IBM

IBM UK - Response to the Royal Society's Call for Evidence: Computing in Schools

Context:

IBM UK is one of the largest technology and professional services companies operating in the UK, with ca. 20000 direct employees. Whilst many of its employees are involved in a diverse set of commercial activities – sales, marketing, consulting etc. – a very significant proportion of the workforce is employed in technical roles e.g. software development, IT architecture, systems integration etc.

Almost all IBM employees are educated to at least Level 4, and in many cases to Level 5 and beyond. A minimum requirement for all new hires in IBM is a 2.1 degree classification. However IBM accepts graduates from any degree discipline – STEM qualifications, whilst valued, are not a pre-requisite for most roles.

IBM UK operates several research and development laboratories – most notably IBM Hursley, Europe's largest software development laboratory, but also in Milton Keynes and in Manchester. It is worth noting that generally employees in the Software Development Laboratory are not required to have a STEM / Computer sciences degree – though many do.

IBM Hursley has been directly responsible, over many decades now, for some of the most significant software programming developments that under-pin the functioning of many IT systems globally. IBM UK software developers have helped build and operate the software that put man on the moon, that enables automated cash dispensing, produced the first mainstream relational database - DB2, have developed voice recognition systems etc. and it continues to innovate and create new technologies. Much of the current progress in computing now resides in the application of computing technology, through advances in software development, although there is of course still a requirement for investment in core computer science

It is this contribution to technology which informs this response.

Submission:

IBM undertook an internal consultation amongst members of its 'Technical Consulting Group' and this response is largely based on the result of that consultation. The views expressed are not necessarily informed by a high level of knowledge of the current curriculum in schools, or of recent developments such as the IT Diploma. Nevertheless a number of the group are directly involved in schools and several have young children in schools, so are thus able to use their observations of / discussions with their children to inform themselves.

Despite some very divergent views there was a broad consensus that there are serious issues relating to the current state of computing and ICT education in schools and that there is an urgent need for radical reform. There is no consensus at this stage as to what that reform should be.

Some felt that the problems are so significant that the whole educational system might be regarded as dysfunctional – at least in respect of computing – and not only schools but universities too. Whether this particular view is accepted or not we certainly agree that the current situation is leading to a view amongst students who might be persuaded otherwise, that computing no longer provides an interesting, relevant and sustainable career.

We use the terminology of 'computing' deliberately to encompass a wide range of topics related to computing, so not simply focussing on computer science or ICT - treating computing as an "umbrella" subject would likely cause harm as it risks diluting capability and killing enthusiasm for its many sub-disciplines.

The alignment between the 'mainstream' curricula, with its focus on 'ICT', with the needs of the industry sector is very weak – industry has not articulated its needs as well as it could, it has not done enough to assist the teaching profession to keep abreast of the (rapidly) changing developments in computing and it has not done enough to profile the career opportunities that computing can offer.

More needs be done to raise the status of computing amongst school leadership teams. We need to elevate ICT / computing from being viewed as the equivalent of 'plumbing' to being understood and respected as a challenging intellectual discipline, requiring academic study, rather than simply being seen as a vocational subject. We are not in favour however of an inflexible, forced categorisation of computing as being either a vocational or an academic subject.

We feel that universities need to be far more proactive in both promoting computing within schools (and equally, directly to parents, whose views are hugely important in determining choice of subjects studied and career choices) and thus recruiting students with an interest in the field. Simply 'expecting' appropriately educated students to apply for degree courses in computer sciences / studies is no longer good enough. Universities need to build and deliver comprehensive programmes of outreach into schools and other communities to build awareness, understanding, engagement and enthusiasm. They could learn much from the progress that has been made in other areas of the STEM curriculum where, during the last decade and more, there has been a very concerted effort to engage, to promote 'enhancement and enrichment' activities in schools.

As an aside we were mindful that the current routes and processes for gaining professional accreditation could benefit from some improvement as well – and this might help drive related understanding and thus impact on what is taught in schools – and how it is taught.

We are concerned at the lack of high profile, publicly celebrated role models in computing, to act as an inspiration to young people who might otherwise be interested in this area of study. We observe that whilst few students study law in schools there is no shortage of applicants to universities to study law, and that the calibre of those applicants is generally of a good standard. We believe that to effect change there is a critical need for us all – industry, academia, educators – to come together and act as a single community to promote the successes of such leaders when they emerge.

Related to this we believe that there is little awareness amongst students of the role that technology and computing has to make in addressing and solving some of the grand, global challenges that we face in these times – climate change, sustainable energy supplies, managing resource scarcity etc. Young people in secondary schools are frequently very idealistic and are motivated by what they can do address and ameliorate some of these types of challenges. Demonstrating the potential of computing to address these types of issues would surely be a benefit and would drive increased numbers to study computing.

Related to this is the issue of gender – both the industry and academia are failing to ensure that computing is viewed by young women as relevant to them and thus women are significantly under represented in both the workforce and in academia. Demonstrating the contribution that computing can and is making to the global challenges we face may assist in this.

The quality of careers guidance in this area, as in so many other areas of STEM, is perceived as being beyond very poor, with few Information, Advice & Guidance professionals having any real view or understanding of the sector or the career opportunities ICT offers.

We consider that if the teaching of either ICT or computing in schools is to have any real prospect of success then not only will the curricula have to change, but the knowledge and skills of teachers will need very radical enhancement. Very few existing teachers of either ICT or computing have any prior knowledge, formal training or industry experience of the development and application of computing technology. Furthermore there is comparatively little established pedagogy relating to this discipline. Without extremely significant levels of investment in training, including provision of work related learning opportunities for teachers, and in establishing an agreed pedagogy for the teaching of ICT and computing, then simply making changes to curricula or investments in other related areas is only likely to result in continued failure.

We considered the question of what areas of study at GCSE / A Level might better prepare students to embark upon a computer sciences / studies degree course and there was significant divergence of opinion, with those feeling that some study of the subject before applying to university was essential. However others felt that studying mathematics at A level was a very good preparation. All felt though that whichever route taken, a focus on subjects that encourage the application of logic, reason and computational thinking is essential. In our discussions there was an awareness of the competing demands from ‘special interest groups’ for inclusion of their issues / subjects

in the curriculum, which might result in a diminution of depth in critical subjects, if acceded to. We appreciate that the curriculum cannot offer everything to everyone. We would probably advocate for a better quality of education in fewer subjects therefore.

Lastly, we felt that the educational establishment must embrace the fact that many students studying either ICT or computing, may well be more competent than their teachers. Thus non formal learning opportunities delivered through self-motivated and self directed extracurricular activities such as school STEM clubs can have very beneficial effects both for students, their teachers and their respective educational establishments. Many of the participants observed very forcefully that their own routes into ICT and computing had been through self directed activities, mostly at home. We believe that given the current state of affairs, non formal activities are likely to be THE best and in this moment in time, the most affordable and thus pragmatic, means of moving forward in the short to medium term.

Appendix: Detailed Responses to Questions:

1. Is computing a discipline, like mathematics, physics, chemistry?

On the question of computing as a discipline, the participants thought that it can quite clearly be perceived as such, but that the lines blur when comparing with more traditional subjects (we would posit that the pure sciences are subjects rather than disciplines!), such as mathematics and sciences. These have a strong heritage which is firmly embedded in the history of education.

It was, nevertheless, agreed that there is a mathematical approach to computer science that is not unlike like physics or chemistry in its educational needs. Furthermore, computing is a “catch all” term and can be broken down into multiple competencies, such as application (use), architecture, software engineering and so on. This was supported by the view that computing is somewhat young discipline in comparison to many other sciences.

It was agreed that computing can therefore be broken down into separate teaching components which fall into one of number of tried and tested teaching areas such as logic (Boolean and continuous), physics (electronics) and so forth. What is not clear was the relation between more formal sub-disciplines and ICT. As an analogy it was observed that whilst architects study some structural engineering, and structural engineers study some physics and chemistry, those disciplines are quite distinct. This principle applies equally within computing.

2. Is programming a fundamental form of literacy for the modern age?

The participants see programming as different to traditional literacy in that literacy calls on a completely separate set of thought processes and skills. Literacy relies on complex intertwined rules of syntax, social awareness, contextual reference and so on, whereas programming mainly calls on analytical and logical thinking

Several were keen to point out that, on the one hand, you don’t need programming to function in the modern age, but that, on the other hand, computers and technology are commonplace and an understanding of even the most basic level of computer language(s) could therefore be beneficial, especially in terms of providing more options for students early on in their education.

The general consensus was that programming is useful as it provides a means of learning problem-solving approaches needed to use commonplace technologies (software applications) such as Facebook, and that simple acts, such as setting preferences in such technologies can be been seen as simple problem solving tasks, that in turn might lead to more intricate programming and logic based problem solving.

3. What purpose should the teaching of ICT and computing in schools serve?

Comments received suggested that ICT and computing should serve two purposes: firstly to allow informed use of everyday IT systems for all, and secondly to help those who wish to eventually develop the skills needed to work in the IT industry. It was also felt that it should help individuals become informed consumers of IT.

4. Is the teaching of ICT (and accompanying qualifications, such as ICT GCSE) fit for purpose for all students? What should be done to address this?

With regard to the first question participants agreed that (anecdotally) the evidence does not support the proposition that teaching and accompanying qualifications are fit for purpose. The current GCSE in ICT in particular is viewed very negatively – a weak curriculum that does not stretch or engage students, and in many instances serves only to put students off ICT / computing (students frequently viewing the two as analogous).

They felt in particular that computer languages have changed and that the educational system has not taken account of this.

The consensus was that nowadays it might be better to teach students how to 'orchestrate' technology rather than just "play" with it. This is because technology is all around our youth and they need to know how to use ICT.

It was felt that there seems to be a significant lack of any relationship between computing as taught in schools, and computer science (or similar degrees) as taught at university level. In particular the participants were frustrated that the high extremely high dropout rate amongst computer science students at degree level and the apparent blame for this failure that universities are placing on schools and the curriculum / qualifications. They believe that this misses the point – that it is more about the fitness for purpose of the university curricula!

The participants thought that ICT and computing in schools could follow a structured progression which clearly connects to further education, and aims to prepare and / or motivate students towards a possible career in computing, instead of simply providing a basic level of computer orientation.

ICT and computing could also aim to form a modern understanding of more technical components than it currently does, for instance, simple HTML, network fundamentals and so on. This would basically offer entertaining and rewarding opportunities for students yet still promote pragmatic methods towards producing tangible results – both in terms of qualifications achieved and technical artefacts produced through assessed course work. Schools could bring in projects for students e.g. based on social networking, building basic web sites etc. - all of which should aim to stimulate as well as educate. From this it was clear that the participants considered that "the fun had gone out of computing" for students and that this was a real shame. This led onto a discussion on the IT profession keeping its own house in order and the opinion what we (the IT profession) need to promote professional accreditation as the IT profession is weak in this area.

It was also mentioned that very few role models exist in IT and that there even fewer in computer science. This is a significant factor in turning young people away from computing. All agreed that when such role models do appear, the industry should actively support their development and public exposure.

5. Is computing and ICT best "taught" in classrooms or "learnt" by other means? How do learners learn computing and ICT skills?

Several commented that hands-on work is essential. Although the creation of appropriate facilities and materials required to enable relevant learning processes is not easy, the Imagineering Trust, as an example, had successfully overcome the problem in respect to engineering and Lego Robotics events point a way forward for computing.

6. What motivates students to study computing? Is ICT what they learn in school or something else?

The participants agreed that nowadays there are a lot of freely available resources to teach computing away from the traditional school environment. Many students interested in computing will teach themselves the basics from an early age, thereby bypassing any teaching that might be available in schools. The educational system should be sympathetic to this. For example, some youngsters might be creating their own iPhone applications in their spare time, but they get little or no educational credit given for this - yet it is exactly this sort of self motivation and initiative that is the lifeblood of professional practice.

Such individuals may well have more computing knowledge and skills than their teachers but this is not respected or utilised by educators. Many teachers do not have the required skills and just follow a book to teach ICT / computing. This is a poor reflection on the modern educational system. To remedy this participants recommended the idea of more after school clubs, competitions and projects. They further agreed that more support and supplementary education should be available for experienced self taught students. Computing in schools should be more enjoyable and encouraging to the students. Experimentation should be encouraged through practical example and experience. In particular the participants pointed towards Imagineering and Young Engineers Clubs as good exemplars of this approach.

Again it was mentioned that an appreciation of computing s lacking today and that “the real magic of how things fit together” is losing appeal amongst today’s youth. This was seen as a pity as computers are almost ubiquitous today. They are in cars, kitchens…everywhere, but education appears not to convey the universality of such devices or their inherent wonder.

With specific regard to the first question the participants assumed it meant “to study computing at university". As a result it was felt best to distinguish between "study computing" and "gain some knowledge and skill in it". The latter might come at university but not result from a computing degree. The participants believed one of the motivators that differs from general drivers in all kinds of subjects is the ability to quickly build something that responds (a program) from something that doesn't (some code). In such a way computing is unique in that “it’s much quicker than building a steam engine from plans.”

6. How is computing presented at school, and is there a variation between schools? Why?

This question was not answered, due to a lack of an informed perspective.

7. Who is teaching computing, and what qualifications do they hold? Are teachers sufficiently supported with subject-specific CPD? Are there enough specialist teachers? Why do they leave / join the profession? What are the barriers to improving the situation?

Participants felt they had little insight into this issue but were nevertheless of the view that there were very few teachers in schools who possess the requisite knowledge and experience to teach computing well. CPD opportunities are very few. There is a view that rather than teaching computing badly it might be better not to teach ICT at all in schools, rather than risk further damaging students experience and understanding in this area.

8. Why do some universities prefer their undergraduate applicants to have studied mathematics rather than computing at A-level?

The participants considered that mathematics is a clear and traditional subject whereas computer science and ICT are not. They felt that mathematics also involves logical and analytical thinking and that universities do not trust the school and college curriculum in computing. They agreed that most teachers don't understand or appreciate computer science. Some (not just teachers) believe it is better not to teach computing at all at a more junior levels. Others, however, believe that if we had teachers from industry, the educational experience would be more beneficial.

The participants commented that computing evolves fast whereas mathematics is rather more static, so most teachers have had time to get to grips with the fundamental. The fundamentals of computing are still emerging however and this has to act as a deterrent. It was also felt that mathematics is a clear discipline that cannot be done well without ICT skills these days. They asked if perhaps computing at A-level does not demonstrate any evidence of promise at ICT then why have an ICT A-level at all? Maybe it is better to focus only on ICT literacy and, say, have a GCSE in ICT - or maybe not even that.

9. What are the perceptions of computing and ICT amongst learners, teachers and head teachers? How can information, advice and guidance be improved?

The opinion was expressed that "everyone splashes around in the shallows of the Internet" Whilst this is a great observation there was a need to "sell the kids on diving deeper." Again the lack of role models in computing was touched upon.

The participants felt that influencing head teachers and enabling the teachers under them is key factor in the success of computing in schools. Passionate teachers are also extremely important. If a teacher is passionate that will be reflected in their students.

Again the opinion was passed that anecdotally teachers and head teachers are usually at the level of informed ICT consumers at best, and have no access to materials and approaches that help them learn or teach computing in an adequate or inspirational manner.

10. Are these issues unique to the UK?

We have no information that enables us to make any informed comment on this question.

11. What (should) can universities do to improve the situation?

We suggest that one of the key success factors would be to get the head teachers more interested and informed. This would directly help to motivate currently frustrated teachers.

Furthermore, universities should “get out there” and speak directly to the ICT and computer science champions in schools. In addition it was considered that open days are always successful, that computer science degrees should have more publicity and there should be more encouraging advertising to students.

This sentiment was summarised in the view that universities should become more proactive in reaching students before they enter higher education: holding events, funding projects, engaging children in enrichment activities and so on. Universities should not assume that the students will come to them.

It was also felt that continuity across preceding levels of education is paramount and that an appropriately structured and beneficial pre-university curriculum would set the students up for their careers and the real world. Accordingly universities must strongly communicate their requirements and promote potential post graduate careers. They should decide to take the creation of an understanding of, and constructive relationship with, the IT industry seriously, and then work to create an appropriate academic discipline focussed on real-world industrial need. This relationship should not only be based on viewing students as prospective employees but also as researchers. The current university IT community was perceived as being too self-contained and insular.

12. Is there a case for curriculum reform? Is this the barrier?

There was a view that this might be attributing the wrong solution to the wrong cause – much as a bad workman blames his / her tools, but as noted above the current GCSE in ICT is generally seen as inappropriate and should be either removed or radically changed.

13. Is there a need to increase recognition of ICT & computing as part of the T in STEM, through representation in STEM fora and increased funding?

Our short answer is ‘yes’ - there is. The T is largely silent, and covers any number of activities that have little or nothing to do with computing (but which are nevertheless critical, interesting and worthy of study). Industry, academia and educationalists all have a responsibility to address this individually but more constructively, together. We observe too that little other fundamental research in STEM these days is undertaken without the aid of computing in some form.

14. What if we do nothing?

The participants strongly felt that at the global level computing skills are needed for the future of technology – but IT is largely a global market these days.

Without enthusiastic young people the future of technology is uncertain. With regard specifically to the UK, the participants were in agreement that without a regular cohort of well educated and trained young people emerging from our universities, the indigenous industry will die out here and that without the educational system in support we (‘UK PLC’) will have little relevance or value going forward. The demise of the computing sector in the UK will have a serious and long lasting impact on UK economy.

15. How might learners learn computing skills outside the curriculum?

The participants suggested a number of ideas such as competitions that youngsters would really enjoy. Activities and competitions must be contemporary in their appeal and the example of 'World of Warcraft' was given as a successful example in the gaming arena (not withstanding a debate on the appropriateness of promoting warfare through gaming or its lack of appeal to many young women!). There was agreement that the gaming industry and social networking should both be held up as examples of the application of technology in promoting technology to the younger generation. Apple's work with the iPhone and iPad was also admired.

In general it was felt that whatever activities were offered, they should lead and encourage youngsters to get involved in less immediately appealing activities such as programming – a 'learning by stealth' type of approach.

The participants agreed that activities such as the Young Engineer Clubs, the Imagineering programme and Computer Clubs for Girls schemes, each in their own way provide good models of how to stimulate interest outside standard curricula. They considered that creating physical artefacts which involved programming through the use of cheap kits was an ideal way encourage interest and develop practical skill at the same time. They also felt that such initiatives might be run in conjunction with STEM Clubs or something similar to young engineer clubs.

16. What does IBM look for and what can they do to help?

As might have been expected our participants were quite vocal on what IBM looks for and what they (IBM) might (should) do to assist. Specifically they believed that more graduates with good problem solving skills are needed and specifically those with strong logical and analytical capabilities. They also felt that graduates with confidence and drive who have an interest in technology, but not necessarily a technology degree or experience, are of great value. But that this needs to be coupled with good 'employability' skills.

It was felt that IBM needed to introduce more basic technology training for graduates entering the organisation. This is missing across most of industry today and all agreed that the idea of an apprenticeship should see a revival (IBM has recently started a small scale apprenticeship programme).

It was also considered that mentoring of students, both in universities and schools, by experienced IBM staff would add significant value for all parties. Finally the participants agreed that IBM events such as open days and "Blue Fusion", where students come into IBM and participate in enjoyable and stimulating projects involving technology, serve a valuable and relevant purpose.

IBM staff contributing:

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Erwin Frank-Schultz, Executive I.T. Architect
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