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Education recoded: policy mobilities in the international 'learning to code' agenda

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Abstract Education policy increasingly takes place across borders and sectors, involving a variety of both human and nonhuman actors. This comparative policy paper traces the 'policy mobilities,' 'fast policy' processes and distributed 'policy assemblages' that have led to the introduction of new computer programming practices into schools and curricula in England, Sweden and Australia. Across the three contexts, government advisors and ministers, venture capital firms, think tanks and philanthropic foundations, non-profit organizations and commercial companies alike have promoted computer programming in schools according to a variety of purposes, aspirations, and commitments. This paper maps and traces the evolution of the organizational networks in each country in order to provide a comparative analysis of computing in schools as an exemplar of accelerated, transnationalizing policy mobility. The analysis demonstrates how computing in schools policy has been assembled through considerable effort to create alignments between diverse actors, the production and circulation of material objects, significant cross-border movement of ideas, people and devices, and the creation of strategic partnerships between government centres and commercial vendors. Computing in schools exemplifies how modern education policy and governance is accomplished through sprawling assemblages of actors, events, materials, money and technologies that move across social, governmental and geographical boundaries.

Keywords *code, computing, curriculum, fast policy, policy mobilities, programming*

Contemporary education policy processes are increasingly dispersed across borders, sectors, organizations, industries, technologies, actors, and objects. A significant education policy agenda on 'learning to code,' programming and computing in schools has accelerated across national education systems around the world. Programming software and apps provided by industry, start-up organizations and computer science are becoming commonplace in classrooms at all stages of compulsory schooling. Venture capital firms, think tanks and philanthropic foundations, non-profit organizations and commercial companies alike are promoting programming in schools according to a variety of purposes, aspirations, and commitments, including the production of skilled technical workers and digital citizens. National government departments of education are responding by creating policies focused directly on introducing programming, learning to code and the knowledge and skills of computer science in schools and curricula.

The development and expansion of education policies related to computing and programming in schools exemplifies how 'educational policymaking and governance are no longer simply occurring within the prefigured boundaries of the nation state but now involve a diverse cast of new actors and organizations across new policy spaces' (Gulson et al 2017: 1). The present paper explores how these issues have played out in the recent renewed prominence of programming and 'computing in schools'. It focuses on the human and organizational actors involved as well as the nonhuman, material 'things,' digital devices, apps, and websites, and events, markets and spaces where policy has been created, recreated, circulated and settled. In particular, the article provides a comparative, critical analysis of how computing has become a key policy priority in England, Sweden and Australia, whilst also tracing the globalizing flows through which computing is being operationalized in education policy and practice around the world.

Unpacking these issues and their transnational dimensions is not straightforward. For example, in the US venture capital and technology entrepreneurs are key catalysts of coding in schools. The non-profit organization Code.org, set up by Silicon Valley 'angel investors' to push the 'Hour of Code' campaign in US public education, has been singled out 'as a new prototype for Silicon Valley education reform: a social-media-savvy entity that pushes for education policy changes, develops curriculums, offers online coding lessons and trains teachers—touching nearly every facet of the education supply chain' (Singer 2017). In 2016, then-President Barack Obama announced US$4billion for states and $100billion for school districts to expand computer science in K-12 education (Smith 2016), while in 2017 Donald Trump's administration ordered the US Department of Education to commit $200 million every year to K-12 computer science education, with additional investment from Amazon, Facebook, and Google, which Code.org marked as a victory for its nonprofit organization (Dickey 2017). Although US tech organizations and Silicon Valley entrepreneurs are linked to the expansion of coding in countries such as England, Sweden and Australia, as part of a new 'global education industry' (Komljenovic & Robertson 2017) of commercial coding products, these relationships are not unidirectional or linear. The focus for the article is on identifying local catalysts and drivers, and on tracing how computing has emerged as a policy preoccupation in diverse ways, through various channels in different national contexts, whilst also being supported through transnationally dispersed networks of cross-border organizations, influencers, investors and providers.

The paper therefore aims to contribute to a recent methodological and conceptual shift in educational policy studies that seek to 'think outside and beyond the frame of the nation state to make sense of what is going on inside the nation state' and to 'rethink the frames within and scales at which new education policy actors, discourses, conceptions, connections, agendas, resources, and solutions of governance are addressed' (Ball 2016: 1). Our argument is that coding in schools exemplifies how new forms of cross-sector and cross-border policy networking contribute both to the formation of educational policies within the nation state and also to the mobility of policy ideas across national borders. Rather than being figured topographically *within* national borders and systems, coding practices and computing pedagogies undertaken in schools are better understood as the outcomes of topologically connected policy spaces that include non-governmental organizations, commercial businesses and an array of material objects. Taking up the conceptual and methodological challenge of studying topological policy mobility, the paper maps and traces the evolution of the inter-organizational networks in three countries—England, Sweden and Australia—and the flows of actors and ideas that move between them, in order to provide a comparative, critical analysis of computing in schools as an exemplar of accelerated, transnationalizing policy movement.

Policy mobilities and materialities

The transnational movement of policy ideas and the formation of education computing policies in distinct national contexts have both a temporal and spatial dimension, exemplifying new policy processes described variously as 'fast policy,' 'policy mobility,' 'policy networks' and 'networked governance' (e.g. Ball, Junemann & Santori 2017; Gulson et al 2017; McCann & Ward 2012; Peck & Theodore 2015). The concept of fast policy in particular captures how:

> The modern policymaking process may still be focused on centers of political authority, but … sources, channels, and sites of policy advice encompass sprawling networks of human and nonhuman actors/actants, including consultants, web sites, practitioner communities, norm-setting models, conferences, guru performances, evaluation scientists, think tanks, blogs, global policy institutes, and best-practice peddlers. (Peck & Theodore 2015: 3)

Specifically, fast policy is understood to be characterized by a temporal compression of policy development, fast-track decision-making, accelerated program roll-out, and the application of fast-moving 'best practice' models. The concept of fast policy is not merely a measure of velocity, but also 'characterized by the intensified and instantaneous connectivity of sites, channels, arenas and nodes of policy development, evolution and reproduction' (Peck & Theodore 2015: 223). Approached spatially, fast policy networks 'work across social, governmental and geographical boundaries' and 'build bridges that bring together a diverse range of actors, including governments, businesses and civil society' (McGann and Sabatini 2011: 67).

However, as Peck and Theodore (2015: 36) also note, such fast policy network analyses 'must not lead to an inappropriate "flattening out" of power hierarchies, or to an underestimation of the roles of significant institutional mediators, translation sites, and centers of authority.' Instead, such analyses open up the power structures of policymaking processes to empirical scrutiny and encourage attention to the movement and mobility involved in the connectivity between policymaking sites. Nor should such studies assume unidirectional 'transfer' of policies or best practices from one site to another, since 'policy networks with extensive geographical reach are central to the construction of apparently local responses, while at the same time apparently global phenomena—globalized policies—are capable of realization only in particular, grounded and localized ways' (Cochrane & Ward 2011: 6). In this sense, policy networks are better understood as multidirectional, with their core agendas playing out differently in the various social, political, technological and economic contexts where they travel, undergo translation and settle.

Material objects play distinctive roles within contemporary policy processes. The concept of 'policy assemblage' calls attention not just to interorganizational networks but to the ongoing effort and labour involved in assembling policies and to the nonhuman, material stuff that assists in the development and enactment of policies (Savage 2017). As McCann and Ward (2012: 43) note, focusing on 'policy assemblages' encourages 'both an attention to the composite and relational character of policies … and also to the various social practices that gather, or draw together, diverse elements … into relatively stable and coherent "things".' Consequently, policy researchers are increasingly making 'use of assemblage to understand complex human and non-human systems,' and to take 'a more pragmatic orientation towards public policy research, as it directs our attention away from theoretical abstractions and ideal types … towards more materialist, relational, and bottom-up orientations that seek to understand the tangible stuff of policies' (Savage 2017: 2). The 'tangible stuff' of policy assemblages is highly varied, but for our purposes we highlight material objects such as glossy reports, papers and websites which act as interfaces to policies and travel across borders, events where policies are communicated and shared, and technical devices and instruments which assist in policy generation and enactment (Williamson 2016; Player-Koro, Rensfeldt & Selwyn 2017). In this sense, we draw on emerging materialist accounts of information which suggest that 'the material arrangement of information—how it is represented and how that shapes how it can be put to work—matters significantly for our experience of information and information systems' (Dourish 2017: 4). Within policy assemblages consisting of both humans and nonhumans, the material objects and digital technologies that carry information and representations are significant in shaping how policies are developed and enacted (Hartong 2018).

Alongside these concerns, focusing on policy assemblages re-emphasizes the ongoing effort, labour and practices required to assemble and reassemble policies, including the unexpected and nonlinear mutations that occur as policy ideas, discourses and materials move and evolve into practical enactments in locally contingent settings and times (Gulson et al 2017). As such, assemblage approaches seek to remove the policy itself from the centre of analysis and instead focus on the dynamic and relational contexts, processes, practices and materials through which policies are assembled, disassembled and reassembled. The analysis we present has partly been guided by Li's (2007) conceptual toolbox for identifying practices 'at work' in the continuous process of assembling and reassembling of policies. By focusing on interorganizational policy networks of actors, institutions and their practices, the mobility of policy across borders and sectors, and on policy assemblages that include nonhuman materials such as technologies, objects and events, our intention is to adopt a pragmatic and empirical orientation to the 'tangible stuff' of policies as well tracing the activities, effort, practices and 'sayings and doings' of the human actors involved.

Methodological approach

The study of policy mobility and materiality demands particular methodological approaches. It involves 'studying the chains, circuits, networks, and webs in and through which policy and its associated discourses and ideologies are made mobile and mutable' (McCann & Ward 2012: 43). Methods for mapping and connecting-together the network structure, and then tracing and following its translations and mutations as its activities move across subnational, national and international spaces, include extensive web searches on actors, organizations and events; attention to social media traces and website documents; interviews with nodal actors within specific networks; following the money and the 'things' that flow through networks; and attendance at key network events (Ball, et al 2017: Gulson et al 2017). A comparative dimension is important to the study of fast-paced policy mobilities in order to understand from specific local and national positions how mobile policies are relocated, translated and operationalized, as well as a temporal sensitivity to policy evolution and mutation (McCann & Ward 2012).

Taking up the methodological challenge of following the 'social lives' of policies (Peck & Theodore 2015) related to computing in schools comparatively, this article reports on data collected through detailed searches in, for example, news media and government database archives and by open web search engines (e.g. by using search terms like coding, programming, school*, educ*) for documents produced by governmental, non-governmental and commercial actors in the three different countries of England, Sweden and Australia. In addition it examines web resources and material devices deployed to support coding—i.e. apps, hardware, training manuals and courses, and print and online downloadable magazines. Detailed interviews were conducted with eight policy influencers in England to further interrogate the practices, events and discussions through which decisions were made to embed computing in the curriculum. Two different IT education trade fairs in Sweden were ethnographically observed as important events for tracing arguments, actors and products around programming. The data collection strategy reflected 'the reality of unexpected connections, mutations, and research sites emerging during the projects' (McCann & Ward 2012: 43) and as a result has required a degree of openness and flexibility as we have sought to map actors and follow policies at different stages of development and evolution in the three sites. For reporting each case study we used a reflective-analytical guide for describing and characterizing the crucial aspects of the policy practices: 1) identifying catalysts and their back-stories, 2) drivers, accelerators and intermediaries forging agendas, 3) (timely) alignments of different agendas, 4) texts, manifestos and inscription devices, 5) roll-outs and resulting curricula and artifacts. Concepts that have been important in identifying these processes and how they are drawn together into policy assemblages (following Li 2007: 265) include:

- *forging alignments:* processes where various practices are linked together;
- *authorizing of knowledge* and *management of failures and contradictions:* specifying a shared body of knowledge by smoothing out contradictions and devising compromises;

- *anti-politics*: closing down debates by reposing political questions as matters of technique;
- *reassembling*: joining new parts into assemblages, including changes of key terms and discourses.

Following the policies as assemblages in these ways has allowed us to trace how core ideas about code, programming and computing—a seemingly globalizing policy preoccupation—have surfaced in discrete locations at different times; how they have travelled, been aligned and combined in different formations and in different ways reflecting locally specific circumstances, political contexts and national conditions; and how they have been differently operationalized, realized and reassembled.

England, Sweden and Australia are used in this paper as cases both for practical reasons (being education systems that the authors are familiar with and have experience of analysing), but also for a number of comparative rationales. For example, all three countries have (re)introduced coding and programming into national school curricula over the past five years. This commonality notwithstanding, the three countries have divergent histories of educational technology policymaking, and developed distinct school systems over the past 50 years. Thus the three countries offer a convenient means of comparing the roll-out of what is ostensibly the 'same' policy idea in countries that otherwise vary in terms of their geography, culture, political and economic context.

'Computing' in England

England is widely acknowledged as playing a leading (if not initiating) role in the global resurgence of policy interest in coding in schools, not least as the first country in the world to formalize computing and programming in its curriculum for schools in 2013 (Gov.uk 2013). The key catalyst was a speech in 2011 by Eric Schmidt, then the chief executive of Google, at the Edinburgh Television Festival, during which he attacked the emphasis in UK schools on teaching students to use information and communication technology (ICT) applications:

> In the 1980s the BBC not only broadcast programming for kids about coding, but (in partnership with Acorn) shipped over a million BBC Micro computers into schools and homes. That was a fabulous initiative, but it's long gone. I was flabbergasted to learn that today computer science isn't even taught as standard in UK schools. Your IT curriculum focuses on teaching how to use software, but gives no insight into how it's made. That is just throwing away your great computing heritage. (Schmidt 2011)

The speech chimed with growing concerns at the time with the subject of ICT in the National Curriculum in England specifically. In fact, within six months of Schmidt's speech, the Secretary of State for education in England at the time, Michael Gove MP, announced the complete disapplication of ICT during his own speech at the 2012 BETT (British Educational Technology Trade) show for ICT teachers:

> I am announcing today that the Department for Education is … withdrawing the existing National Curriculum Programme of Study for ICT from September this year. The traditional approach would have been to keep the Programme of Study in place for the next 4 years, while we assembled a panel of experts, wrote a new ICT curriculum.... We will not be doing that. Technology in schools will no longer be micromanaged by Whitehall. (Gove 2012)

The inspectorate for schools, Ofsted, had already begun to report concerns about the ICT subject, compulsory since 1988, and later also published findings of a review of the subject between 2008 and 2011 (Ofsted 2013). Following the speech, the Department for Education embarked on a period of consultation to work out how it would reform ICT.

The speeches by Schmidt and Gove did not, however, simply emerge as parts of pre-determined and coherent commercial and political aspirations, but were the result of intense activity to forge alignments among a loosely-connected network of campaigning organizations with their own governmental and commercial relationships and links. A year before Eric Schmidt's Edinburgh speech, the campaigning organization Computing at School—a formal partner of the British Computing Society (BCS)—had already produced a 'white paper' detailing a new approach to computing teaching, including 'how computers work,' the knowledge and skills of programming, and 'computational thinking' (Computing at School 2010). One of the other key groups seeking to influence computing in schools was Nesta, a think tank for innovation with particular focus areas on the creative industries, digital economy, and digital education. In 2011 Nesta oversaw a review of the skills requirements for the videogames and visual effects industries in the UK. The *Next Gen* review was commissioned by Ed Vaizey MP, then the Minister for Culture, Communications and the Creative Industries. The public figurehead for the review was the digital entrepreneur Ian Livingstone, the chair of Eidos Interactive games company, and then the government's 'Skills Champion.' The research and the published report and its policy recommendations, however, were developed by in-house Nesta staff who also had roles briefing Google on their findings. Nesta later produced a 2012 report on the legacy of the BBC Micro that

Eric Schmidt had credited as a 'fabulous initiative' to get an earlier generation of UK children coding in the 1980s. Soon after the Next Gen report was released, Livingstone and Nesta formed a pressure group, the Next Gen Skills campaign, which lobbied government to introduce programming and computer science into the curriculum. The campaign was supported by Google, Facebook, Nintendo, Microsoft, led by the interactive games and entertainment trade body UKIE, and was eventually successful in brokering meetings between Livingstone's team and Michael Gove's office (Nesta 2015).

As material devices, Nesta's glossy reports, like Computing at School's white paper, acted as reformatory brochures to be inserted into meetings, distributed to civil servants and special advisors in order to construct relationships, develop policy-relevant knowledge, and build political conviction around computing. According to Nesta:

> Since its report launched five years ago, Next Gen has influenced policy, rallied industry and galvanized educators to improve computer science teaching. The story is proof of the importance of building a rigorous evidence base on which to formulate policy, and the power of partnerships in affecting policy change. It has paved the way for a new generation of coders to reclaim our great computing heritage. (Nesta 2015)

Likewise, at about the same time as the Next Gen campaign was lobbying Michael Gove and the DfE, the Royal Society was also working on its own review of computer science education in UK schools. Its report, *Shut Down or Restart?,* was published just days after Michael Gove's speech in January 2012—he said he was looking forward to reading it. Its emphasis was on establishing computing as a 'fourth science' in the English National Curriculum and reflected the interests of academic computer scientists. This report, like *Next Gen*, acted as a material transmitter of key reformatory ideas to help steer DfE priorities. In other words, these textual inscription devices specified the bodies of knowledge required to devise a shared agenda.

The steering that occurs in policy networks is not always uni-directional, and the DfE maintained a strong presence in subsequent decision-making. In the months following Michael Gove's speech, members of Computing at School began attending consultation meetings for the ICT curriculum organized by the Department for Education (DfE), where they were able to lobby civil servants about computer science as a school subject. As a consequence, its white paper, and the outline computing curriculum it then produced in March 2012 with the endorsement of BCS, Microsoft and Google (Computing at School 2012), was taken forward as a suggested blueprint for the new subject. The DfE then formed a working group to design draft programmes of study for the new subject, led by the BCS, the Royal Academy of Engineering, and Computing at School, with membership that encompassed interests from industry, education and academia. In an effort to reconcile differences and forge alignments among the group, an original high-level draft of the curriculum focused on three core concepts of 'Fundamentals' (computer science and software), 'Applications' (using ICT), and 'Implications' (digital literacy, the role of technology and impact on society and e-safety). However, upon submission to the DfE these proposals were rejected and the curriculum was redrafted with stronger emphasis on computer science concepts, in line with the DfE emphasis on computing as the 'fourth science' in the curriculum, and echoing the Royal Society's recommendations (Twining 2013). As this indicates, the computing curriculum was an accelerated policy event involving a network of organizational and material influences, involving high-level catalyzing actors, a range of intermediaries, textual objects, and a host of practices intended to create timely alignments, smooth out contradictions and assemble consensus.

The role of charitable, non-profit groups focused on computing in out-of-school settings was also significant. Some members from these groups had already helped the DfE understand the possibilities of coding in schools during the consultation period for the curriculum, by acting as 'geek insiders' who could translate the language of the technology sector into the language of government and practice. The Raspberry Pi Foundation began publishing a magazine titled *Hello World* to focus on 'plugging gaps' in teachers' knowledge and skills in computer science, coding, and computational thinking.. Publicly funded organizations were also linked into the policy network. Perhaps the most high profile intervention into coding in schools was the launch of the BBC nationwide campaign Make It Digital in 2015. Make it Digital was intended to capitalize on the legacy of the BBC Micro and the BBC Computer Literacy Project that accompanied it in the 1980s, and help build the UK's digital skills through a variety of new programmes, partnerships and projects. One of the key projects was the launch of the BBC micro:bit, a small coding device distributed for free to a million UK schoolchildren. The planning, design, manufacture and distribution of the micro:bit was enabled through formal partnerships with a mix of commercial, charitable and academic organizations and actors, with the BBC also establishing a non-profit foundation to roll it out internationally (Parkin 2011; BBC 2015). The micro:bit was a material mechanism for translating policies around computing into the hands and practices of children, acting as an 'anti-political' (Li 2007) device that displaced debate about the purpose of computing and instead concentrated attention on technical solution delivery.

Commercial organizations took forward computing and coding with enthusiasm, in effect making a market of material products from the reorganization of the curriculum. The US organization Code.org launched the Hour of Code's online products in the UK in 2014, with public endorsement from then-Mayor of London Boris Johnson, Tim Berners-Lee, Ian Livingstone and the chair of Computing at School. In the same year, the Year of Code campaign was established to help people 'learn code and create exciting things on computers' (Year of Code 2014). Led by the international venture capital firm Index Ventures, as Naughton (2014) noted at the time, 'Year of Code is a takeover bid by a corporate world that has woken up to the realization that the changes in the computing curriculum … will open up massive commercial opportunities.' School computing has become part of a 'global education industry' and 'pro-market' educational policy and governance (Verger, Steiner-Khamsi & Lubienski 2017).

The material flow of money is a significant element in the policy network. Notably, the computing curriculum led to some significant public-private funding arrangements. By early 2015, the new Secretary of State for education, Nicky Morgan, used her invited speech at the BETT show (the same platform Gove had used to abolish ICT three years earlier) to announce £3.6million 'to launch top technology experts—from firms including O2 and Google—into schools up and down the country to help prepare England's primary school teachers for the new computing curriculum' (Gov.uk 2015). These funding arrangements were made as part of the DfE's Computing Matched Fund, first trialed in 2014 with funding agreements with Microsoft, Google, academic departments, private philanthropists, and organizations including BCS, CaS and Code Club (Gov.uk 2014). In 2017, following a further Royal Society report that found disappointing student uptake of computing in schools—which the BCS saw as 'a disaster for our children, and the future of the nation' (Cellan-Jones 2017)—the government's Industrial Strategy committed to 'investing £84m over the next five years to deliver a comprehensive programme to improve the teaching of computing and drive up participation in computer science' (HM Government 2017: 40). Topped up with £1m from Google, this would fund the establishment of a new National Centre for Computing Education to train 8,000 new computing teachers (Humphreys 2017). As such, financial arrangements have played a significant part in establishing alignments across sectors, and in managing early failures of the policy to attract students or adequately prepare staff to teach the subject.

The English case exemplifies 'the hard work required to draw heterogeneous elements together, forge connections between them and sustain these connections in the face of tension' (Li 2007: 264) as policy assemblages form, evolve, and stabilize. Although the introduction of computing in the National Curriculum applies only in England, the other devolved governments of the UK have similar aspirations, and the English example has become a fast and mobile best practice model that has also penetrated into policy spaces in Sweden and Australia.

'Kodning' in Sweden

The initial work for introducing programming in Swedish schools was the public prominence of a series of events in October 2013. First was the publication of two opinion articles in national daily newspapers, titled 'Programming is the language of the future' and 'Teach children programming in elementary school'. Both articles carried the by-line of a high-profile school leader from Academedia—the largest free school group in Sweden owned by the venture capital company EQT. This coincided with the promotion of a public petition titled 'Code is the future' addressed to the Swedish Government and National Agency of Education. The petition was distributed through social media and initiated by a teacher well-known in school circles for promoting a programming agenda. Both these two individuals were members of a non-profit The Language of the Future network, established by representatives from industry and media to advocate for 'programming as the future language and something that all children should be able to learn in school, regardless of gender, age or interest'. These first forging alignments of actors and agendas, reflect the far-reaching neoliberal market governance in Sweden in comparison to other countries. While clearly visible in the policy assemblages of programming and digitization of schools, many other aspects of the Swedish public education sector has been similarly opened up for for-profit and commercial interests.

The 2013 high-profile actions had less high-profile precedents—notably a report produced by the Swedish IT and Telecom industries (2012: 12) which raised concern over the lack of programmers in the sector and the associated need to 'introduce programming and IT development earlier in the school system as mandatory elements of the curriculum'. Tellingly, however, when this group subsequently presented a new national agenda for the digitization of schools in conjunction with the 'Computers in Education' foundation during the annual political lobby meeting in Almedalen, programming was not mentioned. Notably, then, the turn towards programming as part of the Swedish IT education policy can be said to have properly taken form during the autumn of 2013. This was a few months after Michael Gove's speech at the BETT show in England, an event that many cross-sector actors from education, politics, ed-tech industry in Sweden also referred to and/or actually attended. This mobility of actors and ideas, helped the agenda flourish and a certain expert knowledge to be settled, particularly by echoing Gove's speech BETT speech in the UK and framing the problem as schools not keeping up with technological progress and preparing children for the 'knowledge economy'.

Coding in schools became a high-profile aspect of the 2014 general election campaign when right-wing education politician Tomas Tobé provocatively argued that pupils should be able to learn coding and programming instead of arts and crafts in order to be better prepared for the job market. While much debated, this form of anti-politics was largely endorsed by most other candidates. In an opinion article the same month, the founders of the Swedish technology company Spotify and the non-profit organization Mattecentrum [Maths Centre] jointly announced their intention to make Tobé's argument a reality by establishing a network of 'code centers' and teaching resources. These statements were offered with the proviso that this intervention was not intended to 'place arts and crafts and programming against each other'. Eventually, Spotify, Mattecentrum and Microsoft established The Code Centre organization to support children's training in learning to code. Publicity at the time continued to promote the need to upgrade skills and meet labour market needs: 'Each morning 160,000 young people in the country wake up to another day unemployed. At the same time as they want jobs, Spotify and other leading IT companies have a hard time finding skillful programmers'. Once again a rhetoric was advanced around a set of defined problems that could be solved by programming skills and labour. The solution was enforced by arguments that 'coders are needed if Sweden is to remain a knowledge nation. It is time to educate children in the subjects they actually are going to work with in the future'. These industry actors then explicitly appealed to the state government to support them and to make The Code Centre part of the government's orders set for the National Agency of Education.

Such actions were subsequently bolstered by a critical report from the Swedish School Inspection (2012) on technology use in schools and teacher competence, as well as a survey from the European School Net (2015) titled '*Computing our future, Computer programming and coding. Priorities, school curriculum and initiatives across Europe'.* This survey unfavorably compared the implementation of programming in Swedish schools, and was cited frequently in subsequent debates intended to force the Swedish government act on programming in schools. The petition-raising teacher mentioned earlier was then awarded funding from the large infrastructure provider The Internet Foundation for a project titled Hack the Curriculum which was intended to write an alternative digital school curriculum and produce teaching resources in programming. This project was largely organized through social media and a 3000 member Teacherhack Facebook group. The same teacher was in 2016 commissioned to present her own Coding television series by the Swedish Educational Broadcasting company, at the same time as the revised policy documents directed to schools were released and promoted.

Also notable was the part played by several Ed-Tech trade shows in assembling the policy by mobilizing people, technologies and networks around the programming agenda. This commenced with Scandinavian delegates visiting the 2014 BETT trade show in London which addressed the new programming plans in the curriculum for England and Wales. Similarly, the Maker Days trade show in Gothenburg addressed the theme of 'Programming and Creativity with IT as Materiality'. The Swedish SETT trade show similarly had coding (in Swedish 'kodning') as a central feature from 2015 and onwards, including devices as robots for programming for children Bee-bots and programming languages like Scratch, widely used in the Swedish context. Other software resources for programming was also provided by Google—Google Code-In, Code Jam, and Google Summer of Code—which further emphasize Google's school market dominance in hardware and infrastructure (Chromebooks and G-suite and Google Apps For Education) in Sweden as one of the world's most digitally well-equipped school systems. Notably, the new Swedish curriculum on digitization and programming was first launched at the London-based BETT show, and then later at Stockholm's SETT show. This privileging of large trade shows highlights the cross-sectorial and transnational assembling of actors and ideas from seemingly different contexts (Player-Koro et al 2017).

Different media events occurred, not least the Hour of Code introduced by Microsoft Sweden, and the EU's Code Week event coordinated in Sweden by The Code Center organization and carried out in Academedia and their schools. The IT company Consid produced an educational YouTube series on programming together with a school competition. Furthermore, the non-profit organization Hello World was established in 2015, hosting meet-ups at IT companies for children aged 8 to 18 to motivate them for future work in the business, with prominent business sponsorship from Microsoft, Spotify and EQT.

Similar and new practices of forging alignments and reassembling between private and public actors was organized after the 2014 election. Several high stakes meetings were held between the new government and actors like The Swedish Association of Local Authorities and Regions and the Swedish Association of Independent Schools. Various ed-tech and IT industry actors were also invited by The Commission for Digitization to assist with its work towards a national IT education policy which was announced by the National Education Agency as including the programming agenda as a matter for consideration. At this point, in 2015, the research and innovation funding agency Vinnova was also directed by the National Education Agency to support the Triple Helix – National Coalition for the Digitization of School consultation process that had the purpose of moving schools, industry and academia toward a common agenda and had a major impact in mobilizing and stating the interest further. The initiative for this Triple Helix project was seen to originate from Swedsoft, an influential non-profit organization set up to represent software industry interests. Tellingly, this impartial process was coordinated by the Linköping university computer science department. This project was charged with establishing a new policy direction, and was run through a series of invitation-only workshops in big city regions.

Further reinvigorating the agenda in 2016, Spotify initiated a public debate through an open letter stressing the need for the state government to support emerging start-up companies, contending that 'We must act or get bypassed'. One of this letter's main proposals was the early introduction of programming in schools 'to take care of the talents and not losing all women programmers'. Several subsequent plenary debates in the parliament referred to this Spotify letter which received considerable backing from the IT and Telecoms industry. The letter was presented during prime minister's 'Question Time' as a consensual issue (Parliament protocol 2015). As the prime minister, Stefan Löfvén, stated in parliament:

> Entrepreneurship is crucial and programming will be most crucial. Our main task, is to make sure programming become a part of schools and for all students as it is an important future competency…As Spotify pointed out, this is one of the problems.

A national IT education policy was then endorsed in 2016, including the programming curriculum features quickly produced during Feb-March, a matter that demanded extensive teacher professional development efforts. Programming, or coding was announced as being integrated into existent curricula of math, technology, language and social science, and implemented by schools in mid-2018. How this was to be funded quickly became questioned, yet not fully resolved. The National Agency for Education organized a series of information meetings about the revised curriculum, the first one organized at the 2017 London BETT show—BETT had consolidated as the central public stage for policy sharing between England and Sweden. Within the decentralized Swedish education system and market governance, it was announced that responsibility for preparing schools and teachers for the curriculum changes would be led by a municipal association (the Swedish Association of Local Authorities and Regions) together with prominent commercial actors from the education and IT industry. One of the country's largest municipal actors (the city of Stockholm) also established a two-year 'Commission on Programming' in cooperation with the National Agency of Education and involving industry representatives, researchers and school experts. Their three stated working areas of this project were: creating equal life opportunities, meeting the labour market needs of tomorrow and, programming and digital creativity for supporting learning. In this sense, 'Kodning' was rolled-out into Swedish classrooms after a relatively long period of lobbying but with influential events, some hosted at the London BETT trade show, that moved the agenda into the national curriculum and centers of power within a two-year period.

'Digital technologies' in Australia

In Australia, the catalyst to coding becoming a prominent element of educational debate was a fractious parliamentary exchange in May 2015. Then-prime minister Tony Abbott was challenged at the Federal Parliament's weekly 'question time' by main opposition leader Bill Shorten whether or not he endorsed making coding a compulsory element of schooling. The opposition Labor Party had just announced its 'Future Smart Schools' initiative based around a key pledge that: 'A Labor Government will ensure that computer programming and digital technologies—coding—is taught in every primary and secondary Australian school, by a teacher who has had the opportunity to receive training in coding'. Thus computer coding was promised to be part of the Australian Curriculum by 2020, backed up by a $9 million 'National Coding in Schools Centre' that would train teachers, develop resources and promote the integration of coding into classrooms. Abbott's response was dismissive:

> Let's just understand exactly what the Leader of the Opposition has asked. He said that he wants primary school kids to be taught coding so they can get the jobs of the future. Does he want to send them all out to work at the age of 11? Is that what he wants to do? I mean, seriously, seriously, seriously?

Abbott was roundly rebuked from all sides after this response, not least because his own government had already committed to a $3.5million 'Coding Across the

Curriculum' policy to make coding an optional element of the school curriculum. This gaffe sparked a high profile debate, leading to a general consensus that coding in schools was required and – as one of the national newspapers put it - 'while the politicians argue, Australia falls behind' (Singh 2015).

Abbott and Shorten's exchange marked the culmination of two years or so of sustained policy work by a variety of actors. Indeed, the Labor Party's *Future Smart Schools* policy reflected a number of these influences, citing soundbites from Australia's Chief Scientist and the Australian Computer Society, alongside employment predictions from the Australian Workforce Productivity Agency. The policy document also justified itself through lengthy descriptions of work in schools by Intel Australia and the US non-profit organization Code.Org. It reminded voters of coding in schools progress already made in countries such as England, Singapore and New Zealand. Conversely, Abbott's then-Education Minister Christopher Pyne also reiterated the government's existing commitment to coding in schools, pointing out that: 'the Government, through the Department of Education and Training, has been undertaking consultations with key STEM stakeholders—such as university computer science faculties and ICT companies such as Telstra, Intel and Google—in relation to the most effective way to put coding into the curriculum to ensure it is of maximum benefit to students' (Pyne 2015).

Given the continued affinity between Australia and UK education systems, the policy pronouncements from England had prompted persistent—but low-level—lobbying from various computer science actors since 2012. The Australian Computer Society was a consistent voice for the more prominent inclusion of computer science in schools, urging soon after Michael Gove's initial announcements in the UK: 'Let's learn from the British experience' (Tate 2012). Another long-running voice was the University of Sydney's annual summer 'National Computer Science School' (NCSS). Running for 20 years with strong sponsorship from Google and large Australian IT firms such as WiseTech, Freelancer and Atlassian, it allowed academics from the university's IT Department to lobby sporadically for curriculum reform and to advise. In 2014, representatives from the NCSS, Westpac Banking Group and Telstra (one of Australia's largest telecommunications providers) held talks with Education Minister Christopher Pyne and then Communications Minister Malcolm Turnbull to provide public/private funding ideas on how to train Australia's teacher workforce in programming.

Yet much of the mounting pressure for the inclusion of coding in Australian schools came from an amalgam of industry and lobbying actors with commercial and economic interests. Most notably, as in England and Sweden, perhaps the most prominent actor was Google. Two years after Eric Schmidt's 2011 McTaggart Lecture in the UK, Google Australia used a two-day summit on digital start-ups to publically call for similar changes in Australian schools. However, here the company—led by Director of Engineering Alan Noble—looked to appeal to Australian concerns over the country's likely economic future once the country's mining industry eventually begins to decline:

> This is an opportunity for the country, this is an opportunity for our kids, this is an opportunity for our economy … If we don't do it, yes, we're going to be hosed because we can't continue to rely on the same old industries. (Godfrey 2013)

These calls were reinforced by other high-profile local IT actors invited to the summit, such as Freelancer, whose CEO echoed concerns over falling behind other countries 'like the UK and Estonia', and Australian policymakers being 'one hundred per cent asleep at the wheel' (Godfrey 2013).Google remained a regular voice in sustained the profile of debates over coding in schools, warning Australians of falling behind other countries, and urging politicians to positioning coding in schools as a key element of realizing 'the idea that Australia can have its own Silicon Beach' (Noble 2012).

Alongside Google, an amalgam of business interests also sustained interest in the idea of coding in schools in light of what was seen as government inaction. These were a combination of large Australian businesses alongside regional branches of multinational firms. GE (General Electric) initiated 'Coding for Kids' courses for primary school students, Microsoft ran Australian versions of its '#WeSpeakCode' events, with Google offering a similar nationally-tailored version of its Google CS4HS (Computer Science 4 High Schools) initiative. Telstra set up Code Club Australia, a not-for-profit organization that established a network of after-school coding tuition for primary students. Elsewhere, companies such as Cisco, PricewaterhouseCoopers and National Australia Bank seconded employees to mentor school teachers in teaching coding in the classroom. More formal teacher development programs were funded by software companies such as SAP. Google was also involved in sponsoring a Massive Open Online Course (MOOC) developed by the University of Adelaide to prepare primary teachers for delivering programming tuition in their classrooms. Long before either of the two main political parties made a commitment, the notion of coding in Australian schools was made reality through these various activities.

Direct lobbying of government for coding in schools was sustained by other various representative groups. These included the Australian Information Industry Association, the Council of Deans of ICT, the Australian Chamber of Commerce and Industry, the Australian Mathematical Sciences Institute, Warren Centre for Advanced Engineering, Principals Australia Institute, AIIA, Engineers Australia, Australian Council of Engineering Deans. As the Australian Information Industry Association chief executive Suzanne Campbell put it: 'Our kids and our nation deserve better than that. We need to make coding a priority in school' (Bita 2015a). Toward the end of 2014, ten of these organizations 'have written to Education Minister Christopher Pyne and his state and territories counterparts, urging them to make coding and computational thinking mandatory in schools (Foo 2014).

Abbott was ousted from the Australian premiership only 4 months after the parliamentary exchange over coding in school, replaced by his Communications Minister Malcolm Turnbull. Seen as more progressive and technologically-minded than his predecessor, Turnbull's government moved quickly under pressure from many of the groups outlined earlier. Just before Turnbull's succession, SAP Australian vice-president Greg Miller called for bipartisan support for the introduction of coding in schools, stating: 'We need a single voice at the top saying, this is important for Australia, this is important for our future and we're going to invest in it' (ABC 2015). With coding in schools effectively established as a non-political issue, Turnbull proceeded to frame coding to be as 'fundamental as reading and writing' in an 'agile, innovative and creative' Australia, and promising to pursue a commitment to introduce coding into the primary and secondary curriculum.

This momentum saw a range of high-level endorsement and promotion of the idea of coding in schools. The country's 'Chief Scientist' (an influential independent advisory role in the Federal Government) gave his support – highlighting the need for teacher professional development to 'inspire our children and get them interested' (Bita 2015b). The leaders of Atlassian – touted as an Australia tech start-up success story – warned politicians that 'technology education in primary and high school is going to be one of our biggest fails as a country in 20 years' time if we don't fix it and it may already be too late if we don't move very fast' (Chang 2015). Direct cross-over with developments in the UK even took place with a sponsored visit of a CAS (Computers At School) expert 'Master Teacher' from England to 'explain' coding to Australian schools, conveying the messages that: 'We were at your [Australia's] stage about three years ago. It's not going to happen overnight' (Earp 2015).

These were all developments that complemented the broader ambitions of the new Turnbull government. Indeed, momentum for an expanded commitment to a compulsory approach to coding across all school years was bolstered by the Turnball government's avowed emphasis on 'Innovation'. This was manifest primarily through the establishment in December 2015 of a $1.1billion 'National Innovation and Science Agenda' and promise to establish a '21st century government'. At the same time, the decision was taken to delay the finalization of the new national curriculum, thereby allowing more time for a reworked iteration of the proposed 'Digital Technologies Curriculum' by the Australian Curriculum, Assessment and Reporting Authority.

Throughout this time a range of supporting evidence was produced and recirculated by a variety of interest groups, all reinforcing the imperative for Australian schools to better develop coding skills amongst students. These included various reports on the future need of Australian industry for coding skills such as the Australian Computer Society's 'Digital Pulse' report, alongside reports by PricewaterhouseCoopers, Deloitte, McKinsey and the Regional Australia Institute. Microsoft released a survey claiming 'two out of three Australian students wanted to know more about coding'. Similarly, the Australian Information Industry Association reported 'eight in 10 Australian parents think digital skills and computer programming should be taught in schools'.

Latterly, then, these policy maneuverings resulted in the production of a revised set of national Australian Curriculum orders by ACARA in consultation with the ACS' 'ICT Educators' Board' and various academics and education officials. This saw the introduction of computational problem-solving from Kindergarten level, with Visual coding programs introduced in years 3 and 4, and general-purpose programming languages taught from the start of secondary school. In line with the Federalized nature of Australian education, these orders have been reconstituted by each of the country's state governments. This has seen primary schools in states such as Tasmania begin the teaching of coding in primary schools, schools in Victoria develop and implement a new computational thinking 'Algorithmics' subject for its secondary school students, and Queensland establish a 'coding academy' for training its teachers.

Alongside these legislative developments, the Federal government directed $7million of funding from the National Innovation and Science Agenda to scale-up the Google/University of Adelaide MOOC for teacher professional development. Also prevalent has been the continued introduction of non-profit provision of coding tuition such as 'Code Club Australia', and for-profit equivalents such as Code4Fun and the coding education start-up Code Camp (sponsored by WestPac) which provides for-profit holiday camps. All told, the policy orders and market conditions for coding in Australian schools were well-established in the country's schools little more than 18 months after Prime Minister Abbott's dismissive denial of the idea.

Conclusion

As the three national case studies of the 'social lives of globalizing policy models' (Peck & Theodore 2015: xxv) demonstrate, computing and coding have been introduced into school curricula in a remarkably compressed period, through the involvement of loosely connected assemblages of organizations, interests, events, material objects and activities that crisscross the governmental, commercial and civic sectors. In all three countries, policy networks have assembled in the shape of strategic campaigning alliances, public initiatives, funding arrangements and more long-term partnerships, although the paths taken to assemble these networks have been unpredictable. The case studies reveal dynamic, high-speed 'policy making, mobility, and mutation' processes that were 'subject neither to design determinism nor political foreclosure' (Peck & Theodore 2015: xxi) but had splintering trajectories and evolved as they travelled and encountered both 'hierarchical and nodal sources of power' (xxvi). While state government centres have retained hierarchical authority over the curriculum, this has only been possible through horizontally connected webs of nodal organizations, actors, and flows of texts, policy ideas and material resources across national and transnationally arrayed policy spaces.

The result of the activities we have documented has been the production of composite policy assemblages, with various actors, organizations, discourses and materials forged through hard work into relatively stable working arrangements in each national context. Following Li (2007) we have documented how the policy assemblages that enact computing in schools have been drawn together through organizational and discursive alignments driven by key catalyzing actors and the involvement of intermediary organizations. These intermediaries have succeeded in translating high-level arguments into practical policy developments, through, for example, the packaging of knowledge in glossy inscription devices that are designed to contain critique and reassemble key ideas to align with local contexts. Along the way, political debates about computing in school have slowly been re-posed as practical matters of technique and delivery. The policy assemblages we have documented demonstrate the plasticity of education policy, and the effort required to stabilize it into forms for practical enactment, and are illustrative of how policy assemblages were built through relations, coalitions and partnerships. Yet, these assemblages require considerable effort to be sustained, with internal disagreements, failures, compromises and other setbacks occurring along the way.

Much of what has been detailed in this paper suggest a globalized turn toward coding, part of a wider trend in globalizing, transnational education policy development, policy borrowing and enactment (Gulson et al 2017). Indeed, while these specific coding and computing policies have been enacted in England, Sweden and Australia, similar developments have been occurring around the world. For example, the three cases highlight the various guises that Google has adopted to promote coding as an educational necessity. Many of the commercial and philanthropic organizations sponsoring coding in schools are doing so at global scale, not just in wealthy advanced economies. One example is the global software and database vendor Oracle, which claims its interventions into computing education have impacted on 30 million students in 110 countries and annually invests $3.3 billion to 'accelerate digital literacy worldwide,' including in the Global South (Oracle 2016). Clearly, coding and computing in schools has become a transnational policy movement with significant involvement and influence from organizations whose business models, like their products, rely on global digital connectivity and investments of the global IT and education industry. It is notable that following its introduction in the UK, the micro:bit is going global as a material diffuser of the coding policy agenda too. However, as the case studies of England, Sweden and Australia demonstrate, computing in schools cannot be reduced wholly to critical claims about the global commercial takeover of the curriculum, as Singer (2017) has claimed in relation to Silicon Valley influence in coding in the US. Coding and computing in schools across the three countries, as well as elsewhere, is the achievement of topologically-arrayed cross-sector policy networks which have succeeded in pulling together a range of diverse perspectives, rationales and justifications into different national configurations. Different constellations of national actors have coalesced, forged alignments, and reassembled ideas about coding in local terms.

The flow of material 'things' that move across policy assemblages (Ball et al 2017) has also clearly been integral to the introduction of computing in the three countries besides the human actors and organizations. Much of the original support for computing in schools in the three countries became possible because of a growing mass of reports, speeches, letters, white papers, manifestos, working papers and draft curriculum proposals. These inscription devices have circulated through the policy networks as material objects, often crossing national borders—whether virtually as digital files shared online, or physically in the shape of invitations to speak on stages at key events. In terms of the practical enactment of computing curriculum policies, this has also been supported in very material ways, such as through the provision of printed curriculum guidance, the supply of online teacher training materials, downloadable practitioner magazines, and the easy availability of free coding software for use in schools. Physical computing devices such as the Raspberry Pi and the BBC micro:bit instantiate the computing curriculum in hardware. As such, the specific material configurations and objects involved in schools computing policies 'play a role in shaping the emergence of human action' (Dourish 2017: 38).

New global education markets have been created as an industry of product development has emerged to support computing in schools 'in a policy climate that is generally favourable to decreasing the role of the state in direct provision of public services' (Verger et al 2017: 328). Schools are exhorted to choose from a vast market of suppliers of coding and computing resources. Indeed, when Michael Gove gave his catalysing speech in London in 2012, the emphasis was placed on commercial providers to supply the expertise required for the new subject, with Whitehall withdrawing from its 'micro-management' of technology in schools. Notably, then, when the new curriculum in England came into effect, the chief executive of commercial provider Codecademy claimed to have 'struck oil' as it was 'forcing an entire country to learn programming' (Dredge 2014). Governments have become active participants in making such markets function, ultimately pump-priming them through direct investment or matched-funding agreements with commercial companies, in ways designed to expand uptake of the subject, fund teacher development, and thereby stimulate resource demand, market growth and profitability.

As an example of fast policy and policy mobility, computing in the curriculum in different countries demonstrates empirically how contemporary policy is accomplished through sprawling assemblages of human actors interacting with things and artefacts, flows of money, and the blurring of profit and non-profit sectors. Statework is being accomplished at topographically defined national levels through the introduction of computing and coding in schools, albeit through topological chains of connections that traverse national state borders and sectoral boundaries. Commercial companies, think tanks, practitioner associations, venture capital firms, public bodies and philanthropic organizations have all been involved in the de-bordered policy networks behind coding and computing that are enabling the reformatory work of the state to be accomplished. This emerging policy formation space creates new power centres and democratic possibilities for different actors to influence education, but potentially also new power asymmetries that are distinct from formerly nation-based state policy processes. In this context, not only have school ICT subjects been recoded as programming and computing, but education policy is being recoded to become interoperable with the objectives of both nongovernmental organizations and the commercial technology industry.

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References

ABC. 2015. *Lateline: interview with Greg Miller*. 7th August – video and transcript: www.abc.net.au/lateline/interview-greg-miller-vice-president-and-general/6682296

Ball, S. J. 2012. *Global education inc. : new policy networks and the neo-liberal imaginery*. New York, NY: Routledge.

Ball, S.J. 2016. Following policy: networks, network ethnography and education policy mobilities. *Journal of Education Policy* 31(5): 549-566.

Ball, S.J., Junemann, C. & Santori, D. 2017. *Edu.net: Globalization and education policy mobility*. London: Routledge.

BBC. 2015. Groundbreaking initiative to inspire digital creativity and develop a new generation of tech pioneers. BBC Media Centre, 6 July: http://www.bbc.co.uk/mediacentre/mediapacks/microbit

Bita, N. 2015a. Coding in curriculum to prepare kids for tech-savvy future. *The Australian*, November 7th, https://www.theaustralian.com.au/national-affairs/education/coding-in-curriculum-to-prepare-kids-for-techsavvy-future/news-story/7ba0c0702ad0ad9f5dba653a9a709f22

Bita, N. 2015b. Kids who code: Building a digital workforce is child's play. *The Australian*, 6 November, http://media.theaustralian.com.au/kids-who-code/

Cellan-Jones, R. 2017. Computing in schools - alarm bells over England's classes. *BBC News*, 18 June: http://www.bbc.co.uk/news/technology-40322796

Chang, O. 2015. Australian schools are scrapping history and geography and replacing them with coding classes. *Business Insider Australia*: https://www.businessinsider.com.au/australian-schools-are-scrapping-history-and-geography-and-replacing-them-with-coding-classes-2015-9

Cochrane, A. & Ward, K. 2012. Researching the geographies of policy mobility: confronting the methodological challenges. *Environment and Planning A* 44: 5-12

Computing at School. 2010. Computing at School: A national working group, August: http://www.computingatschool.org.uk/data/uploads/Computing_at_School.pdf

Computing at School. 2012. Computer Science: A curriculum for schools, March: https://www.computingatschool.org.uk/data/uploads/ComputingCurric.pdf

Dickey, M.R. 2017. Trump wants the Department of Education to commit $200 million per year to computer science education. *TechCrunch*, 25 September: https://techcrunch.com/2017/09/25/white-house-commits-200-million-per-year-to-computer-science-education/

Dourish, P. 2017. *The Stuff of Bits: An essay on the materialities of information*. London: MIT Press.

Dredge, S. 2014. Forcing a generation to code is unprecedented, says Codecademy chief. *The Guardian*, 5 September: http://www.theguardian.com/technology/2014/sep/05/codecademy-coding-schools-education-apps

Earp, J. 2015. Computing, programming and coding in schools. *Teacher*, 19 October: https://www.teachermagazine.com.au/articles/computing-programming-and-coding-in-schools

European School Net. 2015. *Computing our future, Computer programming and coding. Priorities, school curriculum and initiatives across Europe*. http://www.eun.org/publications/detail?publicationID=661

Foo, F. 2014. Christopher Pyne urged to act on coding in classrooms, *The Australian*, 9 December: https://www.theaustralian.com.au/business/technology/christopher-pyne-urged-to-act-on-coding-in-classrooms/news-story/a6477b152f2e23a64c20a462f2a6402f

Godfey, M. 2013. Google calls for education reforms. *Sydney Morning Herald*, 13 March: https://www.smh.com.au/national/google-calls-for-education-reforms-20130313-2g09r.html

Gov.uk. 2013. National Curriculum in England: Computing programmes of study. Gov.uk: https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study

Gov.uk. 2014. Microsoft, Google and IBM to help train computing teachers. Gov.uk, 3 June: https://www.gov.uk/government/news/microsoft-google-and-ibm-to-help-train-computing-teachers

Gov.uk. 2015. £3.6 million for technology experts to train computing teachers. Gov.uk, 21 January: https://www.gov.uk/government/news/36-million-for-technology-experts-to-train-computing-teachers

Gove, M. 2012. Michael Gove speech at the BETT show. Gov.uk, 13 January: https://www.gov.uk/government/speeches/michael-gove-speech-at-the-bett-show-2012

Gulson, N., Lewis, S., Lingard, B., Lubienski, C., Takayama, K. & Webb, P. 2017. Policy mobilities and methodology: a proposition for inventive methods in education policy studies. *Critical Studies in Education*: http://dx.doi.org/10.1080/17508487.2017.1288150

Hartong, S. 2018. Towards a topological re-assemblage of education policy? Observing the implementation of performance data infrastructures and 'centers of calculation' in Germany. *Globalisation, Societies and Education* 16(1): 134-150.

HM Government. 2017. *Industrial Strategy: Building a Britain fit for the future*. London: Crown Copyright.

Humphreys, S. 2017. Chancellor announces £84m for Computing Education. Computing at School, News, 27 November: https://www.computingatschool.org.uk/news_items/542

IT and Telecom Industries. 2012. Akut och strukturell kompetensbrist i IT- och Telekomsektorn. [Acute and structural lack of skills in the IT and telecom sector.]. https://www.itotelekomforetagen.se/fakta-och-debatt/rapporter_1/rapport

Komljenovic, J. & Robertson, S.L. 2017. Making global education markets and trade. *Globalization, Societies and Education* 15, no. 3: 289-295.

Li, T.M. 2007. Practices of assemblage and community forest management. *Economy and Society* 36(2): 263–293

McCann, E. & Ward, K. 2012. Assembling urbanism: following policies and 'studying through' the sites and situations of policy making. *Environment and Planning A* 44: 42-51

McGann, J.G. & Sabatini, R. 2011. *Global think tanks: policy networks and governance*. London: Routledge.

Naughton, J. 2014. Year of Code already needs a reboot. *The Guardian*, 15 February: http://www.theguardian.com/technology/2014/feb/15/year-of-code-needs-reboot-teachers

Nesta. 2015. Next Gen. Nesta website: http://www.nesta.org.uk/next-gen

Noble, A. 2012. Science the key to seize control of the future. *Sydney Morning Herald*, 26 December: https://www.smh.com.au/politics/federal/science-the-key-to-seize-control-of-the-future-20121225-2bv55.html

Ofsted. 2013. ICT in Schools: 2008 to 2011. Gov.uk, 22 April: https://www.gov.uk/government/publications/ict-in-schools-2008-to-2011

Oracle. 2016. Oracle Pledges $1.4 Billion to Support Computer Science Education in the European Union. Oracle press releases, 1 December: https://www.oracle.com/corporate/pressrelease/oracle-pledges-computer-science-education-eu-120116.html

Parkin, T. 2011. Milestone or millstone? BBC and computer literacy. Agent4Change, 18 November: http://www.agent4change.net/news/1280-milestone-or-millstone-bbc-and-computer-literacy

Parliament protocol. 2015. Riksdagsprotokoll. [Parliament protocol for question time.]. April 21 2016. https://www.riksdagen.se/sv/dokument-lagar/dokument/protokoll/protokoll-20151696-torsdagen-den-21-april_H30996/html.

Peck, J. & Theodore, N. 2015. *Fast Policy: Experimental statecraft at the thresholds of neoliberalism*. London: University of Minnesota Press.

Player-Koro, C., Player-Koro, Bergviken Rensfeldt, A. & Selwyn, N. 2017. Selling tech to teachers: education trade shows as policy events. *Journal of Education Policy*: https://doi.org/10.1080/02680939.2017.1380232

Pyne, C. 2015. *Media release: memo to Bill Shorten: time to do your homework on computer coding and STEM*: https://www.pyneonline.com.au/media-centre/media-releases/memo-to-bill-shorten-time-to-do-your-homework-on-computer-coding-and-stem

Savage, G.C. 2017. Policy assemblages and human devices: a reflection on 'Assembling Policy', *Discourse: Studies in the Cultural Politics of Education*: https://doi.org/10.1080/01596306.2017.1389431

Schmidt, E. 2011. Eric Schmidt's McTaggart Lecture—full text. *The Guardian*, 26 August: https://www.theguardian.com/media/interactive/2011/aug/26/eric-schmidt-mactaggart-lecture-full-text

School Inspection. 2012. Satsningarna på IT används inte i skolornas undervisning [Investments in IT are not used in school teaching.]. https://www.skolinspektionen.se/globalassets/publikationssok/granskningsrapporter/kvalitetsgranskningar/2012/it/pm-it-iundervisningen.pdf.

Singer, N. 2017. How Silicon Valley Pushed Coding Into American Classrooms. *New York Times*, 27 June: https://www.nytimes.com/2017/06/27/technology/education-partovi-computer-science-coding-apple-microsoft.html

Singh, L. 2015. Kids who code: Why the App Store will soon be dominated by young developers. *Sydney Morning Herald*, 5 June: https://www.smh.com.au/technology/kids-who-code-why-the-app-store-will-soon-be-dominated-by-young-developers-20150602-ghetgt.html

Smith, M. 2016. Computer Science for All. *The White House blog*, 30 January: https://obamawhitehouse.archives.gov/blog/2016/01/30/computer-science-all

Twining, P. 2013. Digital literacy does not compute. PeterT's bliki: http://edfutures.net/PeterT%27s_bliki#12-Feb-2013_Digital_literacy_does_not_compute

Verger, A., Steiner-Khamsi, G. & Lubienski, C. 2017. The emerging global education industry: analysing market-making in education through market sociology. *Globalisation, Societies and Education* 15(3): 325-34.

Wiliamson, B. 2016. Digital education governance: data visualization, predictive analytics, and 'real-time' policy instruments. *Journal of Education Policy* 31(2): 123-14

Year of Code. 2014. What is Year of Code? Year of Code website: http://yearofcode.org/