Working Group 9: Curriculum - Advancing Understanding of the Roles of Computer Science/Informatics in the Curriculum

Policy Paper

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Introduction
Computers are constantly becoming smaller, cheaper and more powerful and Information Technology (IT) more diverse and personalised. IT increasingly pervades many aspects of everyday life, for example in business, leisure, social and sporting aspects in most developed and developing countries. This technology revolution has major implications for the current and future education of the world citizens. However, the IT in Primary and Secondary Schools hand-book produced by a range of IT in Education experts across the world (Voogt & Knezek, 2008) and previous Edusummit discussion papers has shown that the school curricula in most countries have been slow to respond to this technological revolution and struggle to keep up with the education needs for a 21st Century work force.

Relevant Research
Arguments for the inclusion of computer science/informatics in the core curriculum to meet the needs of educating children with 21st century skills have confirmed the importance of computational thinking. A large body of evidence over more than 40 years (Voogt & Knezek, 2008; Edusummit2015 - Working Group TW9, 2015) and substantial research conducted by
Papert (1980) and more recently by Wing (2008) has shown the value of creativity in problem solving using computers. Previous research has shown that the key concepts, such as abstraction (generalising solutions), data representation (simulations and modelling), automating solutions (algorithms) and design thinking all form significant foundations for not only computing skills and theories but also for many other traditional subjects in the curriculum such as Science, Mathematics, Geography etc. Design thinking emphasises a critical aspect of the argument; i.e. that school students should become creators of digital systems and content, not mere consumers.

**Innovations in The School Curricula**

Over the last two decades many IT – resource rich countries have been strongly differentiating between ICT as the use of computers in the support of teaching and learning of other subjects and Digital Technologies as a subject which encompasses computational thinking and coding. The former has been adopted more easily and readily by schools in many countries because it requires fewer fundamental changes in teachers’ pedagogies and could be flexibly interpreted by individual schools. However, as a consequence of the substantial evidence discussed above and summarised in the TWG9 discussion paper (Webb et al, 2015) and the concerns and recommendations of industry and commerce, many countries, including the UK, the United States and Poland have taken the firm view that the computing curriculum is for all and adopted this new subject into their respective national curricula (as of 2014). In reality though, student access to computing resources can be problematic for schools trying to comply with teaching a Computing curriculum. Some countries, districts and individual schools, e.g. New Zealand, have been addressing this by adopting the traditional Computer Science teaching methods of the 1970s by producing learning materials which do not require machinery (CS unplugged).

**Issues and Challenges for Practitioners and Policy Makers**

The TWG9 working group has identified a range of issues and challenges which Practitioners and Policy Makers face in order to address the need for educating all their students in Computing within a CS/Informatics curriculum. The key ones are summarised below.

1) **Is the IT Resource provision and infrastructure in schools adequate?**

There are a range of government strategies to meet the extensive IT provision needed to resource a CS/Informatics curriculum. These include policies such as: providing one-laptop-per-child in a school; bring-your-own-device with varying levels of connectivity and support; large-scale networks of desk-top computers; and thin client technologies. Increasingly it is recognised that broadband Internet connections are also needed to resource an effective CS/Informatics curriculum.

2) **Are there sufficient teachers in schools adequately trained to teach CS/Informatics curriculum.**

With the shift from ICT across the curriculum incorporated by teachers of a range of different curriculum subjects to a requirement for schools to deliver a CS/Informatics curriculum there has been an urgent need to train existing and new teachers in this subject. To date, in most developed and developing countries there are insufficient specialist computing teachers to teach this curriculum in all schools (Webb, 2014).
3) Does curriculum design in all subjects, as well as in the CS/Informatics curriculum, support computational thinking of all students?
As with other core subjects such as mathematics and the mother tongue language, computational thinking is relevant to many areas of the school curriculum yet it is still not an established component of the more traditional subjects.

Policy Recommendations
Policymakers should recognise the relative importance of the computer science curriculum as a means of supporting the country’s economic needs for computing professionals compared with the need for learning opportunities and learner engagement.

1. In order to address the 21st Century economic and educational requirements there needs to be enough teachers with strong subject knowledge who have also received appropriate training in pedagogy specific to computer science learning.
2. In order to address the shortage of computer science teachers more people with computer science degrees need to be encouraged into teaching.
3. Curriculum specifications for schools in computer science should recognise the dual rationale of developing expertise needed by computer scientists/computing professionals as well as the importance of computational thinking of all students.
4. Opportunities for computer science teachers need to be identified and supported with professional development to engage with other teachers to develop cross-curricular opportunities for computational thinking.

References