Moving to mainstream: developing computing for all

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ABSTRACT

In 2018, the Department for Education in England awarded a contract for over £80 million for a 4-year programme of development of teacher training and student resources in computing. Together with a mandatory curriculum for computing for all children aged 5-16 since 2014, this represents one of the most substantial moves towards educating all children in the discipline of computing in the world. This initiative focuses on supporting and developing teachers in order to establish computing as a core and foundation subject. Such a large-scale and lengthy project has the potential to deepen our understanding of what works in computing education, and there will be much to explore and report on. In this keynote presentation, I will look at research opportunities, and how this project can feed into the global computing education research agenda and contribute to our understanding of what computing for *all* children means in practice.

CCS CONCEPTS

• **Social and professional topics → K-12 education**.

KEYWORDS

computing education, professional learning, K-12 education

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1 INTRODUCTION

Many countries are introducing computing as a subject in the curriculum in a range of different ways - in secondary schools, primary schools, as mandatory, or as an elective. At the other end of the scale, some countries are still undecided whether to implement digital education at all. In England, Computing – a broad discipline including computer science, information technology and digital literacy – was introduced as a mandatory national curriculum subject in 2014. It is now being taught to all children aged 5 to 16 in schools following the national curriculum [1].

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Teaching computing to all children is not just an issue of generating suitably qualified IT professionals from the education system. There are compelling reasons for mandatory computing beyond economics and employment. Access to a high-quality computing education can be seen as an equity issue. The recent curriculum framework for computing launched in USA states that *"Computer science for all students requires that equity be at the forefront of any reform effort"* [3]. Similarly, the English national curriculum requires that that *"all pupils can understand and apply the fundamental principles and concepts of computer science and all pupils can analyse problems in computational terms and have repeated practical experience of writing computer programs to solve problems"* [2]. These requirements bring with them the need to challenge stereotypes around who is able to study computing. We need to prepare all young people for a world full of technology that does not yet exist and ensure that an understanding of technology is an entitlement not a privilege. This goes beyond basic digital skills; our rapidly changing world means that a more thorough understanding of how and why computers influence every aspect of our lives is needed.

In addition, the discipline of computer science engages certain ways of thinking, broadly referred to as computational thinking skills, which are useful for the kind of problem-solving involved in computational subjects [6]. This extends to the computational analysis, design and algorithmic thinking involved in a range of subject areas such as science, engineering, medicine, finance and economics, all increasingly using computational modelling. More broadly, proponents of the computing curriculum in England have argued that the development of these thinking skills will prepare students for the kind of problem solving they will be doing in the modern world regardless of vocational or academic interest [4].

With computing throughout school education, there is much we still need to understand around making topics accessible and supporting learners of all ages. The need for high-quality research in this area is greater than ever before [7].

2 TEACH COMPUTING: A NEW INITIATIVE

England has 30,000 schools and over 8 million students. A new £84 million government-led initiative, the National Centre for Computing Education[1] will impact millions of students over the next three years, and potentially for many years to come, by giving teachers the subject knowledge and support they need to teach pupils the new computing curriculum. This far-reaching initiative represents the highest per-capita investment in school computing education in the world. The project will deliver:

- A comprehensive set of resources, including all teaching and assessment materials for children from 5-16.

[1] http://teachcomputing.org

- A complete programme of professional learning, integrating online and face-to-face training, sustained over time, for primary and secondary teachers.
- 40 Computing Hubs led by schools, offering regionally-delivered professional learning for teachers.
- A network of teacher communities, led by teachers, offering peer support and networking, led by Computing At School.
- An online learning resource, specifically for 16-18 year-old students studying for A Level computer science and their teachers[2].
- A 3-year research programme focused on interventions to address gender balance in computing.

This work is being led by three organisations, including my own. Given that it is five years since the establishment of the mandatory Computing curriculum, we now have the opportunity to properly ensure that it is delivered effectively in all schools. The scale and longevity of this project presents a golden opportunity to research what works in computing education!

3 RESEARCH INITIATIVES

Although the National Centre focuses primarily on delivery of professional learning and resources, there are a number of research initiatives embedded within:

(1) **Progression**. In developing a comprehensive set of resources for the classroom, we are conducting research into progression in computing. There has already been some burgeoning research in this area, but much more is needed to ensure we understand how we sequence topics, meet the needs of all children, and support development of effective assessment.
(2) **Gender balance**. This project will involve a series of interventions that aim to increase girls' engagement with computing and tendency to select it as an elective subject. Projects are related to specific barriers such as the feeling of not belonging, not being encouraged, and feeling that computing is not relevant. Other initiatives include more inclusive pedagogical approaches to teaching computing, and linking non-formal and formal learning of computing.
(3) **Pedagogy.** Since computing has been introduced, the focus of professional learning has been on teachers' subject knowledge. However there is much discussion amongst teachers about 'how' to teach computing effectively. Through a series of podcasts, research summaries, and research newsletters, the goal is to support teachers wishing to explore pedagogical approaches and to move towards research-informed practice. Topics include pair programming, cognitive load theory, PRIMM, worked examples, and semantic waves. Professional learning materials are developed to explicitly model pedagogical approaches.

4 A RESEARCH AGENDA

There are many other opportunities to use the scale and length of this project to contribute to computing education research. In particular we hope to investigate issues around computing provision in school at scale. Some examples identified are:

(1) **Online learning at scale.** Online teacher professional learning courses in computing are able to reach thousands of educators, and approaches used to encourage collaborative work, teacher participation, and transfer to the classroom, using this genre, are being evaluated.
(2) **Communities of practice.** Our experience with Computing At School in the UK has evidenced the effectiveness of teacher-led communities of practice in supporting teachers who are isolated and lack confidence [5]. We now have the opportunity to scale this approach and evaluate thoroughly.
(3) **Computing for all.** The primary challenge around computing in the mainstream is being able to engage and effectively teach mixed-ability groups of children, and those who are not engaged with the subject. High on the research agenda is the need to trial different approaches to engaging students of all ages who find some computing concepts difficult to acquire.

5 STAKEHOLDERS

Our experience suggests it is important to involve many stakeholders. A school-led model is used for regional delivery, but universities and other organisations are already involved in leading on professional learning opportunities and will continue to advise and support the Computing Hubs. Industry engagement is key, not only for supplementary funding but for work experience, testimonials, role models, mentoring, technical expertise and generally sharing the vision.

6 CONCLUSION

This short paper has described some of the elements involved in establishing computing education across a whole country, and the breadth of possibilities for research. There are of course many challenges. Where general funding to schools is limited, teacher release from school to study can present an obstacle. Teachers are having to teach a subject they themselves did not learn at school. Teacher workload and teacher shortages will of course impact on all our best efforts. However this initiative presents a huge opportunity to bring computing education to millions of students and to move forward our understanding of computing in the classroom.

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