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Dr Jo Saxton
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8 October 2021

Dear Dr Saxton

I chair the BCS School Curriculum and Assessment Committee (SCAC), which was established under the auspices of the BCS Academy of Computing in response to a major recommendation of the Royal Society. The Committee, which draws on representation from schools, universities and employers, has had a constructive, ongoing dialogue with Ofqual about qualifications in computing.

I offer my congratulations on your appointment as Ofqual's Chief Regulator. Few things are more important than ensuring that young people get the qualifications they deserve, and that those qualifications are recognised for their rigour and reliability. The whole school system has faced immense challenges during the pandemic, and the aftershock will be felt for some time to come.

Concerning computing qualifications, there is one particularly urgent issue for which I would welcome your early attention. There is substantial evidence that students typically get a grade lower result in GCSE in Computer Science than they do in comparable other subjects. That leaves computing teachers with a huge struggle to persuade their senior leaders to resource GCSE Computer Science, and their students to take it. Both groups respond, quite understandably, "why take CS if I can get better grades in physics/French/drama?".

I wrote to Ofqual in February 2020 about this issue, accompanied with a substantial white paper giving the evidence base. Alas, the pressure of the pandemic meant that the SCAC's work was submerged in more urgent matters. Would you be willing to re-open this discussion, especially in view of your proposals about grades in the current consultations about GCSE and A level?

The GCSE in Computer Science, which was introduced in 2010 with a very small cohort, is now the flagship KS4 qualification for the new computing curriculum. It forms a major focus of the government's new National Centre for Computing Education (NCCE), which was set up to ensure computing teachers have the necessary subject knowledge and skills to ensure the future supply of a workforce with advanced computing skills and knowledge. However, the Committee has become increasingly concerned that the perceived difficulty of the

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subject may undermine this ambition if we simply return to the profile of grades awarded before the pandemic.

The 2017 Royal Society's report said (p35): "Computer science – the difficult option? Our evidence gathering suggests that computer science GCSE is increasingly regarded by teachers and pupils as a 'difficult option'." The perception that GCSE CS is more demanding than other subjects has major negative consequences. School leaders are less willing to offer the subject and students less willing to take it if they believe it to be too difficult. This has a detrimental impact on young people's opportunities and the supply of computer scientists into the economy.

The SCAC white paper reviewed the comparative data in the public domain on candidate's performance in GCSE Computer Science and other subjects, drawn from several independent sources. It concluded that there is evidence that students taking GCSE Computer Science typically get a lower grade than they do in other subjects. While there could be several reasons for this, there is prima facie evidence that warrants further investigation. I have included our original submission as an annex to this letter. (All of this evidence predates the special arrangements introduced as a result of the pandemic.)

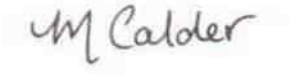
We would be delighted to discuss with Ofqual the case for a review. Should a compelling case be made, as the data suggests, we would also be delighted to work with Ofqual on any review. Should, after further examination of the data, no compelling case be made, we would similarly be delighted to work with Ofqual to communicate the factors underlying the perceived misalignment in grading standards, to reassure schools and students that they are not disadvantaged by taking GCSE Computer Science.

The matter is urgent. The mere perception that GCSE Computer Science is a grade harder than other subjects is damaging to our young people's future, by putting them off a subject in which they could flourish. If the perception is justified, as we believe it may well be, that is even worse.

Please may I suggest a short meeting with myself and some colleagues, as a next step?

I look forward to working with you.

Yours sincerely



Professor Dame Muffy Calder DBE OBE FREng FRSE
Chair, BCS School Curriculum & Assessment Committee
Vice-Principal and Head of College of Science and Engineering, University of Glasgow

Annex: Grading standards in GCSE Computer Science

Evidence of misalignment

A submission to Ofqual, by the BCS School Curriculum and Assessment Committee

January 2020

1 Purpose

1.1 This annex reviews comparative data on candidate's performance in GCSE Computer Science and other subjects from the last four years. It concludes there is statistical evidence that students taking GCSE Computer science (CS) typically get a lower grade than they do in other subjects. **This paper argues there is a prima-facie case for reviewing the grading standards for GCSE CS.**

1.2 Ofqual identifies four criteria for forming a "compelling case to adjust grading standards". Namely:

A Statistical measures of relative subject difficulty show evidence of potential misalignment over several years.

B Persuasive evidence of the potential detrimental impact caused by perceived severe grading on those who use the qualification and on society at large.

C Evidence of dissatisfaction with the current grading standard from those who use the qualification, and those responsible for maintaining the standard.

D The likely benefit to users of the qualification and society as a whole from a change to grading standards must outweigh any potential negative effects.

1.3 While there could be a number of reasons for the under-performance of GCSE CS students, which we discuss in Section 4, there is prima facie evidence that Criterion A has been met (Section 3). This annex also touches on the evidence gathered to date on the other Criteria B, C, and D, in Section 5.

1.4 Setting the standard in specifications in new subjects is extremely challenging. The ability profile and the extent of learning can be atypical in terms of 'value added' measures and assumptions. Awarding is always affected by assumptions, and these assumptions need constantly to be reviewed. If the standard set in the first years is affected by these contextual factors, measures for carrying over the standard to following years can lead to penalisation of later cohorts.

2 Background

2.1 The **GCSE in Computer Science** was introduced in 2010 by OCR, with a very small cohort. It is now the flagship KS4 qualification for the new Computing curriculum. A major focus of the new National Centre for Computing education is to offer professional development to schools and teachers to improve the teaching of GCSE CS. A major goal is to increase substantially the cohort of students taking GCSE CS.

2.2 The **BCS School Curriculum and Assessment Committee (SCAC)** is a permanent committee under the auspices of the BCS Academy of Computing. It was established in response to a major recommendation of the Royal Society's report 'After the Reboot'. It aims to offer thoughtful, well-evidenced scrutiny and review of the school curriculum in computing, how it is taught, and how it is assessed.

2.3 BCS SCAC aims to have a constructive, ongoing dialogue with major stakeholders in its space, including Ofqual.

3 Criterion A: statistical measures of relative subject difficulty

3.1 This section presents evidence drawn from five separate analyses

1. An analysis by the Fisher Family Trust comparing candidates' performance in GCSE Computer Science with their performance in GCSE English and Mathematics.
2. The University of Roehampton Tracer report's comparison between candidates' performance in GCSE Computer Science and a variety of other GCSE examinations, together with further data provided by Peter Kemp of the University of Roehampton at the request of the committee.
3. An analysis by BCS using publicly available 2019 data making comparisons between candidates' performance in a variety of GCSEs based on their prior attainment at Key Stage 2.
4. An analysis by BCS comparing the grades awarded in GCSE Computer Science with other STEM GCSEs.
5. An analysis carried out by Cambridge Assessment in 2016, based on the Kelly method.

3.2 The committee concluded that, while the newness of GCSE Computer Science prevents the analysis of data over a large number of years, there is prima facie evidence that:

> A student entered for GCSE CS will, typically, get lower results than **that same student** gets in English and Maths (which everyone takes), and in their other subjects.

Evidence from the Fisher Family Trust analysis

3.3 In September 2019, the Fisher Family Trust published a blog post[1] '**Are some qualifications scored too generously?**' that neatly encapsulated the perceived problem, and backed it with data from the summer 2018 exams. They presented evidence that compared, for each student, that student's grade in computing compared with that same student's grades in maths and English. The findings are summarised in figure 1 below (taken from the blog post) which shows subjects with at least 20,000 entrants in 2018.

[1] https://ffteducationdatalab.org.uk/2019/09/are-some-qualifications-scored-too-generously

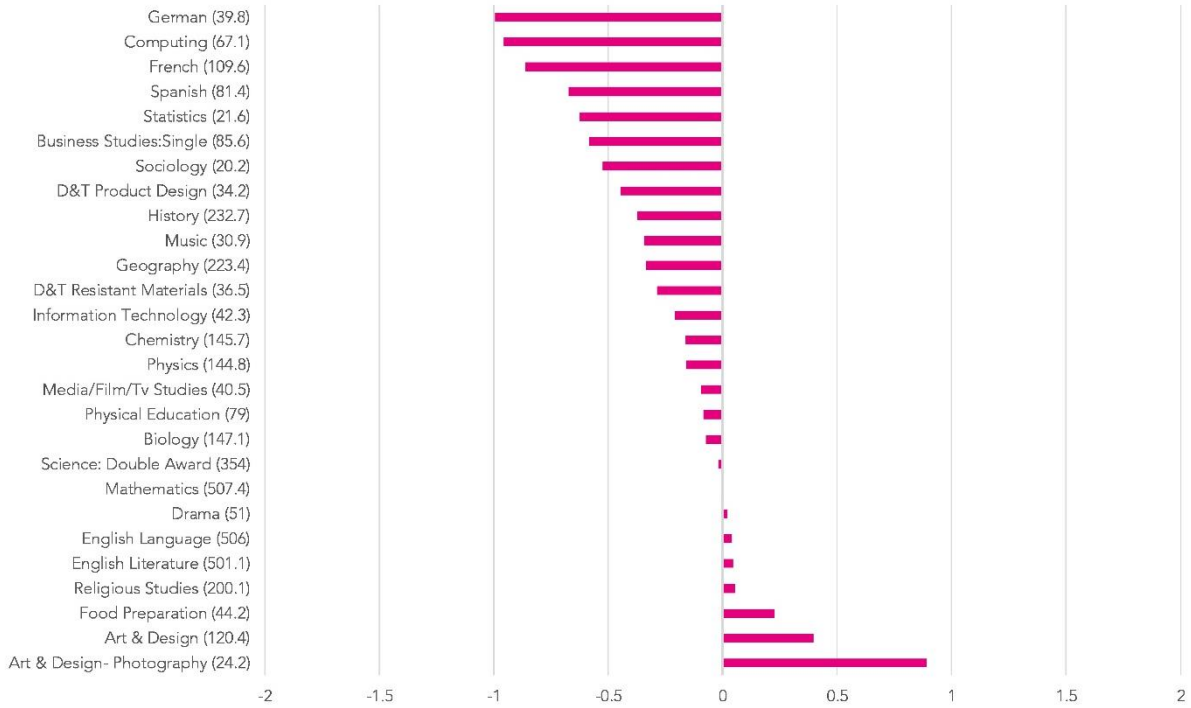


Figure 1: Difference in points scored in GCSEs compared to English and mathematics in state-funded schools in England in 2018 (number of entrants in thousands in brackets). (Source FFT Blog)

3.4 They found computing students to be amongst the lowest performers, achieving almost a grade lower in GCSE CS compared to maths and English. Only students taking German did worse. The committee noted that the overall rank order is very similar to that shown the FFT's earlier 2016 blog post[2] on GCSE inter-subject comparability. While Computer Science was not included in the 2016 analysis, this similarity in overall subject ranking provides reassurance that there are real differences between subjects that underpin the observed differences in the grades awarded.

3.5 Comparisons with English and maths constitute a robust baseline because, since they are taken by all students:

- There is no concern that the baseline is skewed by being taken by a self-selected cohort
- Every student taking computer science GCSE has a corresponding maths and English result to compare with.

However, the committee recognised the limitations of using performance in English and mathematics as the *sole* benchmark for comparison. It therefore considered further evidence that makes more direct comparisons between a range of GCSEs

Comparisons with performance in other GCSEs

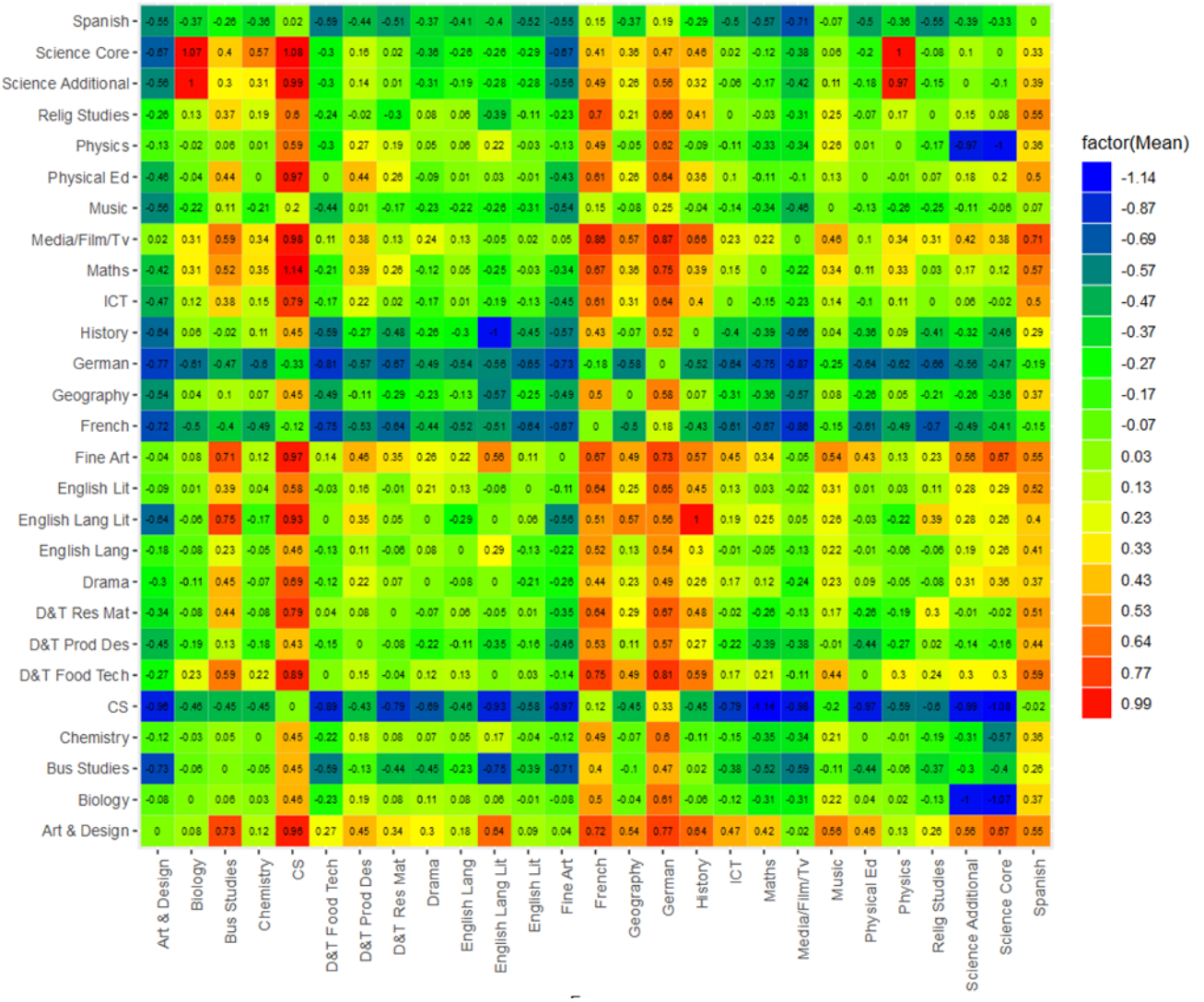
3.6 The Roehampton Annual Computing Education Report[3] brings together government data on computing provision in English schools, including the school performance tables for exams taken in 2018 and the school workforce census up to 2017. The data

[2] https://ffteducationdatalab.org.uk/2016/02/which-are-the-most-difficult-subjects-at-gcse/
[3] https://cdn.bcs.org/bcs-org-media/2520/tracer-2018.pdf

for 2017 showed that students "*typically get half a grade lower in [GCSE] CS than in their other subjects*". This disparity appears across regions and school types. Additionally, "*No groups of schools are doing better in CS than they are overall*". The BCS School Curriculum and Assessment Committee therefore commissioned a more detailed analysis of 2016 exam results looking specifically at the grades achieved across a range of GCSEs.

3.7 The analysis identified the average differences in the GCSE Grades achieved between students' performance in pairs of subjects when students took both subjects. Results in 26 subjects were considered. The following table (figure 2) summarises all the comparisons made.

SUBJECT A



SUBJECT B

Figure 2. Table showing average difference in grades between subjects, amongst students taking each subject combination.

3.8 Each cell in the table shows the comparison between the subject on the vertical axis (Subject A) and the subject on the horizontal axis (Subject B). If the cell contains X,

then considering all students taking both A and B, these students averaged X grades higher in A than in B. For example, reading across the horizontal line of mathematics comparisons we see 1.14 in the computer science column, showing that on average students performed 1.14 of a grade higher in GCSE Mathematics than in GCSE Computer Science. (Reading across the horizontal row for GCSE Computer Science it will show a difference of -1.14 when compared with GCSE Mathematics).

3.9 Individual cells are colour coded in line with the average differences in grades awarded for candidates taking each pair of subjects.

- Cells coloured green indicate that candidates who took both the corresponding subjects A and B achieved similar grades.
- Cells coloured blue indicate that candidates who took both subjects achieved on average a higher grade in Subject B.
- Cells coloured red indicate that candidates who took both subjects achieved on average a higher grade in Subject A.

So, a subject row that is mostly blue indicates that candidates achieve lower grades in that subject in comparison to a range of other subjects.

3.10 Computer Science and Modern Foreign Languages (French and German) stand out as blue rows: they are subjects where students' performance is lower on average than in the other subjects they take. Interestingly, German and French (the subject of the recent Ofqual review of GCSE grades) are the only subjects where candidates achieve lower grades than they do in Computer Science.

3.11 Additionally, Kemp, Wong and Berry[4] show that female underperformance in Computer Science in 2016 was worse than male.

Comparisons using Key Stage 2 data as a baseline

3.12 The extent to which Key Stage 2 data can be used as a predictor of future GCSE performance varies from subject to subject (it is of limited value in predicting performance in GCSE Art and Design for example). However, the committee felt that it would provide valuable additional insight since:

- Key Stage 2 data is used by awarding bodies to 'benchmark' the GCSE cohort
- GCSE Computer Science as an EBacc subject places similar cognitive demand to other EBacc subjects.

3.13 The provisional data on the 2019 GCSE results is now available. In order to measure 'value added', DfE publishes Transition Matrices[5] that compare pupils' past attainment in the Key Stage 2 National Tests in mathematics and English for 11-year-olds with their performance at GCSE. The following table shows the data for all students taking GCSE Computer Science. For each possible result in the Key Stage tests it shows the percentage of pupils achieving each GCSE Grade.

[4] Female Performance and Participation in Computer Science: A National Picture. Due to be published November 2019 through https://toce.acm.org/

[5] https://www.gov.uk/government/publications/ready-reckoners-and-transition-matrices-for-key-stage-4

Pupil Percentage		KS4 Attainment GCSE Computer Science									
		U	1	2	3	4	5	6	7	8	9
KS2 Attainment	W	0	25	25	0	25	0	25	0	0	0
	1	43	14	7	7	14	14	0	0	0	0
	2	41	30	15	5	4	1	2	1	1	0
	3c	36	38	12	9	2	1	1	1	0	0
	3b	27	33	21	10	4	2	2	0	0	0
	3a	16	35	24	15	6	2	1	1	0	0
	4c	12	28	26	18	8	4	2	1	0	0
	4b	6	19	25	23	13	7	4	1	0	0
	4a	3	11	18	24	18	14	8	3	1	0
	5c	1	4	9	18	19	20	15	9	4	1
	5b	0	1	3	8	12	18	21	18	14	6
	5a	0	0	1	2	4	9	15	21	27	22

Figure 3: Transition matrix for all candidates taking GCSE Computer Science.

3.14 Taking all the pupils who achieved level 4c in the national tests as an example, we can see that, of those that went on to take GCSE Computer Science in 2019, 12% were unclassified, 28% achieved a grade 1, 26% achieved a grade 2, and so on.

3.15 The transition table for GCSE mathematics is shown in Figure 4.

Pupil Percentage		KS4 Attainment									
		U	1	2	3	4	5	6	7	8	9
KS2 Attainment	W	17	13	30	14	9	5	4	3	4	0
	1	41	27	13	9	3	2	2	1	0	0
	2	24	41	20	8	4	1	1	0	0	0
	3c	11	34	29	16	8	2	0	0	0	0
	3b	7	29	30	20	10	3	1	0	0	0
	3a	4	21	31	25	14	4	1	0	0	0
	4c	2	11	24	30	24	7	1	0	0	0
	4b	1	5	13	26	34	16	4	1	0	0
	4a	0	2	5	15	35	27	10	5	1	0
	5c	0	0	1	5	22	30	20	13	6	1
	5b	0	0	0	1	6	16	21	25	21	9
	5a	0	0	0	0	1	4	9	19	32	35

Figure 4: Transition matrix for all candidates taking GCSE Mathematics.

3.16 In order to make comparisons between the two tables more visible, comparisons are made taking three different 'starting points'. The following graphs (figures 5,6 and 7) show the comparisons in GCSE results in Computer Science and Mathematics for candidates who achieved levels 3a, 4a and 5a in the Key Stage 2 tests.

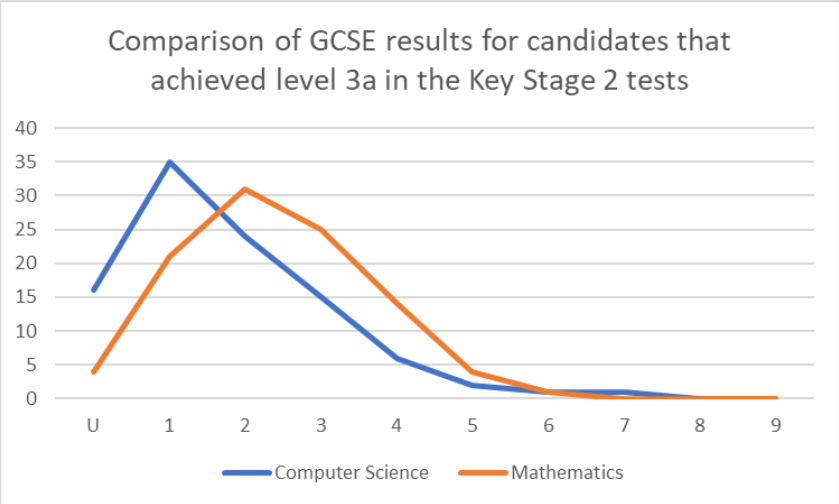


Figure 5: Comparison between GCSE outcomes for candidates who achieved level 3a.

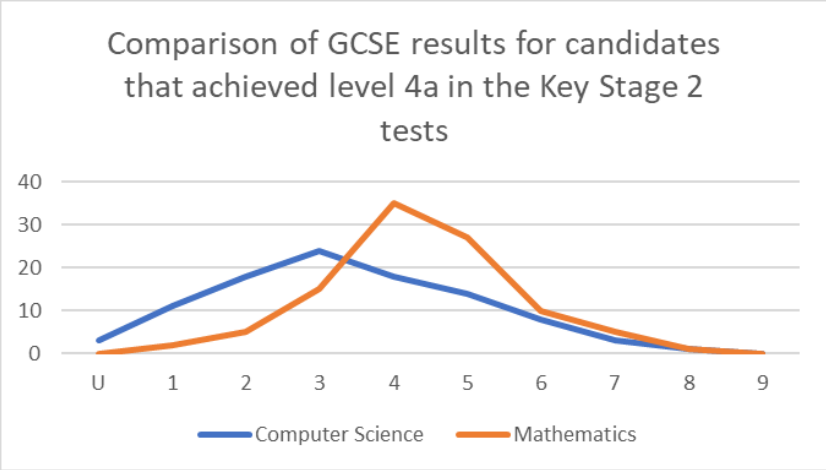


Figure 6: Comparison between GCSE outcomes for candidates who achieved level 4a.

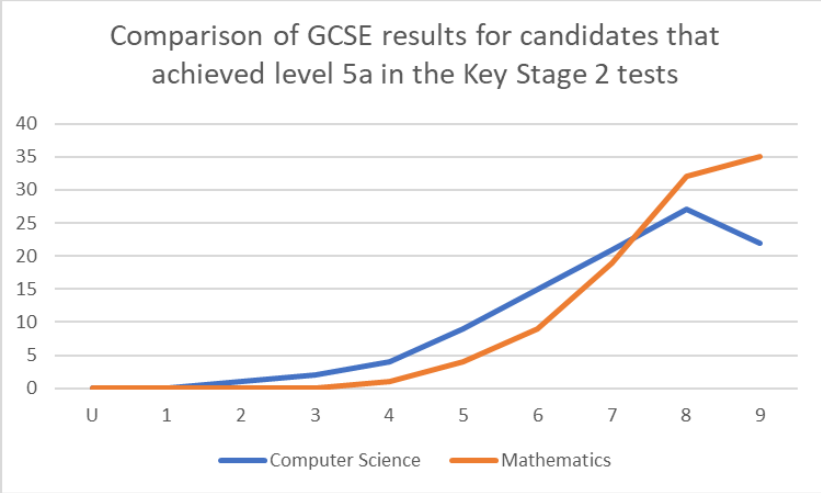


Figure 7: Comparison between GCSE outcomes for candidates who achieved level 5a.

3.17 Two observations are immediately apparent. Firstly, as would be expected, the grade distributions for both GCSEs move progressively to the right as the Key Stage 2 starting point increases. Secondly, **candidates from all three starting points achieved on average worse results in GCSE Computer Science than GCSE mathematics**.

3.18 The comparison with mathematics could be anomalous, so we now move on to consider a wider range of EBacc GCSEs. Selecting the cohort who attained level 5c at KS2, the table below (Figure 8) shows the percentage of candidates who achieved each GCSE grade in a variety of subjects. The mean grade/point score in each GCSE has been calculated for this group of candidates.

	U	1	2	3	4	5	6	7	8	9	Mean Grade
Computer Science	1%	4%	9%	18%	19%	20%	15%	9%	4%	1%	**4.42**
Maths	0%	0%	1%	5%	22%	30%	20%	13%	6%	1%	**5.33**
Physics	1%	0%	1%	7%	17%	24%	23%	16%	10%	3%	**5.60**
Chemistry	1%	0%	1%	7%	16%	24%	21%	16%	10%	4%	**5.61**
Biology	0%	0%	1%	5%	13%	25%	27%	16%	10%	4%	**5.74**
History	1%	3%	6%	13%	14%	18%	19%	14%	8%	3%	**5.10**
Geography	0%	1%	4%	12%	15%	21%	22%	15%	7%	2%	**5.20**
English Language	0%	1%	2%	10%	17%	27%	24%	12%	6%	2%	**5.25**
English Literature	1%	1%	3%	9%	16%	25%	23%	14%	7%	3%	**5.33**
French	2%	1%	5%	20%	20%	24%	12%	9%	4%	2%	**4.58**
German	2%	1%	5%	19%	23%	25%	14%	8%	3%	1%	**4.56**
Spanish	2%	1%	6%	20%	19%	22%	12%	10%	5%	3%	**4.64**

Figure 8: GCSE outcomes for candidates who achieved level 5c in the Key Stage 2 tests.

3.19 Candidates achieving a 5c at Key Stage 2 on average achieved 4.42 in GCSE Computer Science, nearly a whole grade lower than the mean for mathematics. While the higher grades in the natural sciences might be expected as single sciences tend to be studied by more able candidates, the mean grade in GCSE Computer Science is the lowest mean grade in all the subjects considered. The low mean grades in modern foreign languages are in line with other findings presented earlier. However, the mean grade achieved by these candidates was lower in Computer Science than for French, German or Spanish.

3.20 Similar patterns are seen when other KS2 attainment cohorts are considered. To show this more concisely, the following table (figure 9) sets out the mean grades achieved at GCSE in EBacc subjects at GCSE. Where the mean is higher than the mean for candidates taking GCSE Computer Science, the cell has been coloured green. Where the mean grade achieved is lower than for computer science, the cell has been coloured red. As students who achieved a level 1 in the Key Stage 2 tests were not entered for GCSE Computer Science, this row has been ignored.

Key Stage 2 Level achieved	Mean GCSE Grade Achieved										
	Computer Science	Mathematics	Physics	Chemistry	Biology	History	Geography	English Language	English Literature	French	German
1		1.3			2.0	1.6	2.3	2.0	2.0		2.3
2	1.2	1.3	2.1	2.1	1.8	1.6	1.5	2.2	2.1	2.7	1,5
3C	1,2	1.8	2.2	2.3	2.0	1.8	1.7	2.5	2.4	2.5	1.7
3B	1.5	2.1	2.7	2.6	2.4	2.0	2.0	2.7	2.7	2.8	2.0
3A	1.8	2.4	2.8	2.8	2.6	2.3	2.3	3.0	3.0	2.9	2.3
4C	2.1	2.9	3.4	3.3	3.2	2.7	2.7	3.4	3.4	3.1	2.7
4B	2.6	3.6	4.0	4.0	4.0	3.3	3.3	3.9	3.9	3.4	3.3
4A	3.4	4.3	4.8	4.8	4.9	4.1	4.1	4.5	4.5	3.9	4.1
5C	4.4	5.3	5.6	5.6	5.7	5.1	5.2	5.2	5.2	4.6	5.2
5B	5.8	6.6	6.7	6.7	6.7	6.3	6.4	6.1	6.1	5.6	6.4
5A	7.1	7.8	7.8	7.7	7.8	7.5	7.6	7.1	7.1	6.9	7.6

Figure 9: mean 2019 grades/point scores achieved at GCSE for candidates in each KS2 performance band.

3.21 Candidates across all ability ranges, except for the top performing candidates in French and English perform better in all subjects than they do in GCSE Computer Science.

Comparison with other STEM subjects

3.22 Clearly, an important comparison is with other STEM subjects. It might be argued that differences between, for example, grades in Computer Science and Art and Design simply reflect the fact that the examinations are measuring fundamentally different things. But the knowledge and understand that underpins Computer Science, and the skills to demonstrate that knowledge and understanding in an examination setting, draw on similar cognitive domains to other STEM subjects.

3.23 Figure 10 shows comparative data on the candidates within the 2018 cohort that entered GCSE Computer Science and triple science. It compares the average point score (grade) that pupils achieved in computer science with other STEM subjects. The average in all cases is over students who take maths, and triple science, and computer science. The majority of pupils (75.8%) in this cohort have high KS2 prior attainment (above Level 5).

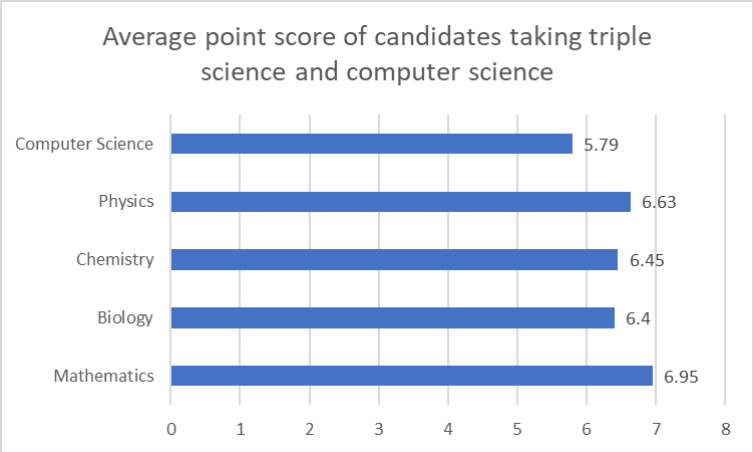


Figure 10: Average GCSE grade/point scores for students taking maths, triple science, and computer science.

3.24 As can be seen in Figure 4, this cohort of pupils (ones who take maths, triple science, and computer science) achieve lower computer science grades compared to other STEM subjects. The average difference in scores ranges from 0.62 of a grade difference (Biology) to 1.16 of a grade (Maths).

Cambridge Assessment comparison using the Kelly method

3.25 Cambridge Assessment published "On the impact of aligning the difficulty of GCSE subjects on aggregated measures of pupil and school performance[6]" in 2016 in their journal Research Matters. This article discussed the impact of adjusting GCSE grades globally, but it also contains a very illuminating table comparing GCSEs with each other.

3.26 The paper computes the so-called **Kelly adjustment** for each GCSE. To quote: *"In essence this method defines a subject as easy if the candidates taking it tend to achieve higher grades in this subject than in their other subjects. On the basis of this assumption, the method is designed to calculate adjustments to grades so that, across the group of pupils taking a particular subject, their mean grade in that subject will equal the average of the mean grades they achieve in all of their other subjects."*

3.27 The results, in Table 1 of the paper, are striking. Out of 83 GCSEs, computer science is 78th in rank order, with a Kelly adjustment of 0.59. That is, according to the Kelly method, one should add 0.59 to a student's grade in computer science, to make it comparable to other GCSEs.

3.28 This figure of 0.59 was on the old A-G scale. Converted to the new 1-9 scale it would be more like 0.9 grades, which is in line with the other data we have presented. Only a handful of minority subjects with tiny cohorts did worse: English Studies (720 entries), General Studies (9,300), Applied Engineering (6,350), Astronomy (2,300), and Law (2,214). In this sample there were 32,200 entries in computer science. French and

[6] https://www.cambridgeassessment.org.uk/Images/374665-on-the-impact-of-aligning-the-difficulty-of-gcse-subjects-on-aggregated-measures-of-pupil-and-school-performance.pdf

German, which have received recent attention from Ofqual, had a Kelly adjustment of 0.5 and 0.54 respectively; less than computer science.

3.29 These data date back to 2016, and pre-date the recent GCSE reform. The issue of GCSE Computer Science grading severity goes back a long way, and the grading standards were carried forward across the reform.

Summary

In summary, candidates taking GCSE Computer Science achieve lower grades:

- than would be expected given their performance in GCSE English and Mathematics
- than they do in other subjects that they take except for French and German
- than would be expected based on their performance in the Key Stage 2 national tests
- than other STEM subjects in particular.

4 Potential explanations of these grade differences

4.1 The committee considered several possible explanations for the differences in the grades awarded in Computer Science and other subjects. These fall broadly into two categories:

- Contextual issues in the school such as the teachers' subject knowledge and experience of the qualification or an anomalous entry profile.
- Potential issues within the qualification itself including the subject content, the level of demand in examination questions and associated mark schemes, and the awarding process

The committee's views of each of these are discussed below.

Contextual issues in the school

4.2 Clearly, teachers' knowledge and experience will have a critical impact on the grades their students achieve in their external examinations. This may be a partial explanation for the lower grades in GCSE Computer Science. If this were the case, less experienced teachers would be expressing more concerns than more experienced ones. However, feedback from experienced CAS Master Teachers[7], including through the CAS online forum, indicates that they share the concern over grading. Indeed, some of them have carried out detailed analyses in their own schools of their students' performance in GCSE Computer Science.

4.3 Given the concerns are shared by experienced teachers, the committee's view was that, while teacher competence may be part of the explanation for lower grades in GCSE Computer Science, it cannot be the whole explanation.

[7] Computing at School (CAS) Master Teachers were appointed under the DfE-funded Network of Excellence programme. CAS Master Teachers in secondary schools have a strong track record of teaching the subject at GCSE and A level.

4.4 The committee considered whether the mis-aligned results could be the result of a skewed cohort. For example, results in Polish might be higher than expected (using the methods described above) because many self-selected entrants are native Polish speakers.

4.5 For this explanation to be plausible, one must imagine that the self-selected cohort that chose to take computer science were *systematically weaker* in computer science than their peers. This does not seem likely; indeed the exact opposite is more likely to be true, which would make the underperformance in computer science outcomes even more stark.

The committee concluded that, while contextual issues will inevitably have some bearing on GCSE grades, they do not explain the consistent miss-alignment between grades.

Potential issues within the qualification itself

4.6 When GCSE Computer Science was introduced in 2010 the number of candidates was very small (initially around 4,000) with a significant proportion being high performing students in independent and grammar schools. The committee's concern is that mechanisms that work well for well-established qualifications may "grandfather in" serious biases for newly-established qualifications, particularly when the initial cohort is not representative of future cohorts. This may skew subject content and examination questions when material that is well within the grasp of the early cohort is too demanding for the majority.

4.7 In particular, the committee's view was that 'grandfathering' could influence two key factors considered by awarding bodies when setting grade boundaries, namely criterion referencing and cohort referencing.

4.8 **Criterion referencing** seeks to ensure that a script that gets (say) grade 7 in one year would also get grade 7 in a subsequent year. If in Year 1 and 2 of a new qualification, only exceptionally able students take the qualification, the initial grade boundaries will be set to provide a reasonable distribution of outcomes, so that (say) only 25% of student get the higher grades 7,8,9. But, since all the students are able, that sets the bar very high, and criterion referencing will carry forward that high bar into subsequent years.

4.9 Criterion referencing also depends on a shared understanding of the criteria being used. The criteria for Grade 5 Computer Science include: '*demonstrate mostly accurate and appropriate knowledge and understanding of fundamental concepts and principles including digital systems and societal impacts*.' There is a lot of interpretation needed e.g. of the three words 'mostly', 'appropriate' and 'fundamental'. In practice scripts at and around grade boundaries are used to make concrete the criteria being used.

4.10 **Cohort referencing** embodies the goal that student who get the same level at KS2 should get similar grades later at GCSE. Cohort referencing is also vulnerable to grandfathering. If the grade boundaries are initially set so that high-attaining-at-KS2

students obtain a reasonably broad distribution across grades, then low-attaining-at-KS2 students will be permanently compressed into the very low end of the distribution.

The committee concluded that, as the initial cohorts for GCSE computer science were (a) small and (b) unusually able, there may be a risk that the mechanisms used by Ofqual and awarding organisations to ensure consistency of grading may miss-fire when applied in this new-subject situation.

The committee does not have access to the necessary data to determine whether this risk has become an issue or the extent to which it explains the observed differences in grading between GCSE Computer Science and other subjects. We urge Ofqual to consider this issue more fully and offer the committee's support.

5 Criteria B, C and D: dissatisfaction and impact

5.1 This annex has focussed on the statistical evidence. When considering the case for a review Ofqual rightly also considers, in its criteria, whether any apparent misalignment in grades is leading to dissatisfaction amongst the qualification's users and wider stakeholders; whether this is having a negative impact on young people, society and the economy; and whether the benefits of any change would outweigh the potential disruption caused.

Evidence of dissatisfaction

5.2 The 2017 Royal Society's After the Reboot report said (p35): "*Computer science – the difficult option? Our evidence gathering suggests that computer science GCSE is increasingly regarded by teachers and pupils as a 'difficult option', one that is really only suitable for the most able pupils and, in particular, pupils who are high achievers in mathematics. If teachers, pupils or parents identify computing as a specialist subject, this will affect the future job prospects of pupils and narrow opportunities for particular groups of young people."*

5.3 Further 'evidence of dissatisfaction with the current grading standard from those who use the qualification, and those responsible for maintaining the standard', is provided from within the teaching and assessment community. The committee has ample anecdotal evidence that GCSE Computer Science is perceived as "too hard", and that this perception suppresses take-up by schools and by pupils. Indeed this anecdotal evidence is what led the committee to investigate the matter in the first place.

5.4 The CAS online forum provides a safe space for teachers to discuss challenges and successes. The perceived difficulty of GCSE CS is a frequent topic of conversation with teachers sharing anecdotal evidence and supporting school level data. Examples include:

At KS4 my school teaches iMedia and Computer Science. According to the link above, students nationally score around one grade lower in CS than they do in English and Maths and about 3/4 grade lower than English and maths in iMedia.

I was a bit disappointed with results this year. The lower ability students particularly struggled.

Whatever the cause of the results mismatch, allowing it to continue seems particularly unfair to the students and likely to hold back our subject.

Students on average do worse in computing and mfl than than their average points score.

My Middle ability did the worst. we've found that generally "anyone can get a 1-3" the students you think will get a 7-9, but it's that black hole of 4-6 middle ability boys.

My experience of high achieving female students was that they were always very careful and ensured they were well informed about their subject choices. Some actively avoided taking computer science as they perceived it would be harder to achieve the top grade.

*Have a look at your school's CEM, baseline prediction data. Look at the % of A*s / 9s that are predicted for every subject. I have found that Computer Science (for KS4 or 5) has the lowest %s of all subjects. Could of course be specific to my school's cohort - but it appears to point to it being the hardest subject.*

5.5 More analysis will be needed to gauge the strength of teachers' dissatisfaction.

The consequences of the perception that GCSE CS is "too hard"

5.6 The perception that students are likely to get a lower grade in GCSE CS than in other possible subject choices has immediate and harmful consequences.

5.7 School leaders, concerned about outcomes for their students and their schools' Progress 8 score, have a strong incentive to discourage students from taking the subject, to 'ration' it to high performing students, or even to drop it altogether.

5.8 In addition, students who do take the GCSE will be put off further study of computing, including Computer Science, because their results tell them they are, typically, better at other things.

5.9 "After the Reboot" found that only 46% of secondary schools in England offered GCSE CS in 2016. This rose to 61% in 2018. However, there is a large turnover of schools and the Roehampton Tracer report worryingly reported that 8.2% of schools offering GCSE CS in 2017 ceased doing so in 2018. In this group, one in five (19%) girls' comprehensive schools who offered GCSE computer science in 2017 dropped it in 2018.

5.10 Computer Science is a very immature as a school subject, and hence is particularly susceptible to the consequences of perceptions of severe grading, because there is no existing settled consensus about the educational value of a computing education, in the way that exists for other subjects. The danger is that GCSE CS becomes perceived as an elite subject for the geeks of the future, precisely the opposite of the intent of the new computing curriculum.

5.11 Evidence for this perception is growing, including the low retention rate for schools offering the subject[8] and a declining workforce[9]. Ongoing issues around the need for

[8] https://cdn.bcs.org/bcs-org-media/2520/tracer-2018.pdf p4
[9] https://royalsociety.org/-/media/policy/Publications/2019/21-08-19-policy-briefing-on-teachers-of-computing.pdf

digital skills in general are well understood[10] and the failure of GCSE Computer Science to fill the gap left by GCSE ICT are of a current concern[11].

5.12 More work is needed here to gather views from teachers and students across the country and keep track of emerging data now that the government has established the National Centre for Computing Education.[12] However, the committee's initial conclusion is that there are indications that these consequences are having a detrimental impact on young people, teachers, schools and the supply of computer scientists into the economy.

6 Conclusion

6.1 We have presented prima-facie evidence, based on data from multiple independent analyses, that students achieve consistently lower grades in GCSE Computer Science than those same students do in other subjects.

6.2 The perception (whether justified or not) that GCSE Computer Science is graded too severely has immediate and seriously harmful consequences, for a newly-established subject that is of great importance both for our children and our nation.

6.3 Precisely because the qualification is relatively young, it makes sense to keep its grading criteria under particularly active review. Every ship sails with teething problems.

6.4 **The matter is urgent**. Schools are making decisions about whether to offer GCSE CS at all, whether to hire computing teachers, and what GCSEs to recommend to their students.

6.5 We recognise that any change to GCSE can be disruptive. However, the BCS SCAC draws on representation from schools, universities and employers all of whom are united in their view that the social and economic consequences of not considering any misalignment in Computer Science grades far outweigh the small disruption caused by a change that would largely be welcomed by schools. We believe that a change in the grading system would make this qualification more accessible for schools, teachers and students, resulting in larger in school cohorts sitting the subject.

[10] e.g. https://www.edge.co.uk/publications/digital-skills-shortages-in-the-uk-economy
[11] https://www.bbc.co.uk/news/technology-49438969
[12] https://teachcomputing.org/