English Baccalaureate

Executive summary

1. We propose that "Computing" should be embedded in the E-bac either through a specific modification mathematics and science curriculum or by providing it as an option alongside a humanities, language and science component of the the English Baccalaureate (E-Bac).

2. Computing is a rigorous, intellectually rich discipline that is founded in mathematics and science and acts as a motivating context for learning in these subjects. Like those subjects, Computing explores foundational principles and ideas that underpin transferrable skills and knowledge. In an increasingly digital, knowledge-based age, Computing is fundamental both to full citizenship, and to our economic health as a nation. Section 1 gives more details.

3. Computing is virtually absent from UK schools having been displaced by Information and Communications Technology (ICT) that has become progressively weaker in supporting underlying technical knowledge. Using ICT for supporting teaching and learning in other curriculum contexts (see Section 2) is a perfectly legitimate purpose but not at the expense of the discipline of understanding and knowledge of computers and the way they work. This is equivalent to an English curriculum which only served teaching other subjects and had no emphasis on grammar, spelling, or the underlying structure and form of language.

4. The creation of the EBac provides the perfect opportunity to send a clear signal to schools and pupils of the importance of Computing. Our key recommendation is that Computing should be clearly identifiable in the English Baccalaureate with a compulsory element for all students embedded in the mathematics and science schemes of work and with mandatory assessment in the GCSE specifications for those subjects and an option to take a full GCSE in computing or a QCF vocational qualification. This would have two merits:

- It would provide an entitlement curriculum in modern digital technologies that is almost entirely missing when this is having the biggest impact on society of human learnt discipline.
- It would enable those with a specific interest to take the subject further in preparation for A level or hi-tec apprenticeships while maintaining a broad balance of maths and science that under-pin professional capability in this field.

5. In the body of this submission we explain what “Computing” is and why it is important. Computing is often confused with ICT because they both employ common technologies. We are drawing a clear distinction so that the quality of learning can be focused on fundamental knowledge that can be transferred to new and changing situations rather than entrenching learning in specific applications that soon become dated. A draft of “Computing: a curriculum for schools” is available here [1]. It outlines a full curriculum in computing for Key Stage 3 and 4 with attainment targets. This has been drawn up by and consultation with classroom teachers, business partners and academics in the field of education and Computing. It is important not to see KS4 in isolation but to build progression routes from KS3 and on into the post 16 curriculum.

What is “Computing”?

6. To understand why Computing should be part of the E-Bac it is important to explain Computing is a subject discipline in its own right. Computing is the study of how computer systems work, how they are constructed and programmed, and how they process information. It is a discipline, like Mathematics or Physics, that explores foundational principles and ideas (such as techniques for searching the Web), rather than focusing on artifacts (such as particular computer programs). We teach mathematics and physics in schools rather than engineering because all engineering is under-pinned by mathematics and physics. We are proposing that computing in the same way under-pins

all digital technologies.

Computing is characterised by

- The study of algorithms and data structures: efficient and ingenious ways to study and solve computational problems
- An understanding of computer systems and networks: for example, how the internet works, and the decentralised protocols that keep data flowing smoothly.
- An appreciation of the challenges of human-computer interaction, which focuses on the challenge of making computers accessible to people.
- How computers work. This includes binary arithmetic and digital hardware, but also biologically-inspired computation paradigms. This reflects the richness and forward-looking nature of the subject of Computing.
- In all of these areas there is a fruitful interaction of theory, design, and experimentation. For example, information theory informs the design of compression algorithms such as those used for MP3 digital audio files, whose performance on real test loads is measured experimentally.

7. Computing is an absolutely key discipline for the 21st century because it prepares learners for technological change. We have so much bad decision making in the adult world related to digital technologies that it is imperative to change this through the education system. Every school-leaver should have an understanding of Computing to improve their decision making whether it is at a personal level or in their business.

8. We want our children to understand and play an active role in the digital world that surrounds them, not to be passive consumers of an opaque technology subject to the whim of advertisers or digitally expert criminals. A sound understanding of Computing concepts will help them see how to get the best from the systems they use, and how to solve problems when things go wrong. Moreover, citizens able to think in computational terms would be able to understand and rationally argue about issues involving internet safety, digital inclusion, value for money in procurement, software patents, electronic voting systems. The list is almost endless. Just consider the track record of government IT projects and whether less or more understanding of digital technologies is warranted in our schools.

9. Computing is of crucial economic importance. Computer and software services contribute approximately £35b a year in GVA, and UK businesses spend approximately £70b a year on IT products. In addition BIS figures show there are around 1.5m Computing professionals in the UK workforce. For the UK to flourish we need home-grown graduates that have a deep understanding of computation, and the practical skills of design, abstraction, and programming. The lack of graduates with this background led to the 2011 NESTA report [2] on the £2bn UK games industry, which concluded “Computer Science should be on the National Curriculum as an essential discipline alongside Mathematics and Physics”

10. Computing develops thinking skills in a practical context that is both motivating and relevant to the lives of young people, and transfer well to the adult world. These include logical thinking, problem solving techniques, the ability to think at multiple levels of abstraction, and the habit of precision. Research through projects such as CASE in the 1980s have shown that stretching children in these areas increases their performance in all subjects but motivating them to go through the process is not easy. This is why relevant learning contexts are vitally important.

11. The Computing at School Working Group has developed a “Computing: a curriculum for schools”, to give substance to the overview above. It is attached as an Appendix to this submission.

The difference between ICT and Computing

12. Over the last two decades Information and Communication Technology (ICT) has been a statutory component of the National Curriculum. It was intended to emphasise the skills and knowledge needed to support learning across the curriculum and was specified so that it would not

go too quickly out of date. The unfortunate consequence is that it is virtually devoid of any emphasis on technical skills and knowledge and not infrequently taught by people with no recognisable technical qualification. We think that a lot of the malaise with ICT can be treated by teaching fundamental and transferable principles since these will not go out of date and will enable transfer to new technologies just as learning physics allows knowledgeable students to quickly learn in a wide range of engineering disciplines. In English, a good grasp of grammar and linguistic structure means good quality written communication flows on in a range of subject contexts.

13. Computing is one of the most exciting and life-changing subjects on earth yet the statutory curriculum is almost devoid of Computing concepts and many of our students are left feeling that all computers have to offer is blindly using desktop applications often in uninspiring contexts.

We summarise some of the evidence briefly:

The annual CBI survey shows UK employers are increasingly dissatisfied with basic IT skills in their workforce:

- in 2008 - 55% dissatisfied
- in 2009 - 57% dissatisfied
- in 2010 - 66% dissatisfied

The number of students taking ICT or Computing courses has collapsed over recent years:

- The number of students studying A level Computing fell 7% from 5,068 in 2008 to 4,710. Over the period 2001-2009 the total fell by 57% (10,913 down to 5,610)3. Not only is the number declining, but it is very small in absolute terms: just 0.6% of students take A level Computing.
- The number of students taking A level ICT reached a high of 18,029 in 2003, but has fallen every year since then, to 11,948 in 2009, a fall of 33% in six years.

14. This neat juxtaposition is only part of the truth, because it focuses too narrowly on computers as a technology, and Computing is much broader than that. As Dijkstra famously remarked, “Computing in no more about computers than astronomy is about telescopes”. In contrast the approach to ICT in schools has been absolutely focused on specific technologies to the extent that it is now very difficult to get them to sensibly use some of the most powerful technologies that support learning and are entirely freely available from the internet.

Source: Joint Council for Qualifications, http://www.jcq.org.uk [3]

15. The number of students studying GCSE in ICT reached a high of 109,601 in 2006, but has declined particularly steeply to 73,519, a fall of 33% in only three years. Astonishingly, although there are a host of Key Stage 4 qualifications in ICT, there were none in Computing, until 2010 when OCR launched a small pilot. While it might be argued that this is simply a matter of supply and customer demand, that is to completely misunderstand the power of league table points. Why take a rigorous and intellectually demanding route when you can progress further up the league tables by taking a line of weaker resistance. Awarding organisations need customers and they know they will get more customers the more points they supply to them. We are not arguing against vocational qualification here, there is clearly a place for them but again it should not be at the expense of providing intellectual challenge for those that can benefit from it most. That is why computing should be embedded in the E-bac with a minimum entitlement for all students and that there should be logically planned progression routes from KS3 and on into Post 16 provision.

16. The 2007 report “Developing the future”, sponsored by Microsoft [4], City University, BCS, and Intellect says “With no GCSE in Computing or Computer Science (only the GCSE in ICT which is not about the subject of Computing) learning to use a computer and learning Computer Science become indistinguishable as far as students are concerned. The skew in emphasis has a direct bearing on a

student‟s view of the IT industry; one that results in many negative perceptions”.

17. The 2008 CRAC report [5] “Do undergraduates want a career in IT?” surveyed over 1000 undergraduate Computing students and found that “Although the majority were happy with their choice, only 11% of Computing students felt that the discipline had been strongly promoted to them as a degree choice while at school and over 40% felt that it had received very little promotion there.... The Computing students cited a number of reasons for their choice of degree course. The overwhelming majority of male students appeared to be driven by their personal interest or aptitude for Computing (and a lower proportion, but still two thirds, of females).”

18. The 2008 “IT & Telecoms Insight Report” published by Eskills UK [6] says “The image of IT-related degrees and careers was that they would be repetitive, boring, and more-of-the-same; for example use of IT office applications such as word processing, spreadsheets, and databases”. The next bullet says “The ICT GCSE had a major part to play in creating their (negative) impressions”.

19. A survey of 1000 students in July 2009 by Edge [7], an independent educational foundation, found that a majority (56%) were “unmotivated by three or more of their subjects”. This result is not ICT-specific, but the same survey asked what other subjects the students would like to study instead. The most popular choice was computer programming (22%), beating criminology (21%) and film (18%).

20. The 2009 report “ICT for the UK's future”, published by the Royal Academy of Engineering states "There is an underlying confusion between IT as a fundamental life-skill and "enabler‟ in the teaching of all subjects, and Computing as a scientific discipline, with the present balance skewed towards teaching "software use". Students should be encouraged to explore what goes on behind the IT applications they use, from social networking and messaging tools, to computer graphics and computer games."... "It is essential that a significant proportion of the 14-19 age group understands Computing concepts – programming, design, problem solving, usability, communications and hardware. It is of particular importance to reform the teaching curriculum in schools to differentiate between the learning of genuine IT and the use of IT. Understanding the basis of the subject is fundamental."

21. March 2009 Ofsted report [8] “The importance of ICT” has a particularly detailed assessment of ICT. “The assessment requirements of some vocational qualifications may actually be limiting students‟ achievement. In many of the schools visited, higher-attaining students were insufficiently challenged....much of the work in ICT at Key Stage 4, particularly for the higher attainers, often involved consolidating skills that students had already gained proficiency.”... “Too many of the lessons seen during the survey emphasised the development of skills in using specific software at the expense of improving students‟ ICT capability.”

22. The Royal Society is sufficiently concerned that it has launched a major study on Computing in School, due to report in late 2011. The 2010 NESTA report on the UK games industry pulls no punches. “Instead of building on the BBC‟s Computer Literacy project in the 1980s, schools turned away from programming in favour of ICT. Whilst useful..., ICT fails to inspire children to study computer programming”...”Bored by ICT, young people do not see the potential in the digital creative industries”.

The plain fact is that literally no one is happy with the current state of affairs, not school teachers, not Ofsted, not pupils, not parents. No-one.

Recommendations

23. The Select Committee's review of the EBac provides an ideal opportunity to provide a place for Computing in school learning. There are two main things that should be done at policy level.

24. First, we must clearly establish the idea that Computing is a discrete discipline, distinct from ICT, and one that student should have the opportunity to learn in the same way they do Maths or Physics. This will not happen overnight – apart from anything else there is a tremendous shortage of teachers with a background in Computing – but it would be enormously helpful to articulate the

destination and the direction of travel.

25. Second, Computing must be one of the subjects within the EBac portfolio. The goals of the EBac are to increase the emphasis on core subject knowledge and rigour. The plain fact is that Computing is a core discipline, as important to a modern citizen as Chemistry or French.

3.1 The consequences of omitting Computing

26. Computing is already a Cinderella subject, largely excluded from the curriculum, taught by non-specialists, and with a reputation that is low and falling because of its association with often badly taught IT literacy. If Computing is outside the EBac, head teachers will are most unlikely to focus resources on reversing its decline.

27. Experience shows that intellectually challenging subjects that are not mandated in some form or other have tended to become sidelined and neglected and the way league table points can be transferred between academic and vocational qualifications has exacerbated the problem with ICT. Since modern languages became optional there has been a subsequent collapse in the students taking them at GCSE: only 44% of GCSE students took a language in 2010, compared to 78% in 2001. Most business is conducted in English and so it could be argued that 44% of the population taking languages will still meet the economic need. No such argument could be sensibly supported for Computing.

28. This is not just a UK phenomenon. In the US, where ICT or Computing of any sort is optional, only 40% of high schools offer any kind of Computer Science course (CSTA survey 200711). Indeed, the US is so worried by the lack of Computing education in schools that Congress set up the National Computer Science week in 2010 (http://www.csedweek.org/ [9]) in an attempt to raise its profile. Conversely, in the EU where countries see a subject as of strategic national importance they tend to make it a compulsory part of the curriculum. For example, a 2004 report from the EC12 stated that 20 out of 32 EU countries have computer programming included in their national curricula.

How to embody Computing in the EBac

29. The EBac currently consists of: English, Maths, a science, a humanity, and a language. We have already demonstrated the relationship between Computing, mathematics and science. The best situation would be to include a computing project in the maths and science programs of study that was manageable and strengthened all 3 subjects. This would be built on progression from a compulsory computing element in KS3. For those that want to extend their knowledge a GCSE or vocational qualification could be taken as part of the option pool.

30. A second option would be to make computing one of the subjects that contribute to an EBac. For example, it could be considered as “a science”. Or the EBac could consist of “English, Maths, and three out of: Computing, a science, a humanity and a language”

31. Schools should be strongly encouraged to offer Computing. But it would be unrealistic to require them to do so immediately, because of the national shortage of teachers with appropriate qualifications. This is why having a project approach through the maths and science POS would make an entitlement to computing possible. CAS would support the projects with web based examples and guidance that would be free for all. Effectively our contribution to the "Big Society"

32. The NESTA report has the following intriguing suggestion: “This direct association of computer science with STEM can generate additional benefits: the Institute of Physics suggests, for example, that physics and engineering graduates may be shying away from a teaching career because the general science syllabus they would typically have to teach currently includes biology and chemistry – subjects they often last encountered in GCSE, but might have to teach when they join a school science department. For them, maths, physics and computer science are a much more natural fit.”

Other relevant documents

- Computing at School: the state of the nation. This report that sets out the challenge and

articulates a solution.
- The BCS/CAS response to the Royal Society Call for Evidence on Computing at School15. This document gives a useful summary of the issues in question/answer format, with some graphs.
- Running on empty: the failure to teach K-12 computer science in the digital age16. This 2010 report from the USA shows that precisely the same issues are arising abroad.

Background on CAS

33. The Computing at School Working Group (CAS) was born out of our excitement with our discipline, combined with a serious concern that many students are being “turned off” Computing by a combination of factors that have conspired to make the subject seem dull and pedestrian. Our goal is to put the excitement and intellectual rigour back into Computing at school.

34. CAS is, first and foremost, a grass-roots organisation of concerned individuals, a prime example of the Big Society in action. It has about 500 individual members, most of them school teachers, but with significant numbers working in industry or for exam boards, and members of professional societies. CAS has institutional support from BCS, Microsoft, Google, and the Council of Heads and Professors of Computer Science.
Eurydice report „Key Data on Information and Communication Technology in Schools in Europe 2004 Edition“, http://eacea.ec.europa.eu/eurydice/portal/page/portal/Eurydice/showPrese... [10]
http://www.nesta.org.uk/home1/assets/features/next_gen [11]
http://www.computingatschool.org.uk/files/CAS_UKCRC_report.pdf [12]
http://academy.bcs.org/upload/pdf/royal-society-response.pdf [13]
http://www.acm.org/runningonempty/fullreport.pdf [14]

35. CAS is completely non-partisan: it does not speak for universities, or for schools, or for employers, or for government. Its sole objective is to fix the dire state of Computing education in our schools.

Source URL: https://theingots.org/community/Ebac

Links
[1] http:// http://www.computingatschool.org.uk/index.php?id=documents
[2] http:// http://www.nesta.org.uk/home1/assets/features/next_gen
[3] http://www.jcq.org.uk
[4] http://www.microsoft.com/uk/developingthefuture/default.mspx
[5] http://www.crac.org.uk/crac_new/pdfs/undergraduates_it.pdf
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[7] http://www.edge.co.uk/news/gcse-students-disinterested-in-exams
[8]
http://www.ofsted.gov.uk/content/download/9167/101177/file/The%20importance%20of%20ICT.pdf
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