# IMPLEMENTING THE COMPUTING CURRICULUM AT NATIONAL AND REGIONAL LEVEL: LESSONS LEARNT FROM ENGLAND

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## Abstract

This paper will present how an emerging Community of Practice is supporting the development of a new national computing curriculum in primary (5-11 years) and secondary (11-18) schools in England.

Computing, because of its ubiquity and role in innovation, has become an essential requirement in the increasingly global digital knowledge economy. Consequently, industry, government, academics and policy makers have become increasingly concerned that England was beginning to lose its innovative and competitive edge [1] [2]. This paper will present a background to changes at national level following the disapplication of Information Communication Technology as a subject, in 2013, through to the development of a new Computing curriculum in 2014. This curriculum is applicable for children 5-16 years, while new higher level qualifications for learners 16-18 have also been introduced. The paper will consider the new curriculum, challenges faced by schools, teachers and teacher trainers in terms of delivery of the new curricula, new programming languages, changing pedagogy, and upskilling in-service and pre-service teachers.

The paper will present a national picture of support for teachers in England via funding from the Department for Education, devolved by Computing at School, a grass-roots organization that now has over 28,000 members, to 10 regional universities. The paper will then share how teachers across one region of England are building a networked community of practice comprising: computing master teachers who support less experienced teachers, and regional hubs which host events for local teachers. Data will be presented relating to teacher's growing confidence and the impact in the classroom, measured using Gukey's [3] impact framework. This data indicates growing confidence, and identifies the support still required to increase classroom impact. The paper will finally share some of the resources teachers have found to be most useful – these are all available online for delegates to access and share. The conclusion will focus on sharing lessons learnt from the project (The Royal Society 2017) and consider its future direction.

## 1. INTRODUCTION

This paper presents how an emerging community of practice is supporting the development of a new national computing curriculum in primary (5-11 years) and secondary (11-18) schools in England. This paper provides a background to changes at national level following the disapplication of Information Communication Technology as a subject, in 2013, through to the development of a new Computing curriculum in 2014. This curriculum is applicable for children 5-16 years, while new higher level qualifications for learners 16-18 have also been introduced. The paper considers the new curriculum, challenges faced by schools, teachers and teacher trainers in terms of delivery of the new curricula, new programming languages, changing pedagogy, and upskilling in-service and pre-service teachers.

The paper presents a national picture of support for teachers in England via funding from the Department for Education, devolved by Computing at School, a grass-roots organization that now has over 28,000 members, to 10 regional universities. The paper sets out how teachers across one region of England are building a networked community of practice comprising: computing master teachers who support less experienced teachers, and regional hubs which host events for local teachers. Data is presented relating to teacher's growing confidence and the impact in the classroom, measured using Guskey's [3] impact framework. This data indicates growing confidence, and identifies the support still required to increase classroom impact. The paper will finally share some of the resources teachers have found to be most useful – these are all available online for delegates to access and share. The conclusion will focus on sharing lessons learnt from the project and consider its future direction.

Computing, because of its ubiquity and role in innovation and economic success, has become an essential requirement in the increasingly global digital knowledge economy. Consequently, industry, government, academics and policy makers have become increasingly concerned that England was beginning to lose its innovative and competitive edge. Additionally, the Council of Professors and Heads of Computing (CPCH) have expressed and continue to express concerns in the decline of the number of applicants for undergraduate computing courses and the impact of this decline on the British economy [4]. This decline was paralleled in the USA [5] and action was required to address this in the United Kingdom.

Computing at School (CAS) a grassroot community of practice emerged in 2008, initially to promote Computer Science as a school subject. This was as a response by a collective of 22 individuals concerned with and wishing to address the decline in undergraduate computing admissions [6]. CAS publicly announced its existence to the world during the academic year 2009/10. Immediately, CAS secured and continues to secure funding from a number of organisations including: Department for Education, Google and Microsoft. Strategic alliances and partnerships were established with the Open University's Vital programme to promote continuous professional development[6], [7] calling for individual educational institutions to host a CAS hub as a local physical manifestation of CAS's community of practice.

There were a number of reports that emerged which combined to change the landscape further. The *NextGen* report [2] published in February 2011, and authored primarily by subject experts in the games and creative technology industry, argued explicitly for Computer Science to form part of the school curriculum. In January 2012, the Royal Society, the UK's Academy of Sciences, published a report: *Shut down or restart? The way forward for computing in UK schools* [8] which reported on an 18 month commissioned state of the nation investigation of computer science education within the United Kingdom.  This report analysed the state of computing education in schools throughout the United Kingdom and proposed a roadmap for its future direction. The Royal Society reported 6 key findings including that "the current state of Computing education in many UK schools is highly unsatisfactory" [8 p.5]. The roadmap with 9 milestones proposed the displacement of routine ICT activities with more creative, rigorous and challenging Computer Science for every child, including opportunities for primary school pupils to explore and experiment with coding and secondary school students to engage with physical tangible devices such as robots.

The Rt Hon Michael Gove MP, then the Secretary of State for Education, opened the BETT Show 2012, a learning and technology show with a speech [1] that began a transformation of the ICT educational landscape. Gove recognised the important role that both British individuals and British organisations played in the creation of the computer industry and announced the disapplication of the existing Programme of Study for ICT from the National Curriculum.  This curriculum, was a compulsory part of the National Curriculum.  Gove promoted the importance of programming skills and the development of rigorous Computer Science courses.

This was followed by a new national curriculum, developed by 'experts' in the field, from September 2014.  The new curriculum required children from primary (from 5 years) through to secondary (aged up to 16 years) to understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation,  analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems, evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems, be responsible, competent, confident and creative users of information and communication technology. Attainment is measured at the end of each Key Stage (KS) (KS1 = 5-7 years, KS2 = 7-11 years, SK3 = 11-14 years, KS 4 = 14-16 years), by which time, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study.

It was identified by the Department for Education that this was a significant change in subject knowledge and that teachers would require training in the fundamentals of computer science, including appropriate programming languages. The requirement for this is extensive with challenges for primary teachers, most of whom have no experience in computing, and for ICT teachers in secondary schools, who had knowledge of some elements of computer science, such as networking, but frequently lacked in depth knowledge of programming to higher levels required for national examinations. This funding was awarded to Computing at School.

Computing at School called for bids from universities to lead the training and establish regional communities of practice. Ten universities were selected providing regional centres across England. Each regional centre established hubs across their region to provide local support to teachers. Each hub was led by a master teacher. This paper sets out the perspective of the East Midlands region, covering a large geographical area across England.

## 2. METHODOLOGY

The community of practice, now established, consists of local hubs spread across the region. Each hub is led by a Master Teacher, who has been identified as having sufficient level of computing at the age at which they teach to support other computing teachers in developing their subject knowledge and pedagogy.

Focus group interviews took place with Master Teachers: one interview with 12 primary Master Teachers; one interview with 4 secondary Master Teachers. Evaluation questionnaires, using an online questionnaire, were sent out to all teachers who had attended training events over a 4 month period. The return rate of these was only 8%; anecdotally it was reported that teachers do not have time, in their increasingly pressurised working day, to complete evaluation forms.

Full ethical clearance was obtained through university processes. All respondents gave informed consent and understood they could withdraw. Each interview was translated (where needed) and transcribed. A thematic analysis was then carried out using the process described by Braun and Clarke. Initial codes were identified, and from these themes were developed. Teacher's responses were anonymised.

## 3. RESULTS

Where teachers have engaged with opportunities to develop their skills there has been a great deal of satisfaction.

Respondents from primary schools reported that good models of practice in primary schools are those where whole school upskilling has taken place. This has sometimes been by one teacher attending training events and disseminating their learning across the staff team. One teacher commented on how her head teacher had prioritised computing in the school action plan and had asked all teachers to identify a Barefoot resource (…), adapt this for their class, teach using the adapted resource, then share their experience and learning from the experience at a staff meeting. Teachers had a month to identify the resource, adapt and teach it. The researcher attended the feedback meeting; this was seen by the teachers as a good model for dissemination. The view of teachers involved was that the online resources were detailed and simple to modify for their class. Teachers commented on how the process had developed their knowledge and confidence in teaching computing. The children had really enjoyed the experience and develo9ped an understanding of key computing concepts, appropriate for their age. The computing co-ordinator was developing a whole school planning document for computing which was being shared with the t4eachers and who were looking forward to taking part in the developed curriculum.

Primary respondents also commented on the need to be introduced to computing gradually, building on existing skills and knowledge. Most respondents reported a lack of confidence with the subject, despite the curriculum having been in place for 2.5 years. These respondents preferred to use unplugged computing, building their knowledge following a constructivist approach and gradually developing their programming skills once they had become confident.

The change in pedagogy was seen as most critical in secondary classrooms. While most secondary computing teachers had taught ICT before the curriculum change, many commented that teaching programming required change both in subject knowledge and pedagogy. All respondents reported the community of practice had supported the pedagogy with some respondents providing specific examples

The support of senior leaders was seen by all respondents as essential in bringing about change. One teacher commented 'This is a considerable change for teachers and without senior leaders prioritising it in the school action plan there isn't the support for me to attend training. I am therefore very reliant on resources I can access through the [community of practice]' (p21). This reflects findings by others, c.f. [9].

Barriers were seen as significant (66.8%) by primary teachers and less significant (43.8%) by secondary teachers. Both cited time to learn the new subject as the main barrier [10]. Primary teachers were more likely to be allowed to attend training where it was for a full day rather than half a day. Secondary teachers were at best allowed to attend one full day of training each year, which for an almost complete change of subject area impacts on the teachers being able to develop new content knowledge and pedagogic expertise.

Teachers felt they had become more confident and that was impacting on their classrooms and the achievement of their children. One primary teacher commented her class (aged 6) had been using algorithms in their computing work and were now linking this to other areas of the curriculum, such as maths and literacy. Secondary teachers felt their confidence and impact on student learning outcomes was evident in the increased numbers of students who had opted to take GCSE Computing; she felt her developing knowledge and pedagogy had enabled her to teach the subject in a student-centred pedagogy which was encouraging and supporting higher levels of achievement.

The geographical support through the hubs and Master Teachers was seen as essential by all respondents. This provided them with a local support network within a wider community of practice. Teachers commented that the structure of having a Regional Centre who provided training that was them disseminated locally gave them more opportunity to attend.

Teachers commented positively on the community of practice with all respondents able to indicate teaching resources they had shared, or created collaboratively. A great asset was a Facebook page which had been set up and was being managed by a group of Master Teachers. This was seen as a safe space where they could ask questions of each other, and receive almost instant feedback. Resources were being shared via this page which most teachers interviewed were contributing to. One teacher commented 'I was given the task of developing a whole school [primary] curriculum plan integrating computing from Year 1 to Year 6. I didn't know where to start, but found a whole school plan on our Facebook page and have adapted that for our school. It has saved me hours of time'.

## 4. CONCLUSIONS

We would suggest that there are limits to informal activity, even when underpinned by funding. A new subject area, delivered nationally in primary and secondary schools requires high-quality teacher training and development, a sharing of best practice in the classroom, and materials for teachers. What has taken place so far, reported in this paper, in England has had impact, but there is a long way to go. There has been success in establishing communities of practice at regional level, but how sustainable this will be in the future is difficult to know. The retraining of the teacher workforce for computing has yet to reach all schools. There is a need for continued funding, evidence-informed research about what works, careful co-ordination of activity, and effective dissemination of best practice.

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