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A critique of the current trend to implement computing in schools

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Abstract: *Computing is experiencing a resurgence of interest in schools, and this has led to the emergence of computational thinking as a key 21st century skill forming part of the Science Technology Engineering and Mathematics (STEM) agenda. In England, Ireland and many other countries, industry demands better prepared graduates to develop solutions using technology. In practice, this has led to expecting children as young as five to begin to learn to program computers in England and in Ireland to the establishment of computer clubs. The sceptic would warn that we have been here before. Computing courses were first introduced in the late 1970s and early 1980s only to see their decline as the study of office applications, multimedia and online communications technology took over, offering a broader information technology, digital literacy and creative opportunity to all learners. The recent re-introduction of computing may be critiqued as an ill considered knee jerk reaction. It may be that the call for more computing in schools is simply capital seeking cheaper labour rather than empowerment of learners' creative and curiosity. This discussion paper argues that we should properly invest in pedagogical research, continuing professional development and curriculum development to ensure that the proposed benefits to learners do accrue and better understand their nature.*

Key words: *computational thinking, ICT, United Kingdom, Ireland, historical development of computing in education, curriculum, education policy.*

Introduction

Digital technology in schools can be seen as using computers as a tool for teaching, for general purpose applications or for computing as a discipline in its own right (Bell, Andreae, & Lambert, 2010, p. 17). This paper focuses on the third of these – computing, which is concerned with how computers and computer systems work, and how they are designed and programmed, and specifically in the context of schools in the UK and the Republic of Ireland (henceforth called Ireland), reflecting the backgrounds and personal experiences of the authors. Computing with digital technology became widely available to society in the early 1980s with

the availability of the microcomputer and in education was a minority interest before this. Policy for computing in compulsory schooling has been in development for only around 35 years, and yet in that time has seen a rise and fall and rise again, notably in the development of 'computational thinking' as a transferable set of attitudes and skills (Wing, 2006). The rapid obsolescence of computer technology has made it easy to forget lessons learnt in earlier phases, which may inform future policy.

Theoretical framework

This paper presents a critical account of the historical development of computing in education and its implementation in schools. The position taken by the authors is broadly Marxist, identifying government and education policy as part of the 'superstructure' of a capitalist society which influences, and is inflenced by, the 'economic base' – production organised in companies with the aim of securing profits. Wright (2013) provides a helpful post-Marxist perspective in which education policies are seen as "spaces of political contestation and struggle for hegemony" (Wright, 2013, p. 242); he goes on to discuss policy production and policy implementation. Marxist thinking (Ollman, 1976, p. 131) also identifies humans as naturally social and creative beings with the capacity for self-fulfilment in their work, but experiencing 'alienation' from the products that they produce, the productive process, their own creative nature and other workers. In our paper this concept is considered in the context of learners and their treatment in schooling in this paper. However, the authors are also aware that the novelty of computing may have wrong-footed leaders in society, who were often uneducated in the discipline: "Politics finds its sources not only in power but also in uncertainty – men collectively wondering what to do… Policy-making is a form of collective puzzlement on society's behalf" (Heclo, 1974, p. 305).

The microcomputer revolution

The "microcomputer revolution" of the 1980s came with an ethos that programming was the expected activity. Until the mid-seventies, consumer computers required skill and commitment to assemble. Once pre-assembled microcomputers were available at affordable prices the general public and the enthusiastic teacher could take part in computing. New owners of these machines found that, in order to use their computer, they would have to learn to program it. In the UK, the BBC Computer Literacy Project (1979–1983) was an ambitious attempt by the BBC's Continuing Education Department to implement society-wide public education about computers through television programmes, print media and the specification of a computer, the BBC Micro (Radcliffe & Salkeld, 1983). Blyth (2012) has explored the legacy of this initiative, finding that parents and peers, and the do-it-yourself ethos of tinkering and "hacking", had

a strong influence on the development of programming. Swalwell (2012) traces the microcomputer community in the 1980s from an Australian perspective, finding that games were an essential driver of both computer ownership and computer education. She quotes a correspondent: "If you didn't do it [program the computer], then what was the point of having a computer, because it didn't do anything....". The link to servicing the needs of industry was not yet emphasised so much as the intrinsic interest in the device itself – a far less "alienating" experience.

Early developments in UK schools

In the seventies, the subject of Computer Studies in the UK was often taught by mathematics teachers. Practical work meant drawing flow charts and marking or punching 80-column cards or paper tape. Word processing and spreadsheets had not been invented, emails hardly begun (Millwood, 2010). Pioneering teachers were involved directly in the development of syllabus and examinations which focused on the computer itself. Textbooks were published with the support of industry, interested to develop computing in school. Neil Selwyn traces the development of UK national policy through the late 1970s and the early 1980s, identifying a rhetorical shift away from promoting computer use for economic reasons and towards educational benefits (Selwyn, 2002). Despite the change in political tone, Selwyn identifies a clear economic rationale, quoting the then Education Minister, Kenneth Baker in 1993: "We have to train the young people of today for the jobs of tomorrow" (Selwyn, 2002, p. 432).

Irish schools

From 1971 the Irish Department of Education organised summer courses in programming for teachers, so that (according to the main lecturer) they could prepare students for their future life in the computer age – an educational goal, focusing on students' development, rather than driven by economic or vocational concerns. This led to the foundation of the Computer Education Society of Ireland (CESI) in 1973. Mainly composed of interested, pioneering teachers, CESI pressed for computer education in schools. A key thrust of the Society's policy was to establish Computer Studies as a free-standing subject at second level; it was hoped that programming would succeed where Latin and Mathematics had failed in addressing problem solving for all (Oldham, 2015). The Department introduced a "Computer Studies" option within the Mathematics syllabus in 1980 with the educational goal: "thinking" (Con O'Keefe, personal communication, 27th April 2015). Although a Computer Studies course was eventually introduced in 1985, no official examination in the subject was provided. The content reflected a focus on information processing as well as on programming and also included use of applications packages.

The earlier decline in computing

In the late eighties, in both the UK and Ireland, a decline in computing was observed (Brown et al., 2013). A key factor was the advent of office applications which could be learnt as a skill. Teachers preferred this applications approach, which also engaged more learners in a wider, creative activity than simply programming, and it was backed by an industry hungry for trained office workers. Programming, whilst motivating and fulfilling for some, was alienating for others. This failure of computing to address "problem solving for all" was salutary. The aim was arguably appropriate, but the pedagogy, practice and tools were insufficiently developed.

Throughout the nineties, the advent of the internet and further developments in the use of the computer for creativity and communication (Millwood, 2010) led to the adoption of an ICT model in schools. Lifted by the dot-com boom of the late nineties, computing continued to be taught but with diminishing take-up overall.

The recent decline and current resurgence in computing as a subject

By the late 2000s, against the backdrop of an increase in demand for computer science graduates in the UK (Department for Innovation, Universities &

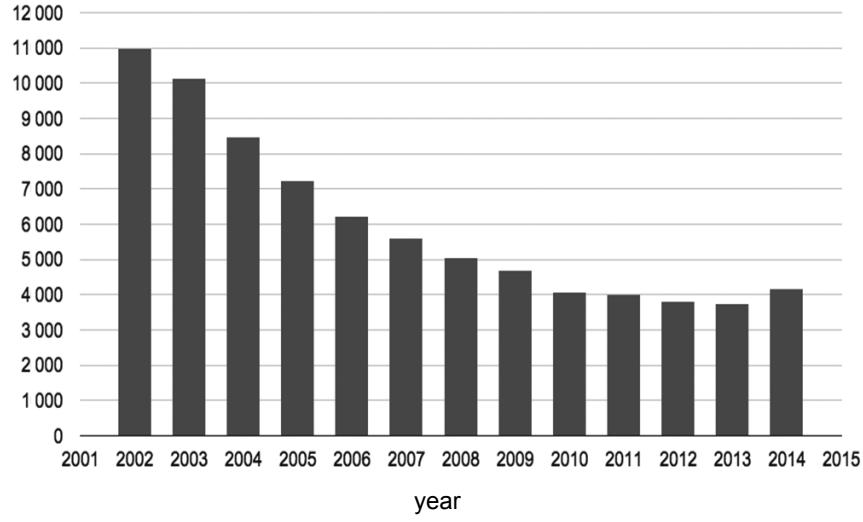

Fig. 1. UK Computing A-Level entries 2002–2014 (Joint Council for Qualifications, 2015)

Skills, 2009), the decline in the uptake of computing in schools began to be recognised as a problem that urgently needed to be addressed. The number taking A-level Computer Science has roughly halved since 2005 (see Fig. 1).

In response to this trend Computing at School (CAS) was set up in 2008 as a grassroots organisation to promote and support the teaching of computing, backed by industry and academia through partnerships and sponsorship. The influential 'Next Gen' report stated unequivocally that "Computer science should be on the national curriculum alongside maths and physics" (Livingston & Hope, 2011, p. 6). Google's executive chairman Eric Schmidt, in a high-profile speech in 2011, declared himself to be "flabbergasted" that Computer Science was not part of the core curriculum (Schmidt, 2011, p. 8). In January 2012 the UK Education Secretary Michael Gove announced the development of a new curriculum to support "new, high-quality Computer Science GCSEs" (Gove, 2012, January 13). The speech referenced the Next Gen report and Schmidt's speech and was a clear reaction to industry pressure. A few days later, the Royal Society published a review of Computing in UK Schools which advocated a radical overhaul of the curriculum and the introduction of computer science as "a rigorous academic discipline" (Furber, 2012, p. 6). The outcome was a new computing curriculum, including strands on Information Technology and Digital literacy, but with Computer Science centre stage and children as young as five expected to learn how to program. Despite industry pressure to produce more high-quality computer science graduates, the curriculum emphasises the broader role of computer science in developing computational thinking, stating that "A high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world" (Department for Education, 2014).

Meanwhile, Ireland had attracted many of the top international IT companies, such as Google, Microsoft, Intel, Facebook and Twitter employing in 2012 an estimated 68,280 ICT professionals including other sectors of the economy. One report expects this to increase by 5 percent per year for the next six years (The Expert Group on Future Skills Needs, 2013). Despite the recent recession there are thousands of unfilled IT positions in the country. In response, the (Irish) Department of Education and Skills (2012) released an 'ICT Action Plan', aiming to double the number of graduates to 2,000 by 2018. But there is little in the way of formal provision of computing as a subject in schools, apart from short courses in Coding and Digital Literacy (National Council for Curriculum and Assessment, n.d.). A new Digital Strategy for Schools in the next five years proposes integration of technology into teaching and learning across the curriculum with little regard for what it terms 'discrete' ICT skills. This lack of provision for programming has led to concern that Ireland will be left behind (O'Briain, 2015) with James Whelton (co-founder of CoderDojo) commenting that

"We are turning Irish school kids into consumers of technology, not creators of technology" (Kennedy, 2011). Whelton's CoderDojo network of after-school coding clubs for 7–17 year olds, started in 2011, has grown exponentially with over 150 clubs currently active and over 500 worldwide (Langhammer, 2014).

A comparison between the early approach and current approach

The motivation for computing in the seventies and eighties was clearly linked to technology's novelty and new-found availability, together with a concern to be prepared for a new information age, both as a society and as a workforce. In parallel, educators looked for computing as a home for problem-solving, analysis and algorithmic thinking. Early ideas of digital literacy, to empower all citizens, were matched by enthusiastic uptake by hobbyists and teachers alike and promoted by the 'superstructure' in the form of the BBC in the UK, specialist magazines and professional education organisations in both countries. Although curriculum and examinations were subsequently developed, these lost momentum toward the end of the period. In recent times, we see a different kind of enthusiasm, driven by an alliance linking computing teachers and industry figures in a struggle for hegemony over the school curriculum. Nostalgic reference to the earlier period of amateur endeavour and public education has culminated in the production of a new hobbyist computer, the Raspberry Pi, and recently the BBC have announced a new microcomputer to enhance computing education. The ultimate triumph of this struggle in the UK has been the establishment of the new computing curriculum, but now justified by a concern that there is a shortage of trained programmers to sustain a competitive lead in a global technology marketplace. In common with the earlier period, a new concern to develop computational thinking has been expressed as a literacy for all. In Ireland, a focus on 21st Century Skills has offered a more general and learner-centred approach that is not so clearly driven by the economic base. But developments in school have not sought to address the risk of a new alienation, unlike the optimistic proposals for 'computational participation' arising from the Scratch online community (Kafai, Burke, & Resnick, 2015) and the CoderDojo movement's learner-centred experience echoing the earlier informal learning.

Conclusions

The authors support the teaching of computing as part of a richer education in computational thinking, but feel the rationale is confused by competing agendas and lack of clarity. If we make computing a key skill in schools, we risk alienating another generation of young people by reducing it to simply programming. Policy production has proceeded rapidly, at least in the UK, driven by capital's call for a narrowly-skilled workforce. Hurried policy

implementation has followed, with little in the way of pedagogic research, teacher preparedness or curriculum resources. Other levels of the system, such as school governance, inspectorate and providers of continuing professional development are also unprepared. The project may thus fail before it has even been established, in part due to other challenges in schools such as the delivery of literacy targets, leading to computing being sidelined as 'too-hard'.

A first step to avoiding such failure is to clarify aims and reject a knee-jerk response to the political contestation. It is easy to value the more general need for 'problem-solving' 'computational thinking' etc. which show promise, but the authors' key recommendation is that we look for a clearer theoretical and practical understanding of the purposes and practices involved in developing computational thinking in learners.

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