The Higher Education Academy Information and Computer Sciences

The Higher Education Academy subject centre, whilst mainly being associated with the HE sector, has been in existence since 2000, initially as the LTSN subject centre. The work in Higher Education has been, like all subject centres, the promotion of all aspects of good practice in Teaching and Learning in the subject and has focussed to that remit.

Notwithstanding that it has been impossible over the years not to recognise the problems in the discipline, many emanating from the perception of the subject, the introduction to the subject at school level, and the subsequent decline in numbers applying to study it at Higher Education since 2001. These factors have been identified from many sources. However from the perspective of the Subject Centre two key issues emerge and form a common thread throughout the responses below to the fifteen points:

1. The confusion between ICT and Computing Science: the distinction needs to be clearly elucidated and a full understanding of the fact that they are not one and the same.
2. The role of teachers and career advisors in schools: subject teachers with appropriate qualifications and skills: access to regular and relevant CPD for teachers of the subject.

The subject centre welcomes the initiative and the opportunity to respond. In responding the intention is a clear distinction between Computing Science and ICT, and the use of either term is not intended to embrace the other.

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

Computing science is very much a discipline in its own right. Creating complex Software Systems is as much a challenging discipline as all other branches of STEM employment. Software system development demands the formal application of rigorous design, development and testing methodologies.

In contrast ICT as a discipline is also a key skill in the modern age, which all should acquire. It could be expanded to a higher level for professional roles such as systems managers in major organisations.

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

To make programming a fundamental form of literacy as those associated with proper use of language or even numeracy skills is to belittle the challenge of creating even the most basic workable programs. Programming is one of the significant components of Computing Science within a broad spectrum of competencies required of a competent practitioner. Where confusion arises is in the use of computers and associated software packages. These are ICT skills and could well be argued as a fundamental form of literacy in the modern age.

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

Problems arise here in the association of ICT and Computing Science and this leads to great confusion with students

As stated in 2 above, one is the use of Computers as a tool and the other as the proper methodology behind the development of such tools and indeed other applications. It might be expected that the teaching of ICT should commence with the use of basic IT packages and expand at higher level into the efficient and appropriate application in the commercial world. Probably to be used in many cases by non computing professionals, for example Accountants, Statisticians and others involved in general Business administration activity.

The teaching of Computing Science should be promoted as a scientific discipline associated with the development of the systems used above and other applications in industry, such as embedded systems. Thus it needs to be directed at students interested in Software Development itself and divorced from ICT skills per se.

To make an analogy engineers design and build cars but a significant proportion of the population can drive them.

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?

There is anecdotal evidence that both teachers and students find ICT somewhat tedious and boring, causing frustration with the subject. Problem for schools is that students studying the subject have varying levels of ability within the same class. This depends very much on their exposure to the subject outside the classroom. Schools themselves are also driven by league tables and there is the perception that getting a good grade supersedes what might be the most appropriate subject to study to get maximum benefit, whether for higher education admission or employability skills. ICT might be seen to have an advantage in respect to subject difficulty, although results at examination do not necessarily bear this out. To address the issue for all students there needs to be a clear distinction between ICT and Computing Science and clear guidance of such.

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

Both the classroom and laboratory environments are very necessary in order to acquire the skills of both ICT and Computing Science. In teaching the subjects in a formal classroom setting the nature of the subject may make motivation a problem so substantial elements need active learning activity in a well equipped laboratory with modern technology.

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

No doubt the proper motivation for computing science is the scientific challenge of creating computer systems. However one suspects this is not always the case and indeed may be the minority. Students are influenced by the use of everyday technology, whether it is communication technology in the broadest sense or the entertainment value of technology. This creates a false sense of the discipline and the skills needed to succeed within the profession. There is an onus on teachers in ICT,

Computing Science and Careers to impart correct guidance in order to steer pupils on an appropriate career path through subject selection in school.

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

This can depend on the teacher and their background and experience of the subject. Very often the applications are emphasised and the scientific and technical aspects diluted.

8. 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?

Those teaching Computing Science and ICT have in many cases taken up the subject more through accident than design. In particular ICT teachers have been allocated the subject by a school principal who needs the subject covered and allocates to someone who may just happen to be more proficient in the use of computers and computing packages than others. A minority have formal qualifications in computing. Whilst this is not by any means ideal for ICT teachers it is more of a problem for teaching Computing Science itself.

All teachers have similar working conditions and presumably access to CPD. Nevertheless probably no subject has had such rapid change and diversification than computing so there is a need for special training for teachers of computing. Historically universities provided 'conversion masters' programs, which were often taken up by teachers, in order to expand their undergraduate qualification into the skills of the subject. These programs were discontinued some years ago, in line with National Qualifications Framework guidelines, although many universities do provide suitable advanced masters degrees. These however require a time commitment, whether for attendance or self study, which many teachers find difficult to find.

Other factor is that salaries in Computing Science in the commercial sector have been quite attractive and thus there is not the same incentive for graduates in the subject to enter the teaching profession.

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

Mathematics in particular and even STEM subjects in general, are deemed to indicate suitability for studying the subject at university level. Historically early computing science courses practically all required mathematics but at that time the curriculum itself was considerably different, with greater emphasis on logical analysis and the earlier generation of programming languages. Thus historically mathematics was an attractive subject. In the current generation it is difficult to say why mathematics is more attractive to university admission than computing science itself. This creates great confusion at school level, both with teachers and pupils. Some of the problems already alluded to indicate a probable lack of confidence about incoming student's knowledge. i.e. who taught the subject at school, what was the school teachers knowledge and qualification in the subject, what curriculum was followed, was it computing science or ICT? The curriculum for Mathematics is well known and trusted and indeed mathematics is a 'fall back' subject for many disciplines.

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

There is very much a perception that this is a 'geeky' or 'nerdy' subject, to use two terms to describe those who are seen to engross themselves in computing to the exclusion of other aspects of life. Very often the media do not help, with the computing person portrayed as described. The good news and benefits technology have provided to society fail to overcome the other negative aspects which attract worldwide news. The internet has had a significant bearing on this, with regular news of inappropriate access to and use of material. This can have a considerable influence on parents of those looking at career paths. This image, which can be evidenced form school surveys, is often seen to be one of the main reasons for the failure of females in large part, to take up the subject.

In addition to guidance at school the good news needs to be better shown and promoted. The general public fail to realise that all aspects of modern day technology, such as mobile phones, entertainment devices, on line booking systems, ATM banking systems are all as a result of computer technology development. The industry itself has a significant role to play in disseminating what a career in the profession entails. Careers in medicine, law, engineering, accountancy etc. are common knowledge but in many cases careers in computing science are unknown to a wide section of the population.

National schemes such as "More than you think" (http://www.morethanyouthink.com/) and CS4FN (http://www.cs4fn.org/) are examples of how such information can be disseminated.

11. Are these issues unique to the UK?

Not so, evidence from ACM and IEEE in the USA indicate similar issues. Countries in Asia appear to have benefited from worldwide communication infrastructure, with Western organisations outsourcing work. As a result the profession is seen as more attractive in emerging economies.

12. What can universities do to improve the situation?

With a perceived lack of understanding of what study of the subject at Higher Education is about, there is a greater need for universities to engage with schools in relation to this discipline than in others. Some activity is already taking place through cs4fn in London, BringITon http://bringitonni.info/ in Northern Ireland and the work with the Computing at Schools consortium. In Scotland the university computing science community are having input to the school's curriculum.

The HE Academy subject Centre for Information and Computing Science, being based in Northern Ireland, have facilitated a community of interested local agencies and stakeholders, including the sector skills body for the subject, e-skills, Momentum who represent the Software Industry in Northern Ireland, the Departments of Employment and Learning (DEL) and Education, Invest Northern Ireland (INI) and the two main university providers of graduates, to facilitate proactive engagement with schools. This initiative received financial support from DEL and INI and has shown to have had significant benefits regarding uptake of the subject and as an invaluable method of disseminating careers information. Input from individual industrial and commercial companies was a significant factor in promoting careers awareness. Whilst this initiative as a model would require a significant increase in scale in England, a more local or regional role for school, university, industrial and public body engagement could be of benefit.

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

Curriculum reform is certainly one aspect. The fact that school qualifications in the subject do not get proper recognition by Higher Education providers means that the continuum from school level into HE needs investigation. This lack of recognition means the value of qualifications such as an 'A' level in computing science needs to be clarified to school teachers and pupils.

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

Computing Science, Information and Communication Technology and Software Engineering, embrace three of the terms within STEM and the importance of Mathematics has already been identified. Yet Computing appears to be excluded from many of the STEM promotion and funding initiatives. If it is not recognised as a core part of STEM one could argue using STEM as an acronym for the remainder is incorrect. Clearly it is the science of designing and engineering technology and needs to benefit from all initiatives associated with STEM.

15. What happens if we do nothing?

Already organisations are outsourcing development work to countries in Asia and the Far East. Whilst the advantage of lower wage economies has appeal in the commercial world, indications from industrial managers are that the lack of available skills, particularly the higher level skills, are a factor in their deliberations to outsource.

Presumably doing nothing will see a continual decline in good graduate output in the subject and subsequent loss of this sector of the economy.

Professor Gerry McAllister
Director HE Academy ICS Subject Centre
Faculty of Computing and Engineering
University of Ulster
Jordanstown
Co Antrim BT37 0QB
email: hg.mcallister@ulster.ac.uk
Tel: (028) 90368156
Mobile: 07904305335
Fax: (028) 90368206