QCF)	
Pearson BTEC Level 3 National Certificate in Computing	
Pearson BTEC Level 3 National Diploma in Information Technology	
Pearson BTEC Level 3 National Extended Diploma in Information Technology	

Annex 6 Current VTQ awards in Scotland

Award (SCQF level 5)	Subject (21)
National Certificate	Computer Arts and Animation
National Certificate	Computer Games Development
National Certificate	Computing with Digital Media
National Certificate	Computing: Technical Support
National Certificate	Digital Media Computing
National progression awards	Cyber security
National progression awards	Digital Media Animation
National progression awards	Digital Media
National progression awards	Digital Media Editing
National progression awards	Digital Passport
National progression awards	Digital Production Skills
National progression awards	Mobile technology
National progression awards	Internet Technology
National progression awards	Web Design
National progression awards	Web Design Fundamentals
National progression awards	PC Passport: Intermediate
National progression awards	Computing with digital media
National progression awards	Business with Information Technology
National progression awards	Computer Games Development
National progression awards	Computer Networks and Systems
National progression awards	Computers and Digital Photography

Award (SCQF level 6)	Subject (18)
Higher national unit	IT in Business: Word Processing, Spreadsheets and Databases: An Introduction
National Certificate	Computer Aided Design and Technology
National Certificate	Computer Arts and Animation
National Certificate	Computer Games: Creative Development
National Certificate	Computer Games: Software Development
National Certificate	Computing with Digital Media
National Certificate	Computing: Technical Support
National Certificate	Digital Media Computing
National Certificate	Digital Media Computing
National progression awards	Cyber security
National progression awards	Digital Media Production
National progression awards	Digital Passport
National progression awards	PC Passport: Advanced
National progression awards	Geographical Information Systems: An Introduction
National progression awards	Software development
National progression awards	Business with Information Technology
National progression awards	Computer Games Development
National progression awards	Creative and Digital Media: Technologies, Processes and Practices

Annex 7 Current VTQ awards in Wales

Title (L2)	21
Agored Cymru Level 2 Certificate in Digital Application Support	
Agored Cymru Level 2 Diploma in Digital Application Support	
BCS Level 2 Certificate in IT User Skills (ECDL Extra) (ITQ)	
BCS Level 2 ECDL Award in IT User Skills	
BCS Level 2 ECDL Certificate in IT User Skills	
City & Guilds Level 2 Award for IT Users (ITQ)	
City & Guilds Level 2 Award in ICT Systems and Principles	
City & Guilds Level 2 Certificate for IT Users (ITQ)	
City & Guilds Level 2 Diploma for IT Users (ITQ)	
City & Guilds Level 2 Diploma in ICT Professional Competence	
City & Guilds Level 2 Diploma in ICT Systems Support	
City & Guilds Level 2 Diploma in IT User Skills	
OCR Level 2 Cambridge Technical Diploma in IT	
Pearson BTEC Level 2 Certificate for IT Users (ITQ)	
Pearson BTEC Level 2 Certificate in ICT Systems and Principles	
Pearson BTEC Level 2 Diploma for IT Users (ITQ)	
Pearson BTEC Level 2 Diploma in Professional Competence for IT and Telecoms Professionals	
Pearson BTEC Level 2 Technical Certificate in IT Support	
Pearson BTEC Level 2 Technical Diploma in Digital Technology	
TLM Level 2 Certificate for IT User Skills in Open Systems and Enterprise	
TLM Level 2 Extended Certificate in IT User Skills in Open Systems and Enterprise (ITQ)	

Title (L3)	49
Agored Cymru Level 3 Certificate in Digital Application Support	
Agored Cymru Level 3 Diploma in Digital Application Support	
Agored Cymru Level 3 Diploma in Digital Content Development	
Agored Cymru Level 3 Diploma in Digital Telecommunications	
Agored Cymru Level 3 Diploma in Information Security Professionals	
Agored Cymru Level 3 Diploma in IT Infrastructure	
Agored Cymru Level 3 Diploma in IT Solution Development	
Ascentis Level 3 Diploma in Digital Learning Design	
BCS Level 3 Certificate in IT User Skills (ECDL Advanced) (ITQ)	
City & Guilds Level 3 Award for IT Users (ITQ)	
City & Guilds Level 3 Certificate for IT Users (ITQ)	
City & Guilds Level 3 Certificate in ICT Systems and Principles	
City & Guilds Level 3 Diploma for IT Users (ITQ)	
City & Guilds Level 3 Diploma in ICT Professional Competence	
City & Guilds Level 3 Diploma in IT User Skills	
OCR Level 3 Cambridge Technical Certificate in IT	
OCR Level 3 Cambridge Technical Diploma in IT	
OCR Level 3 Cambridge Technical Extended Diploma in IT	
OCR Level 3 Cambridge Technical Introductory Diploma in IT	
OCR Level 3 Cambridge Technical Introductory Diploma in IT	
OCR Level 3 Cambridge Technical Subsidiary Diploma in IT	
Pearson BTEC Level 3 90-credit Diploma in IT	
Pearson BTEC Level 3 Certificate in ICT Systems and Principles	
Pearson BTEC Level 3 Certificate in IT	
Pearson BTEC Level 3 Diploma in ICT Systems and Principles	
Pearson BTEC Level 3 Diploma in IT	
Pearson BTEC Level 3 Diploma in IT User Skills (ITQ)	
Pearson BTEC Level 3 Diploma in Professional Competence for IT and Telecoms Professionals	
Pearson BTEC Level 3 Extended Diploma in IT	
Pearson BTEC Level 3 National Certificate in Computing	
Pearson BTEC Level 3 National Certificate in Information Technology	
Pearson BTEC Level 3 National Diploma in Computer Science	
Pearson BTEC Level 3 National Diploma in Computer Systems and Network Support	
Pearson BTEC Level 3 National Diploma in Computing	

Pearson BTEC Level 3 National Diploma in Computing for Creative Industries
Pearson BTEC Level 3 National Diploma in Information Technology
Pearson BTEC Level 3 National Extended Certificate in Computing
Pearson BTEC Level 3 National Extended Certificate in Information Technology
Pearson BTEC Level 3 National Extended Diploma in Computing
Pearson BTEC Level 3 National Extended Diploma in Information Technology
Pearson BTEC Level 3 National Foundation Diploma in Computing
Pearson BTEC Level 3 National Foundation Diploma in Information Technology
Pearson BTEC Level 3 Subsidiary Diploma in IT
WJEC Level 3 Advanced GCE in Applied ICT
WJEC Level 3 Advanced GCE in Computer Science
WJEC Level 3 Advanced GCE in ICT
WJEC Level 3 Advanced Subsidiary GCE in Applied ICT
WJEC Level 3 Advanced Subsidiary GCE in Computer Science
WJEC Level 3 Advanced Subsidiary GCE in ICT

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