Consultation on computing in schools.

An Institute of Physics response to the Royal Society.

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5th November 2010

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The Institute welcomes the opportunity to submit a response to the Royal Society on computing in schools.

In our response, we have distinguished between ICT and the subject of computing (and computer science), for which the issues are quite different.

Prof. Peter Main
Director of Education and Science
Question 1

Is computing a discipline, in the same way that mathematics, physics, chemistry are?

Computing in schools falls into two areas: ICT and Computing (or computer science).

ICT develops a familiarity with computers, their software and applications as tools for everyday use and to support other disciplines. It enables students to become fluent and proficient in the use of word processors, the Internet, spreadsheets, creative packages, etc. ICT is comparable with English Language and basic maths – a life skill and a tool for learning - rather than say, chemistry or history.

There is also a subject called Computing (at A-level leading to Computer Science at degree level) which is not to do with the use of ICT, but its creation and development. The A-level in Computing is not typically an entrance requirement for HE courses in Computer Science; so computer science as an independent subject in schools has something of an identity crisis – probably linked with its history and how it has been perceived as a soft option (which is not the case 1).

In HE, Computer Science does exist independent of other subjects but its essentially interdisciplinary character makes it better thought of as a subject rather than a discipline.

Question 2

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

Broadly no because that is not the way most of the population, even scientists, use ICT professionally. Most computer application involves using various forms of software, for calculation, visualisation and presentations.

Programming is appealing and accessible to some students; so it would be an advantage to give them access to the experience of analysing and solving problems through algorithms and programs in order that they have an opportunity to discover their interest and skills and then develop them. However, at any high level, detailed knowledge of programming languages is best left until later and can be covered by people who specialise in it, although some of the more sophisticated mathematical software does blur the distinction between usage and programming.

Question 3
What purpose should the teaching of ICT and Computing in schools serve?

ICT in schools should provide the basic skills, including understanding the basic metaphor of common operating systems, learning to touch type, etc., for everyone. It is as vital as literacy and numeracy in this modern age and therefore needs its place within the school’s curriculum as a discrete core subject (at least to key stage 3). And, just as with literacy and numeracy, ICT teaching and learning should also be set in contexts that are relevant for future use of the facilities – not just using ICT for the sake of using ICT. For example, they might use a spreadsheet for graphing, statistical analysis and even modelling dynamic situations.

At a more advanced level, computing has a role to play in developing other capabilities: logical thinking, designing and following algorithms and some simple programming. Students (with an interest and aptitude) should be given access and exposure to these ways of thinking to determine whether it is something they would be interested in following beyond school.

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

Students should be explicitly taught how to use packages for word processing, presentations and data analysis. They should also be given access to creative packages (drawing, photo-editing, video editing and music) and given opportunities across the curriculum to improve their confidence and practice their skills. Clearly, ICT policies in schools mean that this may be more or less successfully achieved, depending on whether the implementation across the curriculum and across key stages is seen as a coherent whole, which is not always the case. It is essential that every student should be required to use ICT skills across the broad range of the curriculum and learn by doing as well as being told.

Pupils may enter secondary school with a very varied range of previous experiences and expertise, depending on access and use at home and at primary school. This difference in entry expertise is not easily addressed in schools, but remedial support for pupils in ICT might need to be available.

Computer programming and computer studies are most likely to be a taught subject. There will be some children who involve themselves, as a hobby, in the programming and the way computers work. However, in school, it is best developed as a part of the timetable, rather than across the curriculum. It is distinct from ICT and is probably best accommodated as a module within technology teaching.
Question 8

Who is teaching computing and what qualifications do they hold?

At this stage in the development of computers and computing, school teachers of the subject are largely self-taught users. This works well for ICT (because every teacher has some input to the development of ICT skills across the curriculum). It is less effective for computer science where teachers would be classed as non-specialist.

There are barriers: computer science graduates are not strongly attracted to teaching, and physics/maths graduates are already in short supply in the teaching profession. There is a great variation in who is teaching ICT and computing. For many it is not their first subject. In one school, the head of ICT had had a PGCE in Business Education, the deputy head of faculty was a linguist and other teachers were from art and design and history backgrounds. This is fine for ICT, but may not be so useful for teaching computing.

Another issue is technician support in schools - this varies from school to school in terms of quality. In one school, the ICT teaching staff struggled to deliver lessons with the facilities they had and put off other teaching staff from attempting to use the facilities.

CPD is variable. ICT staff offer training for colleagues, but this needs a whole school focus and push to make it happen realistically.

Question 9

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

Probably the most important skill in programming is to be able to follow a logical pathway: coding the logic is easier to learn than the underlying mathematical skills. From a physics perspective, university departments are happy to teach the programming skills they see their undergraduates as needing. However, they will expect, of course, that applicants have the basic computing skills.

In terms of HE entry to computer science, departments will tend to teach the subject from more or less first principles, so a background knowledge of computer science is less important than an overall facility in logical reasoning. They may also have more confidence in the standards of mathematics A-level.

Question 13

Is there a case for curriculum reform?

The teaching of ICT varies between schools but there is not a great need for systemic reform. The opportunities, funding and teaching skills are largely in place as long as individual schools find a way to manage it effectively. Even when it is unmanaged, the
use of ICT is so pervasive that most school children have a good opportunity to develop fluency.

However, there is a case for reform of Computing (or Computer Science) in schools. Computer Science at university needs to attract well qualified students; therefore they need to have some understanding of what the course might entail through their studies at school or college. So there needs to be a clear pathway that provides students with useful experiences, understanding and skills on their way to a Computer Science degree; the AS level and A-level ought to be part of this pathway. At the same time, Computing at A-level should develop skills that will be useful to other degree courses in the sciences and engineering. Whilst it is true that most scientists do not (and should not) write computer programmes, there are many skills that can be usefully developed through computing: logic, systems analysis, algorithmic approaches to problems and digital processing.

The same argument applies to students who might do Computing after the age of 16. They need an understanding of what that involves with exposure to some of the aspects of programming, analysis and design that they would get in the AS level. This should be practically-based (computing in the past has suffered from too much bookwork – learning structures and theories) and could form a module in a technology cycle. It should not be a large, compulsory subject but sufficient to give younger students a taster and an indication of aptitude and latent interest.

**Question 14**

*Is there a need for an increased recognition of ICT and computing as part of the T in STEM, through representation in STEM forums and increased funding?*

As stated above, the main purpose of ICT in schools is to provide a tool, equivalent to literacy and numeracy, to support learning in other areas. Consequently, what is most important in STEM discussions is a realisation of that role, which would imply a higher profile of ICT in STEM forums. However, the shortage of well-trained teachers and, possibly, the relative lack of involvement of a relevant professional body in education at this level mean that there is a long way to go in delivering that higher profile.