

Does not compute: social dissonance in England's computing education policy

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Abstract

The new computing component of England's National Curriculum was promoted as an effective and egalitarian way to provide young people with the skills, knowledge, and ways of thinking necessary to participate in an increasingly digitalised world, both as citizens and as potential tech entrepreneurs or computer scientists. What policymakers did not adequately account for was how state schools would interpret this new policy, the impact it might realistically have on young people's relationship with modern digital technologies, and whether there might be a mismatch between the pro-technology narratives represented in this curriculum and the everyday beliefs and experiences of teachers and young families.

England is at an important turning point as it haltingly transitions from its manufacturing roots to a digitalised knowledge society, with a growing nostalgia for its former position as an imperialistic power of world-leading technological advancement. Through this study I will unveil the power relationships and shared socio-cultural knowledge behind the computing education policy's creation and its implementation. I will do this by answering the following research questions: 1) How are teachers translating the computing education policy into practice and why? 2) In what ways are the computing education policy influencing students' understanding of and disposition towards digital technology and why? and 3) What does the computing education policy – and teachers' and students' response to it – say about the incongruity between public policy around digital technology and people's real-world experiences and understandings of it?

Using teacher interviews, student writing and drawings, student interviews, extensive classroom observations, and policy analysis, this ethnographic case study of four primary school classrooms in the South of England will examine how the addition of computing to England's National Curriculum came to pass and why it is not meeting its stated goals, before discussing what this means about past assumptions and future possibilities for young people's engagement with and understanding of modern digital technologies in formal education settings. My study contributes a unique perspective of a single education policy as it passes through three different stages in its development and implementation, encountering and being shaped by the beliefs and values of several groups along the way. The results of this study inform our understanding of how power relationships function to define a policy's purpose and value across different settings, demonstrating how the power to define equates to the power to shape reality.

1. Introduction

This research is the study of an education policy as it passes from imagination into law and from law into classroom practice. It is an examination of how a policy changes as it passes through different hands, unveiling the power relationships that define the purpose of education, the function of policy, and the values of particular groupings of people, and how those beliefs and values in turn shape the way the world functions.

The policy in question came into effect in September 2014, when England's National Curriculum was amended to require that computing be taught to all children in every year of compulsory education as part of a major education overhaul taking place between 2014-2017 (Department for Education, 2014c). The reasoning given for this was that the technology sector was growing, and yet young people were leaving school with neither the basic digital skills necessary for the modern workplace nor the advanced skills needed to start a university computer science course or to found a new technology business. There was growing concern amongst government officials and members of industry that a gap was growing between workplace demand and local labour supply in the tech industry, and that the UK was failing to remaining globally competitive as a result (BCS, 2011a; Council of Professors and Heads of Computing, 2008; Department for Education, 2013a). Everyone, regardless of background, must learn the basics of computer programming, robotics, and computational thinking – the reasoning went – if the country was to remain competitive and its citizens were to benefit from the second technological boom.

The purpose of organised education has been argued over since its inception and even today conflicting narratives remain in the public discourage around the benefits of a liberal arts education versus that of skills training in the service of the country's economy. England's computing curriculum has been framed as an economic imperative and so, by making schools responsible for teaching it, schools have also been made responsible for the welfare of the country's economy.

While the idea that all children will have the opportunity to learn these economically-minded skills appeals to many, it is unclear how uniformly state-maintained schools – and primary schools in particular, where teachers are subject generalists – might enact these new curricular standards given that they already face a variety of significant challenges to providing a broad, high-quality education to all. The National Curriculum computing curriculum had not yet been written when most of today's teachers were in their initial teacher training and so they will not immediately know how to integrate this unfamiliar subject into their teaching practice. Different schools have access to different digital devices, not all of which may work and which not every teacher may know how to use in pedagogically significant ways. Each school has its own culture and ethos, and teachers bring their own beliefs and values with them to their profession, including about technology. Also, students will come from families who will have their own issues of access and disposition towards modern technology, which may limit students' ability to complete digital homework assignments, limit their prior knowledge of technology and technological skills, or result in resistance to in-school screen time. Lastly, teacher attitudes towards computing as a subject and their beliefs regarding pupils' academic and social potential play a significant role in the way that they teach, and may impact their

translation of the computing education policy into their own unique teaching practice (Cuban, 2002; Dewey, 1963; Pinkerton, 2015).

The addition of computing to England's National Curriculum was an ambitious move by policymakers and the members of industry who supported it, in the service of what they felt was a laudable goal: digital skills for all and computing jobs for many. Teachers, however, may have a different idea of what is laudable in education and may very well use their power within the classroom to work towards those goals instead.

1.1. Motivation

The United Kingdom's four constituent countries – England, Scotland, Wales, and Northern Ireland – each have their own devolved national curricula. At the time of this thesis' writing, the Northern Ireland Curriculum includes an ICT component, Scotland's Curriculum for Excellence has a technology component that includes computer science digital literacy (as well as other topics such as food and textiles), and Wales is preparing to fully launch a Digital Competence Framework between 2020-2022 as part of their new school curriculum. England, on the other hand, has included the subject of "computing" in its National Curriculum since 2014 and "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" (Williamson, Rensfeldt, Player-Koro, & Selwyn, 2018, p. 6). This curriculum was developed and then introduced to schools "in a remarkably compressed period" (p. 16) and therefore provides a unique and exciting opportunity to study what

factors impact how a digital skills curriculum is implemented and experienced on the ground, making it an ideal setting for this study.

As Larry Cuban (1986) argued, "Without much evidence to support unrestrained entry of machines into classrooms, reopening policy discussions on both the *how* and the *why* seems to be in order" (p. 91). It is entirely clear to outside observers why the computing curriculum was designed the way that it was. Given the important role that digital technologies now play in everyday life and, similarly, the powerful influence schools have over young people, it is important to study both the *how* and *why* of this new curriculum's creation and its implementation in England's state-maintained schools.

When I began developing this project, I set out to identify the socio-cultural impact that the new computing standards were having on schools, teachers, and students in England. However, when I started visiting schools I made a surprising discovery: the skills and knowledges covered by this government- and industry-lauded programme of study were largely not being taught at all. Knowing this null finding would surprise many in both the fields of education research and policy, I shifted my focus to identifying and understanding the motivations and mechanics that informed this situation. As a result, I was able to collect qualitatively rich data on how national educational policy is translated through local culture into teachers' practice, as well as how conflicting narratives around children's needs and the function of digital technology in society can result in the creation of education policy that does not result in the intended teaching practice. It is not clear that the needs and perspectives of teachers and students were taken into consideration during the creation of this economically-inspired curriculum, so this study

fills that gap by sharing the words of these two key groups – as well as those of the people involved in the creation of the policy – on what matters to them most in a digital skills education.

Lastly, this study demonstrates that it is not enough to build an education policy based on industry-stated needs. Evidence-based educational theory and the perspectives of those affected (e.g. teachers, students, and families) must be considered. Not only is this imperative to the creation of a pedagogically and theoretically sound policy, but also necessary for creating a catalyst for feasible and actionable change in schools and society.

1.2. Overview of the thesis

This is a thesis of two parts, studying the socio-cultural motivations behind the creation of England's National Curriculum computing programme of study and how that curriculum is being experienced within the complex social institution of the primary school. I will use data collected through document analysis and during ethnographic field work across four cases (i.e. classrooms) to explore the following themes: a) how the computing programme of study was developed and why; b) what aspects of the computing curriculum teachers are teaching, how, and why; c) how students in those classrooms are engaging with these lessons; d) students' understanding of digital technology and their dispositions toward it; and, e) teachers' understandings and dispositions towards the National Curriculum computing standards specifically and computing education generally.

To do this, I will first review the literature on the changing role of technology in society, why young people need digital skills, how educational policies around digital skills might best be developed, and the challenges faced when implementing a computing curriculum specifically, before addressing what limited research has already been carried on the teaching of England's computing curriculum in schools. I will also establish the importance of power, knowledge, and discourse in how people and societies function, using a Foucauldian perspective to explain how different groups of people come to understand the world in significantly different ways.

Next, I will outline my methodological plans for my research. This will include introducing the methodological theory that informs this study's perspective, before introducing my research questions. After addressing my sampling strategy, ethical considerations, and issues of study site access, I detail the research methods I used to collect data in the field and through desk research before explaining the analysis methods used to synthesise the data from across methods, participants, and field sites.

In my first findings chapter, I explore the actors and narratives that brought about the removal of ICT from the National Curriculum and the creation of a new computing curriculum. The perspectives of actors who had their intentions realised in the final curriculum and those who did not are addressed, as are both the positive and critical responses to the curriculum's initial implementation. Political context is given for the ever-changing but often conflicting priorities of England's Department for Education to help explain the confusing guidance that teachers receive on the state's educational

priorities. In this chapter I will also closely examine the wording of the new computing curriculum, comparing it to the old ICT curriculum.

In my second findings chapter, I investigate what is taking place in the classroom by sharing data collected from the four state primary school classrooms taking part in my case study. This chapter looks into the perspectives of parents towards technology as reported by their children in order to understand what is happening in participating students' home contexts. Children also give their own accounts of what is happening both at home and in the classroom, and their perspectives on digital technology. Through classroom observations I capture a number of interesting examples of use and non-use of technology and computing in schools, with further detail and insight provided by teachers during their interviews around their perspectives and motivations.

In the discussion chapter I will discuss in detail what the study's findings mean for the study's research questions, synthesising findings from the field and from historical research with the extant literature to understand what factors are influencing the low uptake of computing subject matter in primary schools. I conclude the thesis by summarising the importance of accounting for important stakeholders' beliefs and values when developing a new education policy and how the British government's failure to do this led to an uneven adoption of England's new computing curriculum. This has serious implications for how education policy should be developed in the future and for how we understand the relationships between educators and policymakers.

2. Literature Review

This chapter sets the stage for my study by addressing the relevant literature to date. First, I will use a Foucauldian approach to discuss how actions and interactions within human societies build upon one another to develop a locally shared understanding of the world. Next, I will synthesise the literature on the perceived impact of digital technology[1] on society, exploring the claims that Western society has been fundamentally changed by the ubiquity of digital technologies and that children need to be educated in new skills and new ways of thinking as a result. This will be followed by an explanation of *dispositif* and how different *dispositifs* compete to shape education policy at different stages of its development and enactment.

I will next explore the common factors that influence policy implementation, with a particular emphasis on the role that actors or groups of actors play as a policy is translated into practice. This will be followed by an examination of the literature on implementing education policy involving technology, including a look at the history of the problematic ways in which educational technologies have been promoted in the past. Lastly, I will address the highly critical research that has been carried out so far on England's computing education policy, which signposts significant concerns regarding both the translation of policy into practice and the overall appropriateness of the computing education policy as written.

[1] I define computing as "any goal-oriented activity requiring, benefiting from, or creating computers" (Shackelford et al., 2006, p. 9), ICTs as "a diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information" (Blurton, 1999, p. 1), and computer science as "not just the development and use of computers, but also... the principles behind them and their uses" (Passey, 2017, p. 423). I define technology as a tool developed from scientific knowledge (whatever the contemporary definition of "scientific" knowledge is at the time of the tool's creation), most of which existed long before the digital technology revolution.

2.1. Power/knowledge (and discourse)

Before discussing what the literature says about why digital skills are important for children or what evidence there is for implementing a computing education policy this way or that, I must first address the nature of human reality itself. This includes our *knowledge* of the world (e.g. how it functions; what is true or false, good or bad), the culmination of which within any one socio-cultural grouping is a temporally and culturally-specific system of knowledge called *episteme* (Foucault, 1970); *discourse*, which is how we speak about ourselves and the world around us, and which reinforces our locally shared episteme (Foucault, 1989); and *power*, which is the relationship between individuals or groups, and the ability to enact one's own in the moment when it conflicts with another's will (Foucault, 1981a). All of this shapes how we perceive the world, our social practices, and the social practices of those around us.

I posit that everything in human society has a history, including our morality and values (Nietzsche, 1886), and therefore "everything is contingent, and thus, in principle at least, open to change" (Allen, 2012, p. 1). This means that nothing in our culture or societal structures is inherently correct or natural but rather has been born from the circumstances of particular people groups (e.g. institutions, societies, nation states). Changes in those circumstances can change the "history" of a group's knowledge and therefore the episteme (and sociocultural institutions) itself; in other words, "what exists does not exhaust the possibilities of existence" (Burchell, 1996, p. 34). Foucault (1988b) saw for himself a role in unveiling this truth behind the "truth" of the socio-cultural institutions that we take part in:

> My role... is to show people that they are much freer than they feel, that people accept as truth, as evidence, some themes which have been built up at a certain moment during history, and this so-called evidence can be criticized and destroyed (p. 10).

This thesis similarly aims to unveil the truth behind how England's computing education policy was conceived, how it has been conceptualised in media and government reports by policymakers and members of industry, and how the episteme in which the policy was created and promoted is different from that within the average school classroom.

An important point to remember is that knowledge (in the Foucauldian sense) is produced not by powerful institutions lording their strength over weaker individuals, but through the "perishable, seductive, deceptive, lowly world" of human interaction (Nietzsche, 1886, p. 6). This pushing back and forth between human actors, this negotiation of the "conduct of conducts" (that is, the boundaries of what conduct is considered rational, reasonable, and permissible – or not) (Foucault, 1982, p. 341), this "dynamic and interactional force" (Hook, 2007, p. 79) is not restrictive but rather productive. Our understanding of the world is:

> ...secretly based on an "already said;" and that this "already said" is not merely a phrase that has been already spoken, or a text that has been written, but a "never said," an incorporeal discourse, a voice as silent as a breath, a writing that is merely the hollow of its own mark (Foucault, 1989, p. 25).

Foucault said that, "Power produces, it produces reality" (Foucault, 1979); I would add that the reality it produces is local. Just as the reality of a cattle farmer in the Scottish Highlands will differ in particular ways from that of an investment banker in London, so does the reality of a school teacher differ from that of a politician. There will be overlaps

in their systems of knowledge and their discourse as they live in the same country, are exposed to similar media, and have both been tasked by society with making sure children receive a relevant, high-quality education. However, the values and world view of their respective professions will shape their perspective of this task and the best way in which to accomplish it. This can result in clashes between the government and schools, as policymakers create education policy that fits their world view with the expectation that teachers will implement it with fidelity, even though it may very well clash with teachers' own local episteme.

2.2. Societal shifts

Why did England's policymakers create the new computing curriculum? What led them to believe that a new digital skills curriculum was needed? Are rapid developments in digital technology changing society in significant ways or is it society that is shaping technology? Policymakers in several countries have changed their national curricula in response to concerns regarding these possible shifts in societal needs and structures, with the hope of preparing their young people to engage civically and economically with a globalised, digital, and changed world (Hubwieser, 2013; Moller & Crick, 2018; Williamson et al., 2018). Whether those concerns were valid – and whether their suggested solutions are sufficient – depends on who you are and where you sit.

2.2.1. England as a knowledge society

Some in both policy and research say that England has become a knowledge[2] society and, as such, many of its citizens need significant reskilling in order to be successful in (and contribute to) this new social order. Closely related to the concept of an information society, a knowledge society is one in which people identify, produce, process, transform, disseminate, and use information "to build and apply knowledge for human development" (UNESCO, 2005, p. 27; also see Wadha, Finn, Wessels, & Sveinsdottir, 2017). Lytras and Sicilia (2005) refer to it as a new strategic position for societies that, due to the massive increase in information creation and access, now highly value the processing and reinterpretation of that information to create useful knowledge in ways that previous, pre-Internet societies did not.

The concept of the knowledge society presumes the existence first of an information society in that information is widely accessible, reproducible, structured, and formatted. However, it goes further, promoting and valuing the ability to maintain those "cognitive states needed to interpret and otherwise process" so much information (Anderson, 2008, p6). This "fourth industrial revolution" – which is supposed to bring about technologically-enhanced "productivity and wealth creation" (Schäfer, 2018) – is said to require new skills to create, interact with, and manage these new means of production (Avis, 2018). What these skills and cognitive states actually are, how they present themselves in individuals (e.g. if and how they can be identified as present), and how

[2] Not to be confused with Foucault's use of the term *knowledge*.

they can be developed in young people is still under debate (Djumalieva & Sleeman, 2018; House of Lords Select Committee on Communications, 2017; Selwyn, 2011).

Because of rapid improvements in the quality, cost, and access to digital technologies[3], societies have become increasingly networked. Assumptions have been made regarding the importance of digitalising government and other administrative processes – particularly in regard to the abilities of so-called "digital natives"[4] – as can be seen in the digitalisation of important social and commercial services (e.g. banking, health care, education). At the same time, some would argue that this move towards a knowledge society means that the "skills and insights for participating in a variety of knowledge communities over time and distance need to be stressed and assessed as much as (if not more) than the acquisition of knowledge" (Collis, 2006, p. 221); that is, citizens are *not* sufficiently skilled and therefore still need to learn how to access, interpret, and otherwise process information, not just memorise it. Knowing how to access and manipulate information may now be, in many areas of life, more important than knowing the information itself; whether this change will be beneficial or problematic for society (Webster, 2014), and whether it is even a significant change (Vrcelj & Zloković, 2014), remains to be seen. There is an obvious clash then with narratives of an unprepared public and the need for computing education in schools for those very same "digitally native" students. Clearly, it is possible for complex systems to play host to conflicting

[3] Though the British government still struggles with providing high-speed broadband to many areas (Department for Digital, Culture, Media, & Sport, 2014; Morley, 2018; Ofcom, 2018).
[4] The concept of digital natives is highly problematic and largely not supported by the literature (Bayn & Ross, 2011; boyd, 2014; Garcia, 2013; Helsper & Eynon, 2010; Selwyn, 2009), though it is a frequently used term in popular discourse.

narratives; in government and in business, the left hand does not always know what the right hand is doing or thinking.

As policymakers buy into this idea of the knowledge society, they have begun looking into how to provide their citizens with appropriate technical training. Formal education systems have become the main focus in many countries, including the UK (and England and Wales especially) (Jakobi, 2007). Educational policies have been written with the intention of providing students with the knowledge and skills they need to enter the workforce of a knowledge society, and to contribute positively to the British economy and the country's influence in the computing sector and other sectors facilitated and influenced by computing. A state-funded education in these information and digital literacy skills and knowledge is, in theory, supposed to provide young people from all walks of life with a baseline level of ability so that they and their families can access these new systems of knowledge and power, taking advantage of potential affordance such as bypassing traditional barriers (e.g. geographic proximity to resources) and accessing lucrative employment opportunities (David & Foray, 2003).

While I am not taking a technologically deterministic stance on societal shifts in England and the UK more broadly, I can say without irony that "without specific technologies some social structures could not develop" (Castells, 2004, p. 221), and the increasing digitalisation of services and administrative processes is having an impact on how people engage with government, businesses, and other organisations. Whether or not the knowledge society is a fundamentally new state of society compared to information- and pre-Internet societies is not of particular importance to this study, except in

understanding how others might see a need for improved digital skills training. What is clear is that the government and private companies now expect some level of technological skill from everyone in British society and, for various reasons, schools have been selected to impart these skills on young people, even though historically they have often struggled to effectively integrate digital technology into their practice (Hargreaves, 2002; Anderson, 2008; Davies & Eynon, 2018; Young, 2010). Additionally, developing pedagogy to meet changes in social needs requires not only a consideration of students' educational needs, but also the complex economic, political, and cultural contexts in which they exist (Ricaurte, 2016). However, I will first address what prior research suggests regarding which digital skills young people need, before delving more deeply into the challenging, multi-layer socio-cultural structures that policymakers, teachers, and students encounter.

2.2.2. Young people and the need for digital skills

When discussing the presence of technology in educational settings, it is important to first assess whether it is an appropriate tool for the task at hand, either as a way of learning another subject or as a subject of study in its own right: "If *how* is asked before *why*, we will be building a shaky foundation" (Cuffaro, 1984, p. 560). The *why* of England's computing curriculum will be discussed later in Chapter 4. However, we do know from previous studies some of the potential benefits of learning those skills covered by the computing curriculum, particularly how their study can impact a wider range of educationally-important skills and abilities, including improving young people's understanding of and interaction with complex social systems. Of course, such learning requires teachers to have been given the necessary tools (often including training)

necessary to teach with or about technology, and for the goals of a digital skills curriculum to align with their professional beliefs and values.

Research from as early as the 1980s suggests that studying computing (compared to the use of educational software to learn other subjects) can benefit students' reflectivity and divergent thinking, important abilities for engaging purposefully and critically with society (Clements & Gullo, 1984). Ito et al. (2008, p. ix) – in an optimistic ode to changes in how young people engage with digital technology – describe how they see modern technology use as breaking the boundaries of powerful social systems:

> If we look at children and youth through the lens of digital media, we have a population that has been historically subject to a high degree of systematic and institutional control in the kinds of information and social communication to which they have access. This is one reason why the alchemy between youth and digital media has been distinctive; it disrupts the existing set of power relations between adult authority and youth voice.

Wing's (2008) seminal paper defined computational thinking – one of the key components of the new computing curriculum standards – as the understanding and abstracting of "what details we need to highlight and what details we can ignore" (p. 3718) from multi-layered, networked interfaces; that is, computational thinking is the ability to delineate what information should be focused on and what should be ignored. These "compute-rs" that learners are engaging with could be machines, or equally, humans, as both process – that is, compute – information. Consequently, developing a young person's computational thinking not only opens up to them the whole of the multi-layered, networked world of computing machines, but possibly also the multi-layered, networked world of people and the many ways in which they relate to one another.

Computational thinking could, in theory, act as the first step towards understanding and taking control of one's place in various social relationships and institutional structures, both within the school and without[5].

A recent systematic review of the literature on educational outcomes for children learning to code in school (a major part of England's computing curriculum) found several positive outcomes (Popat & Starkey, 2019). The evidence so far suggests that learning computer programming: improves students' verbal problem solving skills (Bernardo & Morris, 1994); encourages students to collaborate (Fessakis, Gouli, & Mavroudi, 2013); improves their problem-solving abilities (R. B. Miller, Kelly, & Kelly, 1988; Palumbo & Reed, 1991); develops a wide range of generic learning-related skills and competencies (Falloon, 2016); and improves students' attitudes towards learning overall (Kalelioglu & Gülbahar, 2014). Paradoxically, learning to code was also shown in some instances to have no impact (Kalelioglu, 2015; Kalelioglu & Gülbahar, 2014) or a negative impact on learning outcomes (Hayes & Stewart, 2016; Psycharis & Kallia, 2017). As such, there is no clear consensus yet on the benefits specific to learning to code – beyond, obviously, the improvement of students' ability to programme computers – suggesting that contextual factors will play a significant role in whether studying computing benefits students or not.

One set of skills that has growing prominence in the media – but is not addressed explicitly in the National Curriculum computing requirements – is the ability to identify

[5] My thesis research was originally going to be exploring how a universal computing education might improve students' awareness of social structures and power relationships (so that they might, in turn, be able to engage productively with them) until I discovered how little computing instruction was actually taking place in schools.

and understand how digital technologies have been programmed to function by their creators and why; Dufva and Dufva (2016, p. 98) even go so far as to say that this ability is necessary "for full participation in modern society." Recent scandals around the (mis)use of Internet users' data (Cadwalladr & Graham-Harrison, 2018; Osborne & Parkinson, 2018) and the use of targeted advertising and fake accounts on social media to influence national elections (Burgess, 2017; Calabresi, 2017; Chen, 2015; Payne, 2017; Quackenbush, 2018; Shane & Goel, 2017) has increased concern that the general public does not have the digital, media, or information literacy necessary to decipher truth from fiction, at the very same time that the public is increasingly looking to the Internet as their main source of news and information (Mitchell, Gottfried, Barthel, & Shearer, 2016; Newman, Fletcher, Kalogeropoulos, Levy, & Nielsen, 2017; The Pew Research Center, 2008). The technologies themselves, not just the content displayed by them, is of concern:

> The code in digital technologies is not value-free, rather it widely reflects both conscious and subliminal values of the programmer, a software company or society's understanding of good code... Code does not reflect objective truth about the world. Instead, it constructs laws in the digital realm (Dufva & Dufva, 2016, p. 98).

When digital skills are framed as necessary to becoming a productive, informed, and influential member of society, provision of an education in these skills becomes a social justice issue, which those in power must recognise "in the spirit of democratic participation" (Drotner, 2008, p. 167). When a society adopts networked digital technologies in the way that the West has, then all free and fair societies must provide their young people with a baseline level of digital skill in order that they might make the

most of their lives, enjoy a freedom of expression, and contribute meaningfully to society.

There are conflicting narratives in the public discourse regarding how much upskilling most young people actually need, or even whether they even need a different skillset from young people a generation before. While many remain optimistic that young people are, one way or another, acquiring the digital skills necessary to participate fully in society, others note that there is often a banality of use amongst young people – "Recent studies suggest that most young people's everyday uses of the Internet are characterized not by spectacular forms of innovation and creativity, but by relatively mundane forms of communication and information retrieval" (Buckingham, 2008, p. 14) – and that the lines between producing and consuming content is blurred in the digital age, resulting in what Weber and Mitchell (2008) refer to as "prosumers." There is a concern that adults who did not grow up with digital technology may be guilty of the "exoticization" of discourse around these technologies, viewing them as inherently "transformative" and "disruptive" (Herring, 2008) when, in fact, their sophisticated use by young people requires just as much guidance and practice as other literacies do.

Non-governmental organisations have adopted the narrative of computing skills translating to social empowerment, and therefore promoting the importance of individuals learning and using those skills. In this view of an increasingly digital society, "citizens themselves require the digital skills to take part in increasingly people-centered and citizen-led digital services" (Williamson, 2016, p. 53). The Nominet Trust and Nesta argue for encouraging "sociotechnical" skills such as coding and computational thinking

as a way of increasing civic engagement with digital government services and interfaces (Williamson, 2016). These organisations praise “tech pioneers” for “changing lives, communities and our world for the better” with their computing skills and see technological entrepreneurship as “transforming our capability to address complex social challenges” (Nominet Trust, 2014). They encourage individuals and other organisations to do “coding for civic service” and explore further “what is (technically) possible and what is (politically) feasible” (Bell, 2014). These tech-positive, technodeterministic statements are among many coming from official voices that support the publicly-broadcast narrative equating computing to empowerment, and coding to changing the world.

What is clear is many people – including representatives of well-regarded organisations – believe that young people today need to develop abilities both new and old in order to participate successfully in modern society. What those abilities are exactly is not yet clear, with the list changing depending on who is asked (and what interests they represent). In the UK, there was a growing belief that these technological shifts meant that society needed to provide young people with formal instruction and guidance in these abilities if they were to be individually prepared for living and working in the new world, and if British society was to remain skilful and internationally competitive.

2.2.3. A shift in society’s *dispositif*

There is a theoretical basis for this narrative around the link between new technologies and not only the need for new skills, but also new values: we are caught up within our local *dispositif*, which is *episteme* reinforced by our *discourse* (i.e. the verbal and non-

verbal ways in which we communicate meaning and value) (Foucault, 1980). Dispositif is the dynamics of:

> ...the supports that these relations of force find with one another... or, on the contrary, the gaps, the contradictions which isolate them one from another; the strategies, in short, through which they take effect, and in which the general outline or the institutional crystallization take shape in state apparatuses, in the formulation of the law, and in social hegemonies (Foucault, 1981a, p. 122).

In this thesis, I will use the term dispositif both to denote socio-cultural structures and processes in general (i.e. social groups, in general, share internally particular beliefs and values which are reinforced by the language that they use) and in specific cases (e.g. politicians in the current British Government value an exceptionalistic form of patriotism, as exemplified through their rhetoric of "British values").

If Western society's dispositif is shifting due to technological advances, then societies will naturally want to enculturate their young people into this shifted way of understanding and engaging with the world. If social institutions are enculturating children in outdated knowledges and discourse that no longer represent the dispositif of greater society, then young people will be ill-prepared to participate in that society as adults and society will be burdened by conflict with their misaligned values and ways of being. In other words, young people not only need to be taught functional skills of computing, they also need to be brought into a particular way of viewing the world around them; for some, this means a world shaped by and (both actively and passively) shaping networked digital technologies.

While Foucault rarely wrote about education himself, he did say that "Education, like the prison and sexuality[6], is fundamental in shaping modern western society and in its effects on [its] subjects" (Devine-Eller, 2004), and therefore just as deserving of examination. Foucault described his work as developing a history of how human beings are made into subjects within and by our culture (Foucault, 1982), and as schools are the most structured and pervasive institutions of enculturation beyond the family in a person's formative years, his theory is well suited for studying formal education. Additionally, Foucault did not see his work as static and was frustrated "that so much effort was devoted to writing about what he might mean rather than doing the sort of practical analytical work that he advocated so vigorously" (Ball, 2013, p. 18); in response, I will continue some of that analytical and empirical work through this thesis by examining the role of dispositif in implementation of England's computing curriculum.

From early modernity to now, schools have increasingly become the "chief socializing mechanism" in the lives of young people (Deacon, 2006, p. 179). In addition to teaching subjects such as maths and English, they teach social boundaries and ways of thinking about the world, often sub-textually (Dewey, 1916; Foucault, 1989). Foucault saw schools as one of many institutions formed of "blocks of capacity-communication-power" (Deacon, 2006, p. 183) that were used for "maintaining or modifying the appropriation of discourses, along with the knowledges and powers which they carry" (Foucault, 1981b, p. 64):

> These "regulated and concerted systems" fuse together the human capacity to manipulate words, things and people, adjusting abilities and inculcating behaviour

[6] Two topics he wrote about with great frequency.

> via “regulated communications” and “power processes,” and in the process structuring how teaching and learning take place. What distinguishes educational institutions from prisons, armies, and hospitals is that the former emphasize “communication” above “capacity” and “power” (Foucault, 1982, p. 218).

The initial one-to-one teacher-to-pupil structure of Western education was first replaced by the “monitorial method,” in which more senior students would first receive instruction one-on-one from their teachers before, in turn, tutoring small groups of more junior students. This would later be replaced by schooling’s current form, in which a single teacher provides instruction directly to groups of students within the classroom. How these students are grouped together changes according to a society’s current values: for example, growing anxiety in the West over maintaining the purity of the young and inherently innocent led to what Foucault referred to as a “pedagogization of children’s sex” (Foucault, 1981a, p. 114) in which younger students were separated from older students, the middle class from the lower class, and those with physical or cognitive disabilities resulting in behaviours or appearances deemed unseemly from those who could more easily have their physiques, character, and reasoning shaped to meet society’s ideals (Aries, 1962). It also came to be seen as important for “certain categories of children to be ‘rescued’ from ‘inappropriate’ institutions": first from places such as “workhouses, poorhouses, prisons, and guilds” to any sort of school (Deacon, 2006), and later from underperforming (or undervalued) state schools to more prestigious grammar schools and private schools by scholarship. Even now, this categorisation of students continues in the grouping of students into sets, the exclusion of students not meeting certain behavioural standards, and the funnelling of students towards “academic” or “vocational” courses.

As formal schooling developed, a "judicial power within the school" (Foucault, 2000b, p. 83) formed that mimicked greater society's model of judicial power, ostensibly in order to allow for the orderly transfer of knowledge from teacher to pupil within the physical bounds of the classroom and the temporal limits of the school day. This judicial power moved from "threats and blows" to "a cold and neglectful countenance" (John Locke in Baskin, 1966, p. 348), from "the public, the spectacular and the physically violent, to the personal, the mundane and the psychologically compelling, ...from external retribution to internal reform" (Deacon, 2006, p. 182). The classroom was not just a place to learn facts and be trained in skills, but also a place to develop one's own character, morality, and values in line with the dominant local culture. The goal of this "is the production of a self-disciplining, self-regulating citizenry" (Peim, 2001, p. 181) that could be kept in line through self-praise and self-discipline rather than through the public shaming or violence of old:

> The strategy of rendering individual subjects "responsible" (and also collectives, such as families, associations, etc.) entails shifting the responsibility for social risks such as illness, unemployment, poverty, and so forth, and for life in society, into the domain for which the individual is responsible and transforming it into a problem of "self-care" (Lemke, 2002, p. 59).

School's control over the shaping of students' "character" and the grouping of them ostensibly by "ability" or even overtly by their level of compliance with authority (e.g. through detention or exclusion from school), extends beyond the classroom itself. Compulsory education forces young people and their families to participate in a particular (geographically, if not culturally) local institution, regardless of whether they accept the episteme of that institution. Other institutions (e.g. law enforcement, the judiciary, social workers) are allied with schools to ensure attendance and adherence to the morality of

the school, which in turns requires or results in surveillance and the supervision of parents and teachers to ensure compliance (Foucault, 1986). Extensive record keeping – "a mass of documents that conspire to make the most banal aspects of our lives accessible to the influence of power" (Allen, 2012, p. 2) – is a tool of surveillance and it aids in the development of "moral coercion between teachers and pupils (often of the most benevolent appearance)" (p. 3) and between governments and schools.

In England, we see this in a recent revitalisation of interest in teaching "British values" in schools (Department for Education, 2014b), in part due to fears that individuals from communities seen as "outside" the dominant British culture were leaving school without having been properly assimilated into the British or broader Western value system. Similarly, fears that England and the UK more generally were being left behind in the digital technology boom of the 2000s and 2010s led to a massive shift in educational policy, making computing skills and computational thinking mandatory learning for all pupils in compulsory education. Students are now to internalise the importance, usefulness, and moral value of STEM subjects and computing in particular. Becoming a computer scientist or the next tech billionaire is positioned as within each child's reach, if only they would apply themselves fully to the education that they have been guaranteed by the National Curriculum. Teachers, in turn, have been made responsible for providing an education capable of producing these outcomes; as a result, they are made responsible for the success or failure of the national economy, ignoring any structural or systemic issues they might encounter along the way (Ball, 1987).

2.3. Stages of education policy

Even if a good set of developmentally appropriate and societally desirable skills and knowledges are written into policy, this does not necessarily mean that young people will receive an education as expected. Education policy goes through several stages before it reaches students and each one of these stages play host to a variety of actors who act upon the policy.

While national educational policy is applied to a diversity of student bodies, school structures, and community cultures, it is also developed and written into law as if "one size fits all." The "all" that policy is developed for depends on the beliefs and prior knowledge of the policymakers involved in its creation, but typically it is a personification of a school ideally set for the perceived needed ideal change (Ball & Bowe, 1992). Assumptions are made regarding this ideal school's: material resources; staff training and experience; and the understandings, experiences, and attitudes of the students. Educational policy also assumes one of two things about teachers: either a) that their professional beliefs, knowledge, and experience aligns with the beliefs of policymakers about what's best for their classroom, or b) that they will comply with national educational policies regardless of their own professional beliefs, knowledge, or experience. If any of these assumptions are not met (and they often are not, given how much difference there is between schools, catchment areas, and teachers across the country), then policy can be interpreted and experienced in unpredictable ways (Cuban, 2002).

The National Curriculum for England is no exception to this. From its inception, National Curriculum policy has assumed a certain level of sameness across schools in relation to the appropriateness of the curricular standards for all students and the ability and willingness of all schools to meet those standards. Since the National Curriculum does not – and cannot reasonably – predict the "unforeseen, unforeseeable and unavoidable difficulties" (Ball & Bowe, 1992, p. 106) inherent to institutions made up of individuals with differing interests, attitudes, abilities, and beliefs, it cannot accurately predict how all schools' attempts to enact its standards will translate into practice in the classroom.

A teacher's "professional responsibility does not begin and end with the National Curriculum" (Ball & Bowe, 1992, p. 109) and there is a tension as teachers balance the academic and assessment-oriented requirements set by national policies with the educational, socio-emotional, organizational, and special needs (e.g. English language learners, children in care) of their particular classroom. As professionals they may choose to enact (or not enact) the curricular standards in a way that they believe will best benefit their students but which does not meet the expectations of the policymakers who created those standards (Biesta, 2012). This does not mean that teachers are failing to meet professional standards; rather, the National Curriculum's computing standards cannot account for the various and unique needs of individual classes and their teachers, and therefore may not be strictly applied where seen (by teachers) as inappropriate. The ways in which teachers translate the policy into practice appropriate for their students and situation – not the intentions of those who created the policy – will be the final deciding factor in what change is created in schools (Knip & van der Vegt, 1991).

In this way, the National Curriculum exists in three different states: the "intended policy," the "actual policy," and the "policy-in-use" (Ball & Bowe, 1992, p. 100). The intended policy consists of various official and semi-official ideologies, such as those held by government and those private sector groups and individuals who play a role in the development of the curriculum. There is a tension between these oftentimes-competing ideologies as groups struggle for the power to influence change in educational policy and, to the extent they believe possible, educational practice.

The actual policy is the official policy as written into law, which states that "pupils are expected to know, apply and understand the matters, skills and processes specified" for each subject (Department for Education, 2013b). This policy state includes legislative wording, policy documents, speeches by government ministers, and other official materials used to disseminate changes to schools, other government and Parliamentary organisations, industry, and the public. The actual policy also consists of what is omitted by the curricular standards as written. What is not required to be taught – the "null curriculum" (Gehrke, Knapp, & Sirotnik, 1992, p. 53) – is just as powerful as what is required. The null curriculum may reflect a failure to translate the intended policy with fidelity into the language of actual policy or may instead be a purposeful omittance reflecting the ideology of policy writers (i.e. the intended policy).

Lastly, policy-in-use is the policy as understood and acted upon by educators. These practices and discourses emerge from teachers' internal struggle between balancing intended and actual policies with the realities of their classroom and their beliefs as professionals: "The distance between the idealized and the enacted is considerable;

between the idealized and the experienced, even more" (Gehrke et al., 1992, p. 97). Given the largely subjective nature of policy-in-use, it will naturally differ from school to school given the needs and beliefs of individual schools, teachers, and students. Teachers, often through trial and error, "develop a repertoire of instructional skills and strategies" appropriate for their teaching context (Huberman, 1992, p. 136) and aligned with their professional beliefs. These highly contextualized practices cannot be replicated wholesale across classrooms and schools with differing needs and resources, and across teachers with differing experiences and beliefs. However, they can reveal the dispositif of a school, casting imperfect shadows on the wall as in Plato's cave (Plato, 1966). By observing the enactment of a policy, we learn not only about the policy, but also about the place and people who enact it.

2.4. Factors affecting implementation of education policy

Once a policy has been created, it must then be implemented. Policy implementation is complicated by the large number of policymakers and practitioners involved – all with complicating normative issues and varied needs – as well as often a lack of sound theory being used during the development and enactment of new policies (O'Toole, 1986, 2000, 2004). There are many factors to consider when examining an intended policy (Chapter 4), actual policy (addressed later this chapter), and policy-in-practice (Chapter 5), and the complex processes that take place as a policy moves from one state to the next:

> ...the National Curriculum policy process is a good deal more complex than this [direct reading of policy into practice], requiring us to recognize there is a *dialectical process* in which the "moments" of legislation (the Act), documentation..., and "implementation" (the work of the teachers) may be more or less loosely coupled. Policy texts are not closed, their meanings are neither fixed nor clear, and the "carry over" of meanings from one policy arena and one

> educational site to another is subject to interpretational slippage and contestation (Bowe, Ball, & Gold, 1992, p. 83).

There is a limited amount of research being conducted on nation-wide computing education policy given how recently the subject has been included in many national curricula (Crick, 2017; European Schoolnet, 2015; Passey, 2017), and it is difficult to transfer results from one country context to another in order to suggest what might a best practice for implementing computing education (Hubwieser, 2013). Small-scale studies of computing education generally focus on the integration of technology into individual or small groupings of schools (Becta, 2006a, 2008; Moss et al., 2007; Somekh et al., 2007), rather than on implementation of educational technology policy or the integration of computing skills into more widely spread curriculum. However, there is wisdom to be gained from even the study of education policy implementation in these more limited contexts, which have shown with some confidence that there are factors that make a policy more likely to be enacted as intended[7].

2.4.1. Policy design

How policy is designed – including what content and considerations are excluded during a policy's development (Fullan, 2015) – will play a significant role in how it is enacted (Bell & Stevenson, 2015). Educational policy is typically made in response to a perceived need which can include serving policymakers' political needs, such as garnering voter favour prior to an election. The reasons why a particular policy is expected to meet a need should be well justified:

[7] This section relies heavily on the work of Viennet and Pont (2017), who produced an excellent literature review on educational policy implementation for the Organisation for Economic Co-operation and Development (OECD).

> Ideally, the analysis of the issue and the resulting choice of policy options should be based on evidence and on a good knowledge of the education sector, of the socioeconomic, cultural, demographic and political contexts, and of the mechanisms of change in a policy system, such as actors and their bargaining strategies (Viennet & Pont, 2017, p. 29; also see Haddad & Demsky, 1995).

While not referencing the concept of dispositif by name, Viennet and Pont do refer to elements of the knowledge and discourse that operate within that apparatus, such as culture and politics. These are, at least in the research community, well-known factors that influence the implementation of policy.

Being transparent about the intentions of a policy can improve stakeholder buy-in by presenting clear expectations of the policy's outcomes and, therefore, the style of implementation necessary to achieve those outcomes. When policy is written in such a way so that it is clear what its creators a) intended it to accomplish, and b) the steps they anticipated as necessary to meet those goals [i.e. a clear theory of change (Fullan, 2015)], there is a higher likelihood of implementation success (Ingram & Schneider, 1990; Sabatier & Mazmanian, 1980). The clearer a policy document is on these two points, the less room there is for alternative interpretations (Spillane, Reiser, & Reimer, 2002) and misunderstandings (McLaughlin, 1987) by important stakeholders involved in its translation from policy into practice. Given the heavy revisions made from draft to draft during the writing of the computing curriculum, the clarity of its purpose may very well be significantly compromised. I will examine the clarity of the computing education policy in Chapter 4.

2.4.2. Stakeholder engagement

Since education policies are implemented by people, it is important to keep them central to the development and implementation process (Viennet & Pont, 2017, p. 30). All stakeholders have at least some agency – even within the procedural, social, and cultural confines of the institutions in which they operate – and therefore they are capable of filtering a policy through their beliefs and understanding into a practice unintended by policymakers: "Indeed, the histories and culture of particular subjects may actually lead to different interpretations of possibility and constraint in the National Curriculum" (Bowe et al., 1992, p. 94). Teachers in particular have a great deal of control within their classrooms, a structure which "allows for and reproduces dissensus and goal diversity" (Ball, 1987, p. 11), which means that policy may not make the coherent impact across the education sector expected by policymakers.

For educational policies, most stakeholders are located at the school level (e.g. students, parents, teachers, and school leadership); however, additional stakeholders are also located at the local community level (e.g. local education authorities [LEAs]) and regional or national level (e.g. teacher training colleges, academy trusts, researchers, relevant government agencies). How policymakers can best engage with each of these stakeholders will vary from group to group and can be influenced by the structures, norms, and values present within each institution.

Stakeholders bring their own beliefs and judgments to policy implementation, and whether these beliefs align with those of a policy's creators can play a significant role in whether a policy is implemented to plan and/or achieves the hoped-for outcome. There

are also limits to the capacity of an individual, group, or institution to implement a policy, which can be influenced by issues such as training, funding, prior knowledge or experience, power, and will (Malen, 2006). These combined issues of "interests and capacity form a capital which determines the way actors react to a policy," ultimately resulting in policy being implementing with fidelity to policymakers' intentions or not (Viennet & Pont, 2017, p. 33). Given the limited role that certain important stakeholders (e.g. primary school teachers) were allowed to play in the development of the computing education policy (to be discussed further in Chapter 4), it appears unlikely that all of their relevant beliefs and values – and, subsequently, their buy-in – will have been adequately accounted for in the policy's final wording.

2.4.3. Policy context

Policies are implemented by groups from different social, cultural, and institutional levels, with one policy possibly focused on serving different agendas for different groups (Hill & Hupe, 2002); for example, the computing education policy is supposed to benefit both students and employers. Issues local to on-the-ground implementation of a policy include habits, norms or conventions, and rules (e.g. laws; institutional politics) (Pont, 2008). Organisational structures – that is, how institutions and the people they are made up of interact and function, both internally and externally with other institutions – can also play an important role in how educational policy is translated into practice (Fullan, 2015). For these reasons, policymakers should be intimately familiar with how institutions such as schools, LEAs, and academy chains operate and consider how much direct power they have to influence practice once a policy has been set into motion if they wish for their particular policy to be implemented as planned (Nakamura & Smallwood, 1980).

Institutions – and heavily regulated institutions such as schools especially – are required to conform to a prodigious number of laws and guiding policies. It is important that, when designing a new educational policy, policymakers consider how the new policy might complement or conflict with existing policies (Porter, 1994). This is not only an issue of law (i.e. whether two policies mandate conflicting actions), but also an issue of practicality and priority. For example, creating an educational policy that is resource-intensive while also having a nationwide policy of austerity is illogical and will only cause frustration for both those who created the policy and those who are expected to implement it. Policymakers should aim to create a cohesive set of policies that support one another; if an old policy needs to be changed for a new policy to function, then the old policy should be changed before the new policy is put into place. Given the desirability of providing teacher training and updated digital technologies when starting a new digital skills curriculum – and the lack of any new funding provision by the British government for these resources when the computing curriculum came into effect – it would appear that this requirements for the smooth, high-fidelity implementation of policy has not yet been met.

2.4.4. Implementation strategy

Having a thorough (yet flexible) implementation strategy in place before a policy is made into law is important for a policy's success. This plan should include: which organisations will be allocated certain tasks and with what support; the timing of implementation; both the overarching and step-by-step goals of a policy; how to engage with stakeholders; a communication strategy for various audiences; the political tools and resources which will be used; the collection and monitoring of data; and mechanisms for accountability.

There is also a strong argument to be made for having stakeholders play a role in the development of this strategy, as they are most familiar with the relevant institutions and processes, and may very well have the best idea of what is possible in practice and what is not.

2.5. Challenges facing computing education

While studies on computing education in primary schools is slim, there is a large body of research available on the integration of technology into the school classroom. Though the computing component of the National Curriculum could, in theory, largely be taught offline, many teachers are likely to use digital devices instead and so will face many of the same challenges as teachers using ICTs or other modern technologies. There are a number of factors that can impact if and how teachers use technology – and with what degree of educational impact – in their teaching.

Research has shown that teachers want to integrate technology and technology education into their classroom practice, but that they face feelings of a "lack of confidence, lack of competence, and lack of access to resources" (Bingimlas, 2009, p. 235). The availability of technical support can have a "considerably high influence" on the integration of technology into the classroom, and access to hardware (Inan & Lowther, 2010) and software (Starkey, 2010) has a strong relationship with the frequency of technology use by teachers in their practice. Similarly, a lack of expertise, training, and sufficient time to prepare lesson plans utilising technology has a negative impact on its integration (Giordano & Trufant, 2002; Yeh, Chang, & Chang, 2011). In short, insufficient technical and administrative support, funding, and access to technology act as significant

obstacles for educators wishing to bring technology into their classrooms (Ginsburg & Elmore, 2000). Given that teachers are education's gatekeepers, they "play a critical role" (Alenezi, 2017, p. 1798) in implementing any new computing policy, and so providing them with the support they perceive as necessary is paramount.

2.5.1 Historical technologies and narratives

There is a long history of use of educational technologies in schools and other learning environments (e.g. monasteries). With each new invention comes claims that the device has unique affordances unmatched by previous devices that make it a superior educational aid, potentially capable of truly fantastical outcomes for teachers and learners. While these technologies rarely fully replace another device without essentially replicating its function (e.g. pencil and paper replacing slate; whiteboards replacing blackboards), the lure of new ways to improve schooling remains, and many educators, parents, and policymakers continue to buy into overwhelmingly positive narratives around new devices and techniques as they are released even today.

It is important to study the history of these tools as everything in human society has a history and our present state is dependent on those past events. This means that nothing in our culture or societal structures (e.g. institutions such as schools) is inherently correct or natural but rather has been born from the circumstances of particular people groups. Changes in those circumstances can change the future "history" of a culture and therefore the culture (including tool-use) itself. In other words, other socio-cultural values (including the valuing of particular tools for particular uses) could have functioned just as well had they come to the forefront of our shared cultural knowledge (Foucault,

1980). Have policymakers in England who supported the latest trend in school-based tool use become "enslaved sovereign[s]" (Foucault, 1970): that is, powerful actors within English society who are still subject to local beliefs regarding computer science rather than being informed by a more objective truth[8]? What alternative digital skills might English policymakers have pushed for in the revised National Curriculum had they been more sceptical of the suggestions given to them by representatives of the American tech industry? Or if the American tech industry had developed in such a way that it did not so neatly align with the values of the current British Conservative Government, making them a less desirable ally in the development of this curriculum?

The introduction of new technologies into the educational space in early history was not, perhaps, proceeded by the same complexity of narratives and actors as they are today. The hornbook[9] – a wooden paddle overlaid with a piece of vellum that had text inscribed upon it, which was then sealed over the top with a thin, translucent piece of horn – originated in England in the mid-15th century, first to instruct young monks in religious verse and later to help children memorise the letters of the alphabet and other simple texts (Huey, 1908). They remained popular in American schoolhouses throughout their colonial era, lasting from the early 17th to late 18th century.

The *laterna magica*, an evolution of the *camera obscura* and early predecessor of the modern slide projector (which came into widespread use in the 1950s), was first

[8] Should such a thing exist. I would argue that it does but that we can only view it through our socialised, enculturated lens of experience, beliefs, and understanding.
[9] The hornbook is referenced as a teaching tool in William Shakespeare's *Love's Labour's Lost* (Act 5, Scene 1), written c. 1595.

advocated for as an educational tool to accurately reproduce complicated images for display during lectures (e.g. an anatomy lesson) in 1685, but did not gain significant popularity until the late 18th century (Rossell, 2002). The school slate and chalkboard, which enhanced students' ability to not only view educational content but to also respond to and create content, were used throughout the 19th century. The slate was slowly replaced by the pencil and paper as they became more widely available and affordable in the late 19th century, as did the typewriter (Cothran & Mason, 1978).

As technological innovation began to speed up outside of the classroom in the early 20th century, so did their introduction to and use within the classroom. Along with these new technologies often came big personalities with high hopes – or at least a persuasive sales pitch. Stereoscopes for viewing three-dimensional photographs, radios, and film projectors began to be used in the classroom in the early 20th century, with Thomas Edison predicting that:

> Books will soon be obsolete in the schools. Scholars will soon be instructed through the eye. It is possible to touch every branch of human knowledge with the motion picture. Our school system will be completely changed inside of ten years (Smith, 1913).

Edison – like many advocates of the use of technology in education since – believed that films had unique affordances not present in older teaching tools, such as stationary photographs or books:

> I believe that the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks. I should say that on average we get about two percent efficiency out of schoolbooks as they are written today. The education of the future, as I see it, will be conducted through the medium of the motion picture, a visualised education,

> where it should be possible to obtain one hundred percent efficiency (Edison, quoted in Cuban, 1986).

Though it is not clear from historical documents what evidence he based these beliefs in, it is evident that he believed that there was a quantifiable difference in the educational capabilities of his technological device over all others, a belief which continues to be asserted by technology companies with devices to sell even in our time.

Audio-visual instruction – including the use of overhead projectors (first used by the US military for training in World War II), the mimeograph or "ditto machine" (an early manual copy machine), and headphones – continued to grow in popularity during the 1940s and 1950s (Alenezi, 2017). Beginning in the 1960s and 1970s, the use of technology in education shifted from the use of media aids[10] to more complex pedagogical and administrative uses (Carliner, Ribiero, & Boyd, 2008) as educational technologies requiring active student engagement and interaction, as opposed to passive exposure, were invented. These devices included the handheld calculator and later the graphic calculator, CD-ROM drives, interactive whiteboards, and a range of early to present-day computers.

Within the UK context, early forms of computing instruction was offered by some British schools in the late 20th century as a sixth form subject. By the 1980s, an interest in

[10] However, audio-visual instruction continued to remain popular. Microfilm viewers (and microfilm copies of newspapers and other publications) were introduced to libraries in the 1960s and continue to play an important role in archival research to this day. VHS videotape cassettes became widely available and affordable from the 1980s onwards, until their replacement by DVDs beginning in the mid-2000s. Educational television was also popular from the 1960s onwards (Wilson, 2010). Whiteboards, a replacement for blackboards in many classrooms during the 1990s, were themselves replaced across England in the early 2010s by interactive whiteboards (Somekh et al., 2007).

providing opportunities more broadly for learning computing in schools was spreading and the government commissioned the Microelectronics Education Programme for England, Wales, and Northern Ireland in 1980 in order to "help schools to prepare children for life in a society in which devices and systems based on microelectronics are commonplace and pervasive" (Fothergill, 1981). The BBC Micro – a microcomputer made by the BBC to support widespread computing education – was released the following year. This was followed shortly by the BBC 2 television programme *The Computer Programme* in 1982, *Making the Most of the Micro* in 1983, and *Micro Live* from 1984-1987, all part of the broader BBC Computer Literacy Project. By 1985, over 80% of British schools owned their own BBC Micro (Edmundson, 1985).

During this time, some academics began to predict that the digital computer would revolutionise education, possibly by replacing the teacher. In the US, MIT Professor Seymour Papert worried that:

> There won't be schools in the future... I think the computer will blow up the school. That is, the school defined as something where there are classes, teachers running exams, people structured in groups by age, following a curriculum – all of that. The whole system is based on a set of structural concepts that are incompatible with the presence of the computer (Papert, 1984).

With the use and study of computers soon to be firmly embedded within a formalised curriculum in England, this futuristic educational structure was clearly not to come to pass any time soon. When England's National Curriculum was first introduced in 1988, Informational Technology (IT) was included as one of a number of "subjects or themes" that teachers were expected to weave through the teaching of other "foundation subjects," so that IT could "be accommodated within the curriculum but without

crowding out the essential subjects" (Department of Education and Science, 1987, p. 8; also see Department for Education & The Office for Standards in Education, 2011). "Computing" was also introduced at this time as an optional secondary subject (Department of Education and Science, 1989). IT was later converted into ICT to include the use of technology for communications (Secretary of State for Education and Employment, 1997). During this time, the subject of ICT was focused more on students developing basic digital skills (e.g. with word processing software, spreadsheets, email, and even "electronic toys, calculators and musical instruments") than understanding how computers worked or how computer programmes were written (Department of Education and Science, 1989). However, a meta-analysis of the literature (Cox et al., 2003) found that this instructional strategy of integrating the teaching of ICT into the teaching of other National Curriculum subjects had an inconsistent impact on the learning of those subjects, with some specific uses (e.g. the use of simulations and modelling in science) having positive results but being implemented inconsistently between different teachers.

The British Educational Communications and Technology Agency (Becta) – a non-departmental public body funded by the Department for Education (DfE) – was founded in the same year as the National Curriculum (1988) in an effort to promote the improved integration of IT/ICT into schools by influencing "strategic direction and development of national education policy to best take advantage of technology" and to "develop a national digital infrastructure and resources strategy" (Becta, 2006b). This was especially timely as Tim Berners-Lee would go on to invent the World Wide Web the following year in 1989, and then the first web server and first web browser in 1990. It also followed an

ongoing trend amongst “many reformers, researchers, and policy makers” to embrace “numerous innovations that have promised precision harnessed to efficiency” (Cuban, 1986, p. 86); in other words, the adoption of and instruction in ICTs at schools was seen to be not only of educational importance, but also of national “strategic” importance, tightly linked with issues of national infrastructure and resources. These themes continue on to today, with a narrative of the role of “the digital” in maintaining a country’s strategic power and influence.

By 1997, UK schools were on average spending a fifth of their budget on technology and by the following year there were 820,000 computers (not just BBC Micros) located in British schools (British Education Suppliers Association, 2015). With 99% of schools connected to the Internet by 2004 and the ratio of students to computers dropping to 1:8, the UK joined a small group of countries leading the way in the integration of computing into schools (Nash, Dutton, & Peltu, 2004).

In 2008, the Computing At School (CAS) working group (part of BCS’s Academy of Computing) was formed to promote the study of computing (as opposed to simply the use of computers) in England’s schools in order to increase the number of young people applying to university computing and computer science courses in the UK (N. C. C. Brown et al., 2013; Computing At School, 2012; Crick & Sentance, 2011). However, with the abolishment of Becta, the provision of resources to support teaching ICT and other computing-related disciplines declined significantly (Fowler & Yamada-F, 2009; UCAS, 2011), coinciding with a fall in applications to computing-related programmes at British

universities and a predicted shortfall of 30,000 computing graduates (Council of Professors and Heads of Computing, 2008).

With a growing technology sector, government officials at this time joined industry in worrying that not enough young people were leaving school with the basic digital skills that they needed to flourish in the modern workplace, nor were enough going on to university to acquire the advanced skills necessary to start new tech businesses or fill the growing gap between workforce demand and local labour supply in the tech industry (BCS, 2011a; Department for Education, 2013a). A mutual understanding developed that, if the country were to remain competitive and individuals were to benefit from the global tech boom, then everyone must learn not only digital literacy and e-safety, but the basics of computer programming, robotics, and computational as well (Williamson et al., 2018).

And so, with the support of England's Department for Education (DfE), the British Computer Society (BCS) and the Royal Academy of Engineering (RAEng) drafted a new programme of study for digital skills which resulted in an amendment of the National Curriculum in 2014, requiring that the subject of "computing" be taught to all children in every year of compulsory schooling (i.e. Years 1-11, ages 5-16 years old) (Department for Education, 2013b). The exact details of this development process will be discussed further in Chapter 4.

The long-term implications of the new curricular standards are unclear. ICT was replaced with computing in part to direct more young people towards degrees and careers in the IT, computing, and computer science fields (Department for Education & Gove, 2012). It

was also supposed to support young people who would go on to work in non-technical fields, with claims made that a "high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world" (Department for Education, 2013c). However, there is little research available on the impact that a policy change at this scale might have on equitable, nationwide upskilling or on meeting national labour supply needs.

Additionally, there is little-to-no research on how shifts in computing education policy align to shifts in societal beliefs and values, as computing education is typically framed as a tool for either economic or civic skills development. However, as society creates, integrates, and rejects technological innovation, its dispositif shifts, and a computing curriculum that does not account for these changing societal attitudes towards technology will be unlikely to be integrated as expected into these socio-cultural systems and structures. While IT, ICT, and computing curriculums in England have paid homage to the importance of understanding, engaging with, and creating digital content, they have not yet formally addressed the tie between technological advancement and changes in public beliefs, values, and processes.

2.5.2. What we know about good pedagogy in computing[11]

Clearly, there are several important factors which influence how technologies are perceived and utilised in the education space While investment in physical resources and

[11] I benefited greatly from the prior work of Jane Waite (2017), currently a PhD student at Queen Mary University and CAS London coordinator, for the excellent meta-literature review that she produced on commission for the Royal Society's *After the Reboot* report on the state of computing education in the UK. I rely on her thorough and useful work heavily in this section.

support staff, for example is important, “this pales by comparison with the far greater demands of ensuring [technology’s] effective use” in the classroom (Livingstone, 2012, p. 6). It is reasonable for teachers to be wary of change for change’s sake (Anonymous, 1969), and so their initial approach to the latest educational trend may tend towards older, tried-and-true pedagogical practices. If teachers are expected to make dramatic changes to how they teach digital technology in the classroom, then they will need further guidance on what alternative practices are available to them, how to adopt those new practices, and evidence from trusted sources on why these new methods are best.

Further complicating the implementation of the computing education policy will be the lack of strong evidence on best practices in teaching computing, with most studies taking place in the US context (Sentance & Selby, 2015) and with university students (Falkner & Vivian, 2015; Garneli, Giannakos, & Chorianopoulos, 2015; Lye & Koh, 2014; Rich, Strickland, & Franklin, 2017). I will discuss here what little evidence is available on how this subject might best be taught to school children in formal education settings. Whether these practices are taking place in England’s primary schools – and the impact of those practices in this particular setting – remains to be seen.

2.5.2.1. Learning models and instructional techniques

There are a wide variety of learning models that have been applied to teaching computer science, including the Use-Modify-Create model (Lee et al., 2011), discourse intensive pedagogy (Grover & Pea, 2013), levels of abstraction framework (Perrenet & Kaasenbrood, 2006), abstraction transition taxonomy (Cutts, Esper, Fecho, Foster, & Simon, 2012), and a blending of different pedagogical models (Grover & Basu, 2017;

Hansen, Hansen, Dwyer, Harlow, & Franklin, 2016; Kafai & Burke, 2015). However, "there is limited rigorous empirical research related to the underpinning pedagogy that teachers *should* use to inform teaching and learning of computing" (Waite, 2017, emphasis mine) and so it will be difficult to assess whether computing is being taught "well" during my empirical work in schools.

The efficacy of scaffolding strategies is similarly contested, with some research supporting constructionist making (Brennan & Resnick, 2012; Lye & Koh, 2014; Papert, 1980), constructionist exploration (Ackermann, 2001; Piaget, 1950; Solomon, 1988), a controlled progression from easier to more difficult material (Hubwieser, Armoni, Giannakos, & Mittermeir, 2014; Lourenço, 2012; Sentance & Schwiderski-Grosche, 2012), differentiated learning (Teague & Lister, 2014), and the management of cognitive load during lessons (Alexandron, Armoni, Gordon, & Harel, 2014; Margulieux & Catrambone, 2016; Paas, Renkl, & Sweller, 2003; Van Merrienboer & Sweller, 2005), with no one strategy yet rising to the top as best.

Teachers may additionally struggle to select the best framework or strategy for their teaching practice because many of the materials available to them are about the content of computer science lessons (e.g. coding) rather than how to select the most appropriate pedagogical approach to the subject (Kafai & Vasudevan, 2015) given their school-based context (Brennan & Resnick, 2012; Grover & Pea, 2013; Hansen et al., 2016; Meerbaum-Salant, Armoni, & Ben-Ari, 2013). Further research is needed in order to support teachers in their pedagogical decision-making, with Falkner and Vivian (2015) recommending a particular focus on the study of: the analysis of data and other functional requirements;

algorithm design and evaluation; programming as an element of algorithm design and evaluation; and the use of critical analysis in computer science.

Physical computing is a popular method of teaching computer science concepts at the primary school level (Eickholt & Shrestha, 2017; Przybylla & Romeike, 2014; Sentance, Waite, Yeomans, & MacLeod, 2017; The Royal Society, 2017) and involves learning through making (e.g. learning about computer programming by planning, writing, and executing a simple algorithm). This way of teaching is linked to Papert's (1980) concept of constructionism and is expressed in part through the English computing curriculum's requirement to design and write computer programmes (Department for Education, 2013b). In a primary school classroom, examples of physical computing might include programming a floor-based robot (Benitti, 2012; Major, Kyriacou, & Brereton, 2012; Toh, Causo, Tzuo, Chen, & Yeo, 2016) to navigate a maze, or completing an offline computing activity (Bell, Alexander, Freeman, & Frimley, 2009; Curzon, 2013; Feaster, Segars, Wahba, & Hallstrom, 2011; B. Rodriguez, Kennicutt, Rader, & Camp, 2017; Thies & Vahrenhold, 2016) of arranging a set of paper instructions to open and close the classroom door.

Students in a physical computing lesson might also be asked to programme a microcomputer such as the new BBC micro:bit (Sentance, Waite, Hodges, MacLeod, & Yeomans, 2017) running a video game console simulator or an Arduino used during an e-textile lesson to light up a pattern on the front of a jumper (Kafai et al., 2014; Litts, Kafai, Lui, Walker, & Widman, 2017). Physical computing allows students the opportunity to learn by doing and so they see how abstract theory works in practice while also becoming

familiar with what doing computer science looks like. Additionally, physical computing activities do not necessarily require expensive computing equipment and can even be taught offline ("unplugged pedagogy"), making it an obvious choice for cash-strapped schools or teachers who students' parents are concerned about screen time at school.

Primary school teachers might also consider teaching computer science through game-making (Kafai & Vasudevan, 2015). These types of learning activities are both technical and social, requiring students to consider both their code and their game's audience. These types of activities also provide students with the opportunity to be creative. Research suggests that teaching computer science through game and simulation design results in high student motivation levels (Repenning et al., 2014; Webb, Repenning, & Koh, 2012), which is unsurprising given children's natural propensity to engage in and enjoy play. However, these types of activities require more resources and technological know-how than may be present in most state-funded primary schools. Additionally, more research is needed on the role of gender in game design activities, the social and cultural dimensions of gaming, and the transition from using tutorials on to creating games independently in order to make the most of this pedagogical approach (Waite, 2017, p. 47).

Overall, further research is still needed to develop best practices in teaching a variety of physical computing devices, including: tangible interfaces, microcontrollers, programmable robots, the use of physical computing to learn computer science concepts (e.g. cybersecurity, hardware, big data), and the use of physical computing in the teaching of other subjects (Waite, 2017, pp. 46-47).

2.5.2.2. Programming languages

Block-to-text languages, also referred to a visual, graphical, or block-based languages, and they use images to represent programming commands and are the most commonly used type of programming language in primary schools (Kölling, Brown, & Altadmri, 2015; Wu, Tseng, & Huange, 2008). MIT's Scratch is especially popular in classroom computing lessons in the UK, but other common languages include Logo, Kodu, and Blockly[12]. The English computing curriculum requires primary school students be taught to create and debug algorithms from Year 1 (i.e. age 5 years old) and so most teachers choose to use the more developmentally appropriate block-based languages in their computing lessons. However, once in secondary school (i.e. 11 years old and up), students are required to learn a text-based programming language[13], which can prove a difficult shift (Sentance & Waite, 2017).

The transition from block-based to text-based languages can present a significant challenge for both teachers and learners (Garneli, Giannakos, & Chorianopoulos, 2015; Sentance & Csizmadia, 2015) and the evidence is not yet clear on how best to facilitate this transition (Armoni, Meerbaum-Salant, & Ben-Ari, 2013; Garlick & Cankaya, 2010; Kölling, 2015; Powers, Ecott, & Hirshfield, 2007; Weintrop & Holbert, 2017). However, early research suggests that students who first study a block-based programming language may more easily learn a text-based language later on (Armoni, Meerbaum-Salant, & Ben-Ari, 2015), suggesting that the use of block-based languages in English

[12] A survey of 341 primary school teachers in the UK found that 38% of teachers use Scratch, 17% Logo, 15% Kodu, and 4% Blockly (The Royal Society, 2017).
[13] A survey of 604 secondary school teachers in the UK found Python to be the most popular text-based language, with it being used by 21% of teachers (The Royal Society, 2017).

primary schools will contribute to computing learning outcomes in later years of compulsory education as those students make their way through the schooling system.

2.5.2.3. Cross-curricular pedagogy

Cross-curricular pedagogy will not be unfamiliar to experienced primary school teachers in England, as the ICT curriculum was frequently implemented by using ICTs to teach other National Curriculum subjects. Seymour Papert saw the usefulness of a cross-curricular pedagogy in computing, saying that learning to programme a computer could be a precursor to:

> ...developing the sophisticated and rigorous thinking needed for mathematics, for grammar, for physics, for statistics, for all the "hard" subjects... In short, I believe more than ever that programming should be a key part of the intellectual development of people growing up (quoted in Kestenbaum, 2005, p. 38).

Educational computer languages such as Scratch have been used in research to directly teach other subjects – such as art history, story-writing, and mathematics – and has been shown in some contexts to produce significant gains both in learning coding and the paired subject (Price & Price-Mohr, 2018; Psycharis & Kallia, 2017; Sáez-López, Román-González, & Vázquez-Cano, 2016), though there is not yet enough evidence to say whether it is an effective strategy for all settings and all subjects (Benton, Hoyles, Kalas, & Noss, 2017; Moreno-León & Robles, 2016). School leaders in England have complained that the computing curriculum as written is "quite narrow" and that it is difficult to link it with other subjects (The Royal Society, 2017), so it is obviously not immediately clear to teachers from the wording of the National Curriculum how they might teach these new skills using a cross-curricular pedagogy. More research is needed to identify the costs and

benefits of cross-curriculum pedagogy both to learning computing and learning the paired subject (Waite, 2017, p. 49), and to identify how England's computing curriculum in particular might best be integrated cross-curricularly, if possible.

2.5.2.4. Student engagement

There are different strategies available to improve students' engagement with their computing studies. Pair programming – in which two people work collaboratively at the same computer to design a single algorithm, coding task, or testing task – is a popular educational strategy which has also been used in industry (Plonka, Segal, Sharp, & van der Linden, 2011; Werner et al., 2013; Williams & Kessler, 2000). Unfortunately, there is very little research on how pair programming can best be used in the primary school context or on exactly what impact it has on particularly young learners (Kafai & Vasudevan, 2015). Instead, there is limited evidence on the positive impact of pair programming in higher education settings, where it has been shown to improve learners' grades on computing assignments (Salleh, Mendes, & Grundy, 2011), their task outcomes, and the quality of their code (Hamer et al., 2008). Situating students physically near each other (e.g. across the same table) and allowing them to ask each other questions has also been shown to be helpful, though the evidence suggests that it is still critically important in this format to have a teacher present to explain and assist with more complex activities (Falloon, 2016; Fessakis et al., 2013; Kalelioglu, 2015).

Other forms of collaborative learning (Cajander, Daniels, & McDermott, 2012; Cukurova, Avramides, Spikol, Luckin, & Mavrikis, 2016; L. Porter et al., 2016), as well as apprenticeships and opportunities for student leadership, have been trialled for teaching

computer science (Ching & Kafai, 2008; Passey, 2014) with mixed results. Project-based learning (Garneli, Giannakos, Chorianopoulos, & Jaccheri, 2015), problem-based learning (Nuutila, Törmä, & Malmi, 2005), and process oriented guided inquiry learning (Griffin, Pirmann, & Gray, 2016) are popular strategies for engaging students in learning computer science within formal learning environments, but their impact has so far been studied minimally and with such small participant numbers that the (largely positive) findings are not yet generalisable.

Best teaching practices are supposed to result in best student learning outcomes; however, the evidence base for best practices in computer science education is slim, especially in the primary school setting. Even research-savvy teachers are likely to struggle to interpret the findings so far regarding how they should teach England's computing programme of study, meaning that teachers across the board will need to apply all of their professional experience and pedagogical knowledge to teaching this yet under-studied subject to their students.

2.5.2.5. Limitations of the literature

The research literature on the study and use of digital technologies in the classroom is messy, with different devices and different uses often being conflated with one another:

> One problem with the literature is conceptual and methodological – the conflation of diverse forms of educational technology under the umbrella term ICT"... Thus it is difficult to distinguish which aspects of technologically-mediated learning, if any, are effective in any particular situation (Livingstone, 2012, p. 5).

Furthermore, past research has often failed to account for the fact "that the evolution of ICTs has been accompanied by, indeed, shaped by changing expectations regarding learning among teachers, pupils and society at large," (Livingstone, 2012, p. 10) as well as changes to how modern technologies are used and understood outside of the school context. Given that so many studies are about *this* device being used in *this* specific context with *this* particular outcome, it can be difficult for the reader to identify lessons learned that are applicable to their own contextual use. Given this, it is unsurprising that even the most research-focused teachers have struggled to adopt best practices in teaching computing; the research community has not yet figured out what those best practices are. With these issues in mind, I do not know what to expect to see in England's primary school classrooms. As there is no clear ideal for teachers to be working toward, surely teaching practice with vary widely from teacher to teacher and context to context as teachers do the best they can to both abide by a vague education policy while also meeting the very real needs of their current students.

2.6. Research on England's computing curriculum so far

The most significant study so far of the implementation of the computing curriculum in England's schools is the Royal Society's (2017) report, *After the Reboot*. Following on from their significant 2012 report *Shut Down or Restart?*, the new findings that they report are not encouraging: "Computing education across the UK is [still] patchy and fragile" (p. 6). Secondary schools in particular are suffering from a shortage of specialist computing teachers, as they struggle to recruit anywhere close to enough new teachers or upskill former ICT teachers (Sentance, Dorling, McNicol, & Crick, 2012). Meanwhile, only 44% of current secondary school teachers surveyed said they felt confident teaching

even the earliest stages of the computing curriculum (The Royal Society, 2017). 30% of secondary schools in England do not offer computer science at GCSE level to their students and only 11% of GCSE students in England took this qualification, despite computing (with its heavy computer science focus) having been a part of these students' statutory education for the past three years.

Across both secondary and primary schools, nearly half (48%) of teachers ranked themselves as having low confidence in their ability to teach the computing curriculum, with respondents commonly reporting "that they were lacking sufficient theoretical and technical knowledge of computing" (p. 54) to teach the subject well. This may in part be a result of the low number of hours spent in computing-related continuing professional development (CPD), with a third of teachers (34%) spending between one-to-nine hours in 2015/16 academic year (with an average of six hours) and close to another third of teachers (29%) spending zero hours during that same period. These teachers were, however, most confident teaching the earlier stages of the computing curriculum, when the content was more likely to overlap with what had previously been covered by the ICT curriculum (e.g. e-safety, creating digital content).

The Royal Society report concluded with a final recommendation that education research funders, researchers, teachers, and policymakers should develop a strategic plan to build a long-term research agenda and to build the UK's capacity to conduct such research. Most research on the teaching and learning of computing to date has taken place in higher education, and there is insufficient evidence on best practices in pedagogy and assessment methodologies across the board. Unaddressed by the Royal Society report –

but obvious from reading literature from across the field – is that there is next to no research on how the conception of computing or digital skills education is shaped by episteme and discourse, and how different policy actors' differing dispositifs means that it is possible to create a curriculum that is perfectly logical in one context but appears utterly mad in another. This study seeks to take a first step forward for this new research agenda, unveiling the *why* behind the disjointed implementation of England's computing curriculum.

2.7. Conclusion

Society has seen a significant increase in the variety, complexity, and ubiquity of digital technologies that individuals need to engage with as learners, workers, citizens, social beings, and agentic individuals. England's computing curriculum is supposed to have been designed to better prepare young people for these interactions both now and in the future, by providing them with the skills, knowledge, and ways of thinking necessary to understand, create, manipulate, and control digital technologies so that they can benefit from their affordances and the country can benefit from their expertise.

However, there is a long history of struggle for the effective integration of educational technologies into educational spaces and even less research available on how educational technologies are both perceived and shaped by local cultural knowledge. Additionally, a variety of factors can negatively affect how educational policy is interpreted and implemented, ultimately resulting in its failure to meet the expectations of its creators. England's computing curriculum is asking a lot of primary school teachers; all the while,

more research is still needed to understand how we might better prepare young people to engage safely and successfully in an increasingly digitalised and globalised world.

This study will examine the three stages of England's computing education policy (intended policy, actual policy, and policy-in-practice) by collecting and analysing historical documents and contemporary empirical data through an ethnographic case study. In this thesis, I will demonstrate what is happening in England primary schools, why, and how we might better understand how education policies are created and function in practice going forward.

3. Methodology

This chapter introduces the methodology used over the course of this study. First I will introduce the theoretical underpinnings of my research, which will then be followed by an examination of the research questions, linking them back to theory. Finally, I will describe in detail my study design, giving explanations for the choices that I made while in the field and during the analysis process.

3.1. Methodological theory

This is a study about the world as it is: about how people think and feel, what they understand about the world around them, and how and why they behave the way that they do: "If you want to understand the way people think about their world and how those definitions are formed, you need to get close to them, to hear them talk and observe them in their day-to-day lives" (Bogdan & Biklen, 2007, p. 35).

An ethnographic case study approach was selected as the most appropriate way to identify, "(1) What is happening? And (2) Why or how is it happening?" (Brown, 2005, p. 29) in British primary schools. The ethnographic method has long been used to document "the minutiae of everyday life" (Ball, 2013, p. 6) and "portray events, at least in part, from the points of view of the actors involved in the events," documenting the "local meaning" of these events (Erickson, 1984, p. 52). As individuals are often not aware of the decision-making processes that take place behind the choices that they make, exploring participants' perceptions while also documenting events as an outside observer is a particularly effective way to identify underlying understandings and dispositions, both as they were expressed and as they were experienced by participants. In this study I have

positioned computing as socially shaped and socially shaping, occurring within the socio-cultural boundaries of the school classroom and the wider cultural communities that teachers and students are members of. Within the context of classroom and the school, different actors – including external actors, such as representatives of government agencies – struggle with one another to act upon their knowledge of the world and to persuade others to abide by it as well through their discourse. These negotiations of meaning are critical, as they include defining the purpose of education, the list of subjects to be taught, how they should be taught, how students and staff should be treated, and what episteme children should be enculturated into. A great deal of data is needed to study these complex processes:

> The focus of the research stems from a perceived need to model empirically the process of learning in classrooms and, in particular, the so-called "negotiation of meaning." The use of the metaphor of negotiation grounds learning in social activity, but this research adopts the epistemological stance that the meaning that is constructed as a consequence of this social activity is experienced as personal meaning, and any theory of learning must accommodate this constructed self. Classrooms are complex social settings, and research that seeks to understand the learning that occurs in such settings must reflect and accommodate to that complexity. This accommodation can occur through a data-collection process that generates an appropriately rich data set. Such a complex data set can be adequately exploited only to the extent that the research design employs analytical techniques sensitive to the multifaceted and multiply [*sic*] connected nature of the data (Clarke, 1997, p. 98).

As such, the ethnographic case study method – with its prolonged exposure to field sites' culture and participants' behaviour and thoughts – allowed for "an in-depth exploration of a *contextualized instance*... based on extensive data collection and reflection" (Luo, 2011, p. 8); that is, both the "instance" being observed and its context (which is critically important to understanding social behaviour) could be captured. It was well suited to documenting the dispositif – that is "the interaction of discursive behaviour... non-

discursive behaviour... and manifestations of knowledge by means of acts or behaviors" (Jäger, 2006) – within each school and classroom.

While ethnographies typically take place at one site, case studies are an ideal way to monitor the implementation of policy across multiple sites (Mills, 2010), and so I applied the ethnographic method to several case studies in order to examine more closely the contextual factors influencing why the computing education policy was being enacted as it was (White, Drew, & Hay, 2009). This way I could document more richly these examples of how the new curriculum was being interpreted and experienced in schools according to the beliefs and values of different groupings of people. While the focus of my empirical work was on the behaviours of individuals (Allen & Goddard, 2014) and the thought processes behind those behaviours, it was important to view the same intersection of factors (e.g. individuals, classroom setting, local community, digital devices) from several angles in order to fully understand how the local context influences implementation of the computing curriculum by shaping how it was felt and understood. This provided further justification to include multiple research sites in my study.

The classroom was chosen as this study's case size – rather than the school – as teachers have a large amount of control over their students and they both consciously and subconsciously shape the culture and structure of the school day for their class (Mills, 2010; Mills, Durepos, & Wiebe, 2010). Additionally, the behavioural, cultural, and experiential makeup of one classroom's student body will have a large impact on the educational experience of its members, as they spend thirty or more hours a week together under the gaze of a single, permanent teacher. While the greater school-wide

context is also influential – the decisions made by the school's leadership team, for example, or the facilities and other resources generally available – this is also true for the local community, geographic region, and country that a school is located in.

Defining school class membership as the boundary line of each case had a basis in common sense, theory, and methodology (Mills, Durepos, & Wiebe, 2010): a) the teachers and students identify it at "their space" and "their group," b) this study is about the translation of policy into teaching practice, which takes place almost exclusively at the classroom-level, and c) classes can be followed as a whole unit from activity to activity through most of the school day, but multiple classes could not be observed at once except in infrequent settings (e.g. school dinners, school assembly, break time). Additionally, by working closely with small groups within these relatively small institutions, I was able to "break down the boundaries between the knowledge of the researcher and that of the researched" (Jeffrey & Dyson, 2008, p. 2), capturing the lived experiences of teachers trying to fit new curricular requirements into a busy school year and students negotiating social and cultural experiences in the classroom. With this in mind, I chose the classroom as the smallest consistent social grouping within the formal educational environment to examine as it is the best-case size within which to study how policy is translated through local context into practice.

3.1.1. The archaeology of knowledge

Given the importance of each of the three stages of policy, I knew that I wanted to not only study the policy as it exists currently in theory (through the actual policy) and in practice (through policy-in-practice), but also the historical processes that brought those

two stages to pass (i.e. the intended policy). Foucault's conception of an archaeology of knowledge – like Nietzsche's history of morality – provides an excellent way to think about how social rules (including truths and values) wind through time to result in our present-day episteme. Knowledge and discourse leave behind artefacts which we can examine as archaeological evidence of episteme, and we can use these artefacts to work out the exact knowledges of dispositifs past, including the dispositif of England just a few years ago. While this method is not capable of perfectly tracking "the continuous, insensible transition that relates discourses, on a gentle slope, to what precedes them, surrounds them, or follows" (Foucault, 1989, p. 155), nor can it "rediscover the enigmatic point" at which knowledge "emerges on the anonymous horizon" (p. 156), it can be used to identify the episteme (and reinforcing discourse) which existed during a particular moment in a particular place. This can help us to understand the relationship between dispositifs and events such the creation of a particular policy, like the addition of computing to England's National Curriculum.

These concepts – knowledge and systems of knowledge (*episteme*), power, and discourse, all bound up in dispositif – are as complicated as the social, psychological, and philosophical facts that they represent. I have always found this excerpt from Foucault's (1989) *The Archaeology of Knowledge* particularly illuminating in its explanation of just how these human components interact with one another:

> The positivities that I have tried to establish must not be understood as a set of determinations imposed from the outside on the thought of individuals, or inhabiting it from the inside, in advance as it were; they constitute rather the set of conditions in accordance with which a practice is exercised, in accordance with which that practice gives rise to partially or totally new statements, and in accordance with which it can be modified. These positivities are not so much

> limitations imposed on the initiative of subjects as the field in which that initiative is articulated (without, however, constituting its centre), rules that it puts into operation (without it having invented or formulated them), relations that provide it with a support (without it being either their final result or their point of convergence). It is an attempt to reveal discursive practices in their complexity and density; to show that to speak is to do something – something other than to express what one thinks; to translate what one knows, and something other than to play with the structures of a language; to show that to add a statement to a pre-existing series of statements is to perform a complicated and costly gesture, which involves conditions (and not only a situation, a context, and motives), and rules (not the logical and linguistic rules of construction); to show that a change in the order of discourse does not presuppose "new ideas," a little invention and creativity, a different mentality, but transformations in a practice, perhaps also in neighbouring practices, and in their common articulation. I have not denied – far from it – the possibility of changing discourse; I have deprived the sovereignty of the subject of the exclusive and instantaneous right to it (p. 230).

3.2. Initial research questions

An educational policy is only as good as its implementation in real schools with teachers and students. In the case of England's computing curriculum, we have a policy written under the influence of several conflicting agendas (to be explored further in the following chapter), which has muddied both its purpose and the steps it says are necessary to meet said purpose. Additionally, the policy came into being during a time of rapid change in the public discourse around modern digital technologies, leaving some of the public still enamoured by the digital, while others have grown wary of it. Now the curriculum is being implemented in an education system that has faced years of funding cuts due to a government-wide policy of austerity, resulting in crumbling infrastructure, insufficient staffing levels, and the inability to purchase much needed new or replacement resources.

To understand what the policy-in-practice stage of the computing curriculum is and why, my initial research questions addressed two perspectives: teachers – who are gatekeepers, translators, professional practitioners, and subjects – and students, who are

both agentic beings and subject to the beliefs and decision-making of the adults around them. This research also addresses two levels of subjectivity: a) my observation, understanding, and interpretation of events taking place within the classroom and how that relates to wider education policy, and b) teachers' and students' understandings and interpretations of those same events, from the perspective of their own individual and community contexts.

My first two research questions are:

1. *How are teachers translating the computing education policy into practice and why?*
2. *In what ways is England's computing policy-in-use influencing students' understanding of and disposition towards digital technology and why?*

These questions will be answered using extensive, qualitatively-rich observation and data collected while embedded in four classrooms across two state primary schools in England. As will be seen later in this chapter, a third research question was also added once field work had started in order to address if the computing policy-in-practice aligned with policymakers' intended policy, and why or why not.

3.3. Study design

3.3.1. Sample and access

The focus of this study is on computing instruction in the classroom rather than extracurricular clubs or community organisations, as these programmes tend to target specific groups (e.g. women or ethnic minorities) and participants are self-selecting. In

the English context, teaching computing is now a regulatory requirement and so reaches the full range of demographic groups within the state primary education sector, regardless of current or prior interest in the subject (e.g. women and ethnic minorities, who are underrepresented in computing-related employment, as well as white working class boys, who on average are the worst performing group in British formal education [Equality and Human Rights Commission, 2015]). School-based lessons were an ideal study location as they would, in theory, provide the same instruction to those children least likely to go into computing long-term as well as those least likely to achieve highly academically, whilst also revealing the influence of home, community, and greater societal factors on the formal education experience. The call for "computer science for all" also directly contributed to the addition of computing to the National Curriculum, so the effect of this change in policy on diverse student bodies deserves examination.

Given the amount of time that needed to be spent at each field site to collect sufficiently detailed data, it was impossible to include a large number of classrooms in the study or attempt to claim any sort of statistical representativeness (Boeije, 2010). Instead, I used purposive sampling, selecting only those field sites that met the needs of the study (Punch, 2005) by allowing the kind of access necessary for an ethnographic approach, and which had characteristics (e.g. size; ethnic makeup; percentage of student population receiving pupil premium; "Good" Ofsted rating) that were similar to the local and national average.

Primary schools were targeted for recruitment – as opposed to secondary schools – as this is the age at which young people first leave the family home and are introduced to

and trained in societally-approved knowledges and discourse (as explained in Chapter 2). Only state schools were targeted with recruitment material (including state-funded religious schools and academies opting to adhere to the National Curriculum) so that the study could focus on state-sanctioned enculturation: an official system of bringing children into the fold of those skills and ways of thinking valued by society (or, at the very least, by the current government).

Initially, recruitment materials were distributed to headteachers and heads of computing at all primary schools meeting the recruitment criteria within a single county in the South of England. Institutional gatekeepers such as LEAs and academy trusts often position themselves as "vigilant protectors and hence present the biggest obstacles to accessing vulnerable participants" (Liamputtong, 2007, p. 51), including students and teachers faced with ever increasing assessment, criticism, and threats of restructuring made by powerful government entities (Department for Education, 2016). Though well intentioned, these gatekeepers may block access to research that school communities might otherwise be interested in due to an overabundance of caution. This is what I encountered in my first round of recruitment, with only a handful of responses from school heads and no commitments to participate.

In my second round of recruitment, materials were distributed through individuals known to myself or colleagues who worked directly with primary schools in either a personal or professional capacity. This approach was much more successful, with a head of computing at one school and the headteacher of a second school responding enthusiastically. Winning the support of gatekeepers in positions of authority was still

important to gaining access (Tewksbury & Gagné, 2001), but by contacting them through a third party, I was able to provide heads with an early positive character reference which lent weight to the value (or, at the very least, the competence) of my study. This ultimately resulted in the successful recruitment of four classrooms across two schools.

The two schools recruited for this study were both co-educational state primary schools located in the South of England. They were both of a religious foundation (one Church of England, the other Catholic) which is representative of state primary schools in this region. The Church of England (CofE) school was situated in a rural village and served a largely white British, mixed-income demographic similar to the surrounding area. The Catholic school was in an ethnically diverse, expensive city centre and served a similarly diverse, middle- to upper-middle-income student population. Both schools' numbers of students with special educational needs (SEN) or qualifying for pupil premium (i.e. government funding given to support schools serving children from low-income families) were below the national average. They had both been rated "Good" in their most recent Ofsted inspection and had performed close to the national average on the most recent annual National Curriculum assessments ("Sats") at the time of recruitment, as well as on the Sats that took place during the course of my fieldwork. These schools were selected as examples of government-certified "good" teaching with nationally average academic results taking place in representatively ethnically-monocultural rural and ethnically-diverse urban communities with relatively low student-specific challenges (i.e. SEN or severe economic disadvantage). While not randomly sampled, these schools are culturally and academically like many other schools in their county and across England,

and the results of this study will be useful to understanding the processes taking place within similar state primary schools.

The four participating classrooms were selected to capture the formative years of a child's first institutional experience, with a combined Year 2/Year 3 class recruited from the rural CofE school and a Year 2 class, Year 3 class, and Year 4 class from the urban Catholic school (Table 1). Full-day classroom observations, teacher retrospective interviews (one per teacher observed), and student stimulated recall interviews (an average of 11 per classroom) were conducted over the course of the 2016-2017 academic year (Table 2). Significantly more students were recruited for interviews than teachers as I wished to gain as broad and as inclusive a view of students' perspectives as possible, and in order to complement and extend the classroom observation data. Additionally, more time was spent observing the first school so that I could refine my interview protocols based on the initial observation data before the first interviews took place, and as there was an initial steep learning curve as I identified how best to focus the attention of my unstructured fieldnotes. However, the amount of time spent in each school was approximately equal, though how it was split between classrooms varied from school to school and decreased over time (Table 2).

Table 1. Classrooms recruited.

	CofE School	Catholic School		
	Ms-2/3	**Ms-2**	**Ms-3**	**Mr-4**
Year Group	combined Year 2 & 3	Year 2	Year 3	Year 4

Table 2. Distribution of data collected.

	Ms-2/3	Ms-2	Ms-3	Mr-4	Total
Observations (days)	26	8	7	8	49 days
Observations (time)	124hr	39hr	36hr	31hr	230hr
Teacher interviews	1	1	1	1	4
Child worksheets	8	17	15	6	46
Child interviews	8	16	14	6	44

After permission was granted by the relevant senior member(s) of staff and the schools' governors, recruitment information was sent on to interested teachers as it was they who would be asked to carry the largest burden of participation and organisation during this study. These teachers in turn provided access to child participants, both through allowing me access into their classrooms as an observer and an interviewer, and by facilitating direct access to their students by sending consent forms home to parents and helping me schedule child interviews during the school day. While this study only captured the experiences of a limited number of teachers and children, deeply exploring these individual lives can "reveal insights not just into the experiences and attitudes of the individuals directly concerned, but also of the wider society or social segment of which they are also part" (Arnold & Blackburn, 2005, p. 43).

3.3.2. Ethical considerations

Ethical approval was sought and received for this project from the University of Oxford's Central University Research Ethics Committee (Appendix A) before the start of fieldwork and renewed after an annual review that took place partway through the fieldwork. However, having a research project's ethical implications reviewed by an academic institution "does not absolve one from difficult questions about representation, [or] the benefits accrued from research" (Mills & Morton, 2013, p. 72). It was important to

continue to think critically about the implications and impact of my research throughout the data collection period and beyond; if anything, this was even more important using my chosen methodology, as ethnography requires the intimacy of embedding oneself in a community for a sustained period of time, which results in a certain level of vulnerability for participants.

Only primary schools serving predominantly typically-developing children were recruited because schools for children with severe special educational needs (i.e. special schools) contain different social dynamics due to their students' increased reliance on adult assistance and intervention, unique uses of technology (including assistive technologies), and sometimes significant adaptations in their application of the National Curriculum that this study was not designed to account for. Students identified as having special educational needs located within the recruited classrooms were allowed to participate if a) their parent consented and b) their teacher believed that the activities involved in participation would be developmentally appropriate and not cause the student distress.

Within the recruited schools, teachers were asked to participate in an interview and to allow me to spend time in their classroom as an observer. Teachers may have been concerned that the research was evaluative in nature and that they might be negatively affected by what my research revealed about their teaching style and beliefs, especially regarding their compliance with the National Curriculum, which is a statutory requirement for most state-funded schools. Establishing rapport is critical to being granted access to sensitive situations (e.g. a person's place of employment) and to increase the likelihood that a participant would share thoughts which they might perceive

as unpopular or controversial (Miller & Tewksbury, 2001). Therefore, teachers were reminded in the consent forms and verbally throughout the study that I was there as a third-party observer and that what I saw in the classroom would not be reported back to their employers, barring any issues regarding child safeguarding. I was also careful to explain the exploratory (rather than evaluative) nature of my research and how their data would be anonymised.

A subset of children from participating classrooms were successfully recruited to participate in a writing activity, drawing activity, and an interview. Teachers were asked to help identify children without an Individual Educational Plan (IEP) that precluded them from participating fully in the study without distress or a negative educational impact; however, this resulted in the identification of only one child (at School 2) who would not have participated any way as their parent did not return a signed consent form. To participate in the interview and activity sheets, parents needed to provide written consent and the children verbal consent; families were also sent an information letter and opt-out form for classroom observations (only one student from School 1 was opted out of the observations by their parent).

I worked hard to establish which environments within the schools I could enter as a researcher and in which I should remain a notebook-less visitor:

> ...it is undoubtedly necessary for every ethnographer to establish some type of "contract" with the society to be studied. Such a "contract" may include specifications about what records may and may not be examined; where the ethnographer may or may not go, when, and under what circumstances; which meetings may be attended and which are closed; how long the researcher will stay in the field... (Lutz, 1986, p. 114).

In both schools, I was asked to keep information overheard in the staff room confidential, as frank conversations regarding student behaviour, safeguarding, and teacher frustrations often took place there. While overhearing and, at times, partaking in these conversations inevitably informed my understanding of the school and those within it, I have respected these requests by not reporting on the content of any of these conversations in this thesis or any other works.

3.3.3. Naturalistic classroom observations

Whilst acknowledging that my presence in the classroom as a researcher inevitably affected the research sites and those within them, I also wished to protect the naturalistic setting as much as possible to best preserve the relationships, decision-making, and actions that would occur naturally without my being there (Omodei & McLennan, 1994). In order to do this, I chose to conduct naturalistic observations, attempting to minimise actions on my part that might influence others and developing as neutral to neutral-positive a presence as I could in the classroom. As I will discuss later in this chapter, I believe this fostering of a (relatively) neutral persona greatly improved the rapport I had with student participants during interviews and the quality and richness of the data collected therein.

At each school, I conducted a series of classroom observations in order to document what was occurring in the day-to-day lives of the children and teachers, as well as to experience life in the school myself. Each participating classroom was followed throughout the school day (e.g. typically from before morning drop-off to when children were picked up at the end of the day) for extended periods of time (e.g. a full week or

longer), alternating with other participating classrooms as necessary (e.g. to avoid conducting Year 2 observations during Sats testing). The purpose of these sustained periods of integration and interaction with a limited number of teachers and students was to build trust with those participating in my research so that they might speak and act with candour; to experience every aspect of day-to-day school life and culture, as much as might possible for a non-participant; and to capture a "thick description" (Geertz, 1973) of the complex social interactions occurring within these spaces.

A field journal was kept, documenting participants' words, actions, and physical affect (e.g. body posture, facial expressions, tone of voice), as well as both the static and changing elements of their physical environment (e.g. seating arrangements, location of classroom tablets, use of an interactive whiteboard). On my initial visits to each classroom, my notes were extensive, and I tried to make them as comprehensive as possible, as I did not yet know the social dynamics of the class. This meant that on my first visit of the study, I hand-wrote over 30 pages of notes on everything from the appearance, behaviour, and interactions of the people in the classroom, to the physical layout of the school, the informational posters and displays of student work on the walls (Appendix B), and how classroom-specific systems were carried out (e.g. student disciplinary systems; see Appendix C). Over time, my notes began to focus more on individuals and groups rather than static materials or processes, but I continued to document these as they appeared anew, changed over time, or illuminated something particularly enlightening, and I always included my reflections on what I had observed (Figure 1).

Figure 1. Excerpt from observation field notes: reflection on an event.

School 1, Year 2/3, 9th September 2016

***Morning* – School awards assembly**

+ Teacher leads the line of students from the classroom to the auditorium. The hallway is windy and the queue long (25 students today) so she can't see the middle and end of the line.

+ Some of the school's older students are scattered throughout the hallway, standing or leaning against walls and tables. One has a pencil and small scrap of paper – seems to be trying to hide it(?) in the palm of his hand.

***Afternoon* – Art**

+ The class is sitting on the carpet where Teacher is explaining the art lesson for the day (Christmas cards). Two students are on the laptops, using Mathletics.

+ A pair of Year 6 students come in and hand the Teacher a note. They leave.

+ Teacher announces that Michelle, Nash, and Arnie[14] have each received a house point because the Year 6 students saw them "walking well" on the way to the awards assembly this morning.

***My reflections*:**

* The students appear surprised and so am I! Expectations and consequences are always outlined so clearly, but in this case neither the Teacher nor the Headteacher had announced that there would be other, older children monitoring their behaviour in the hallways. Will the Year 6s always be there? Will they only be there for awards assemblies, or all assemblies, or all whole school moves through the hallways (e.g. break times)? Will students continue to not be warned of when this surveillance will be taking place? Some of the Year 6s were located around corners, catching students going down the stairs by surprise. Early stages of a *panopticon*?

It was important to capture language in the classroom as it "serves [both] to display intelligence" and "to negotiate both peer and authority relations" (Dore, 1985, p. 62). In this "unification of social and academic matters," students are not only "accumulating a stock of academic knowledge," but also of "social knowledge" (Mehen, 1985, p. 119), navigating their relationships and understandings of peers, authority figures, and knowledge (including academic knowledge). This can be seen in the field notes taken in this study as teachers attempted to lead activities in particular ways, students tried to

[14] All names have been pseudonymised to protect participants' identities.

enact their will by negotiating social boundaries with both their peers and the adults present (e.g. by complying with rules when they liked an activity and breaking rules when they disliked it), and the teacher in turn managing the behaviour and perceived attitude of students in an effort to protect and promote a planned activity or routine. I also captured several instances of teachers muttering under their breath or making hushed comments to other adults in the room (including myself), which often provided useful insight into their frustrations.

Nonverbal behaviour also serves various functions, from the pragmatic (e.g. signalling of social identity), to signalling personality dispositions (Scherer, 1979) and psychological states such as emotions and interpersonal attitudes (Scherer, 1981a, 1981b). They can also serve as indicators of participants' reactions to others' speech and behaviour (Scherer & Wallbott, 1985, p. 201), and signal the relationship between participants (Mehrabian, 1969, 1972). Nonverbal behaviour such as facial expressions, body posture, the movement of objects (e.g. hiding a worksheet under a desk), and gestures all served an important role in identifying students' disposition towards and engagement with physical (e.g. technology) and non-physical objects (e.g. ideas), especially as their speech is so constrained in the classroom that nonverbal behaviour is often the only way in which they may communicate. However, nonverbal behaviour is also often constrained (e.g. through punishment for not sitting "properly" during a lesson), and these constraints and responses to constraint were documented as well.

Though some studies use a systematic, quantitative method to analyse nonverbal behaviour, it can also be analysed using "observer judgement." As all discourse analysis

methods rely on “human operators,” there is “a continuum... of inference [that is] permitted to the observer” (Scherer & Wallbott, 1985, p. 205; also, see Scherer & Ekman, 1982). Since the classroom observations were to be used in conjunction with interviews to understand the beliefs and justifications behind individuals’ actions and the influence of certain factors on those beliefs and justifications, a qualitative and holistic method of data collection in this case was most appropriate.

In my findings I will demonstrate how my field notes – as well as student and teacher interviews – answer the research questions by capturing: examples of teachers enacting the computing education policy and incorporating the use of digital technology into their lessons; beliefs and values expressed spontaneously by teachers and students regarding computing, technology, education policy, and what school is or should be; the students’ understanding of digital technology and their disposition towards it; and the influence of outside forces (e.g. anticipation of Ofsted inspections, preparation for SATs, parental feedback, etc.) on what happens in the classroom.

To support appropriate contextualization of this data, I also collected relevant artefacts (e.g. school newsletters, policy documents, press releases) and sketched physical spaces (e.g. classroom seating) that signalled institutional beliefs and expectations regarding the introduction and ongoing success of the new computing curriculum. These methods (i.e. classrooms observations and artefact collection) together provided a significant quantity of rich qualitative data that informed the analyses of each other, as well as of the teacher interview and student data.

3.4. Third research question & changes to interview design

Over the course of the first few weeks of classroom observations at School 1 and through informal conversations with Ms-2/3, it became clear that I could expect to see very little in the way of either stand-alone computing lessons or the integration of the National Curriculum's computing subject content into other subject lessons. Given that I had already scheduled the teacher and student interviews for the end of the observation period in order to avoid influencing the classrooms that I would be observing, I had time to adjust the focus and wording of my interview protocols. Since my classroom observation field notes were unstructured and therefore adaptable to any new theoretical focus, the locus of my observation data shifted to what digital skills and knowledges were and weren't being taught, and why.

Additionally, it broached a new topic that would become the focus of a third research question:

3. *What does the computing education policy – and teachers' and students' response to it – say about the incongruity between public policy around digital technology and people's real-world experiences with and understandings of it?*

With just a small amount of data collected, it had already become clear that there was a disconnect between what the changes to the National Curriculum were expected to accomplish and what was actually occurring in some classrooms. Further exploration was needed to uncover why experienced and well-regarded teachers were teaching in ways unanticipated by policymakers.

3.4.1. Teacher retrospective interviews

Teachers of observed classrooms were asked to participate in a one-hour-long retrospective interview, which took place after the end of their classroom's period of scheduled observations but often in the midst of the student interviewing period (which was also scheduled to commence after observations had finished). Retrospective interviews use verbal cues to help "respondents recollect and report the thoughts they had in mind while performing a cognitive task, with some elaboration, description, or explanation" (Assiri, 2016, p. 106). For this study, I used my observation field notes (e.g. quotes or paraphrases I had written down, descriptions of non-verbal behaviour or tasks, etc.; see Appendix D) to remind teachers of an event, choice, or practice I wished to discuss further. I also used anonymised data from student interviews (i.e. transcript excerpts, notes taken during the interviews, and early reflections and analysis) to probe for more detail about lessons or other practices mentioned by the students but not observed by myself, and to encourage teachers to reflect on the beliefs and understandings of their pupils.

Teacher interviews were used to capture the reasoning behind observed behaviour, as well as to capture data on events that occurred before or outside the scope of the study (Appendix E), to give a biography of the teacher, and to provide a "member's account" of what was happening in the social context of the school and greater community (Denscombe, 1984). Teachers were asked to discuss: their perception of computing and its purpose as a school subject; their experiences with teaching, and with teaching computing specifically; their attitudes towards computing as a primary school subject; the role they saw for computing in their students' lives, both now and in the future; and

their understanding of and disposition towards educational policy and its enforcement generally. They were also asked about their educational philosophy and the role they believed formal schooling plays or should play in their students' development. Additional questions regarding the obstacles they faced teaching digital skills and how they make decisions regarding how to translate educational policy into their classroom practice were added in response to what was observed in early data collection visits, answering Research Question #1.

In practice, selecting questions, prompts, and probes first involved reading through transcripts of interviews with their students and the field notes I had taken observing the teacher's classroom. I annotated copies of these field notes and transcripts and compiled a list of preliminary questions. I then reviewed my three research questions and reflected on the study's purpose, before refining the questions further. Finally, for the second, third, and fourth interviews, I looked over the questions, prompts, and probes included in previous teachers' interviews and added those to my list as appropriate.

3.4.2. Student stimulated recall interviews

The perspectives of young people have historically been marginalised in research (Elliott, 1991), though there are now ongoing efforts being made to include their perspectives when studying issues that have an impact on them. It is common sense to include and value the voices of research subjects, including children (BERA, 2018; Morison, Moir, & Kwansa, 2000; O'Reilly & Dogra, 2016), and research has shown that children will participate enthusiastically when they know that their perspective will be regarded as worthwhile (Beazley, Bessell, Ennew, & Waterson, 2011; Rodriguez & Brown, 2009; Smith

& Haslett, 2016; SooHoo, 1993). It can be difficult to build rapport with young participants with some methods of data collection (Kaplan & Howes, 2004), so I sought to use methods that encouraged child engagement in my study so that I might more accurately capture the meaning and weight of their thoughts and experiences. In other words, I aspired to act "as a narrator who enables children's 'voices' to be heard and provides the link between children and practitioners/policy makers, allowing them to hear and understand children's perspectives" (Barley, 2014, p. 8).

Stimulated recall interviews – in which the interviewee is presented with something during the interview meant to stimulate their memories of a particular event – were used to explore the motivations, and cognitive and emotional processes, that led to actions (or inaction) observed in the classroom. Though audio or video recordings of an event are traditionally used as the stimulus for this type of interview, it is also not uncommon to use other objects, such as the notes taken by observers of the event(s) in question (Affleck & Collins, 1998; Jennett et al., 1995). In this study, the students were asked to create some of the objects themselves, to be used alongside field notes taken down during observations of their class.

Stimulated recall interviews are best used to answer fundamental questions about human interaction, such as "what signals interactants understand as important, what signals they try to convey to others, and how they choose from various options to act upon the information they receive in interactions" (Dempsey, 2010, p. 365). While observations can capture – to an extent – what a person does and what other people see and hear of it, they cannot clarify the thought processes behind an action or behind the

experience of someone else's action. Much of what occurs in relationships is unspoken, and with limited time available to observe the students and their relationships it was important to have them clarify their behaviours and experiences explicitly. Only then could I tell "what is or is not salient to [the] interaction[s]" (Dempsey, 2010, p. 350) observed.

All students in the observed classrooms were invited to participate and a subset of students agreed (and their parents consented) to produce developmentally appropriate artefacts (i.e. a piece of writing and a drawing) in response to prompts (Appendices F & G). These prompts were designed to start them thinking about their perception of the classroom generally, computing in the classroom, and life outside of the classroom (including any computing done there). The artefacts they created were then used in conjunction with excerpts from my field notes to start a conversation (i.e. a qualitative, semi-structured interview) regarding their use of digital technology inside and outside of the classroom, their affinity or disposition towards technology and understanding or perception of its uses or potential uses, and more generally what places, people, or objects particularly animated them (Appendix H).

The writing activity asked students to identify their favourite piece of technology and explain what they liked about it. By sending the writing prompt home rather than asking children to complete the activity in school, students were given time to reflect on the prompt and complete the activities at their own pace. This was done with the intention of allowing them time and space to think more deeply about their responses so that they would then be able to give richer responses than in an interview alone.

The drawing activity asked students to draw a picture of a place where they felt strong, clever, or listened to in order to explore feelings of empowerment or agency. Child drawings have long been used to elicit data from children in the psychological, psychiatric, and medical sciences (Burns & Kaufman, 1971; DiLeo, 1970, 1974; Driessnack, 2006; Kellogg, 1970; Koppitz, 1968) and have been shown to be an effective way of establishing rapport with children (McAuley, 1996), as well as learning about their feelings regarding their relationships with others (Hill, Laybourn, & Borland, 1996; Hill & Triseliotis, 1990, 1991). The purpose of their drawings and resulting discussion during interviews was to explore feelings of affinity or empowerment around learning about and using digital skills, by first invoking those feelings around subjects specific to each interviewee.

After the completed activity sheets and accompanying signed consent form was returned, one-on-one interviews with students were scheduled to take place in their school during the school day, with each interview lasting 10-15 minutes. A semi-structured interview schedule was used to re-engage the students with their worksheet and as a basis for exploring issues of technology use at home and at school, how their use of technology is regulated by themselves and others (i.e. through their beliefs or values), and their awareness of the potential uses of digital technologies. Two of the 46 children who completed a worksheet did not participate in interviews – both withdrew their assent – but the remaining 44 all participated fully.

Providing children with the opportunity to reflect on potentially sensitive topics during the writing and drawing activities before discussing them with an adult (i.e. myself) was

intended to lessen any feelings of threat they may have over disclosure (R. Lee, 1993; Sudman & Bradburn, 1989), whilst anonymity and discretion in my management of the research data did, in turn, protect them in practice (University of Oxford, 2014). Additionally, using student-created artefacts and researcher-created notes of student behaviour and speech helped jog the students' memory of events and motivations, and brought them "a step closer" to their experiences of the past (Dempsey, 2010, p. 349), acting as "a sort of memory prosthesis" (p. 351).

The writing and drawings produced by the students provided them with an early opportunity to have their memories and feelings regarding technology and power stimulated, which in turn made the worksheets useful for stimulating discussion during the interviews. Children who initially appeared nervous and closed off (e.g. avoiding eye contact, speaking quietly, giving brief answers) at the beginning of the interview appeared to largely grow more comfortable (e.g. animated speaking, speaking at length, positive facial affect, more upright posture) once the focus of my (the interviewer's) gaze, gestures, and questions were directed towards the completed worksheet rather than the student directly. Notes on the interviewees' affect were taken after the completion of each interview and analysed in conjunction with the transcripts and worksheets to provide a clearer picture of their (visible) state of mind.

A result of this approach was the discovery that answers given after this initial bout of discomfort were the richest and had more completeness of thought, and students were better able to give extended answers about their feelings regarding particular events (e.g. something I observed them do in the classroom) and more generally about their lives

(e.g. whether they preferred to work alone or with supervision on the computer and why) once they had their attention drawn away from me and towards their worksheet. These responses reaffirmed what has been found in previous studies, which is that stimulated recall interviews – despite potential limitations – provide "a valuable mechanism for linking Naturalistic Decision Making and cognitive processes" (Lyle, 2003, p. 873).

The resulting data from the child activities and interviews was used in conjunction with the teacher interviews (Table 3) to better understand what discourses exist in children's lives and how they interact with the discourse within the child's classroom environment to shape their understanding of and disposition towards digital technologies, answering Research Question #2.

Table 3. Data collection order.

Order	**Data type**	**Informed by prior step**
1st	Observation field notes	
2nd	Student writing & drawing	1st
3rd	Teacher interviews	1st, 2nd, 4th
4th	Student interviews	1st, 2nd, 3rd

3.4.3. Desk research

As the fieldwork began and I added Research Question #3, it became increasingly clear that I needed to not only acknowledge the intended policy stage of the computing curriculum, but also engage with and understand it if I was to fully understand what was taking place in the classroom. I began a review of literature contemporary to the creation of the computing curriculum and its implementation in schools – including documents such as government reports and transcripts of speeches by government officials, blogs

written by attendees of curriculum planning events, and journalistic accounts – in order to examine more closely the "intended policy" state of the National Curriculum computing standards. I knew it was important to get a better understanding of the intentions behind its creation so that I could take a true accounting of what teachers, students, and parents were being approached with, and then identify how far the policy-in-practice had drifted from early stakeholders' vision of intended practice.

Policy-related documents addressing the removal of the ICT programme of study and the creation of the computing curriculum were collected from the official websites of the UK government, UK Parliament, and relevant British learned societies. In cases where hyperlinks were broken or a historical document (e.g. the 2012 National Curriculum ICT standards) was no longer available, copies were recovered using archive.org's Wayback Machine[15]. This corpus of materials included a presentation by Becta's then-Director of e-Strategy at the Association for Learning Technology annual conference (Pittard, 2009), a speech given by the then-Secretary of State for Education in England at the Bett Trade Show in London (Department for Education & Gove, 2012), and the Royal Society's updated evaluation of the state of computing education across the UK (The Royal Society, 2017).

Snowball sampling was used to gather journalistic and personal accounts of the creation of the computing curriculum since, as "unofficial" accounts, they were not gathered or organised online in any way. I began by systematically searching for news reports on a)

[15] The Internet Archive acts as an online, digital library, storing over 279 billion archived web pages from as far back as 1996 (The Internet Archive, 2018).

the replacement of England's ICT curriculum and b) the creation of a replacement curriculum. This collection acted as an initial thematic guide of the narratives coming from different stakeholder organisations (e.g. the DfE, BCS, Nesta, and Vital) and entering the public discourse. It also provided an initial list of individuals whose publicly-shared comments on the curriculum I would want to investigate further.

Additional searches were carried out using the names of involved individuals and the organisations they represented during the curriculum development process. Other relevant names were added to the list as they appeared, until I had a collection of journalistic and personal accounts of what had happened behind the scenes of the curriculum's development, as well as a summary of narratives which were being broadcast around the intended policy. This included narratives broadcasting the policy's (intended) outcomes long after it had already been developed into a very different actual policy; in other words, the public narratives around the policy's current effect on schools often continued to clash with what was being observed during this study. By conducting a narrative analysis of this data set in conjunction with the empirically gathered data, I was able to answer Research Question #3.

3.5. Analysis

While initial analysis began during the data collection process, the bulk of the analytic work took place after the 2016-2017 school year had ended.

All of the empirical study data (Table 4) was imported into NVivo and organised by data type, then by school and classroom. Scans of students' writing and drawing were

hyperlinked to their individual interview transcripts within NVivo so that they could easily be analysed in tandem and analysis memos were linked to their relevant data file. Policy documents, journalism, and first-person accounts of the policy's creation were collected and reviewed prior to the formal analysis of the empirical data but were not themselves formally analysed until much of that first round of analysis had been completed. This was in order to avoid reading into teachers' and students' word elements of the intended policy that were not actually there.

Table 4. Processing and formatting of the empirical data.

Data source	Quantity	Original format	Processing	Analysed format
Student writing	46	Paper	Digital scanning	PDF
Student drawings	46	Paper	Digital scanning	PDF
Student interviews	44	Digital audio file	Transcription	Word document
Teacher interviews	4	Digital audio file	Transcription	Word document
Observation notes	49 days	Paper	Digital scanning	PDF

Having acted as an "alert observer" during my fieldwork, I then set out to inductively identify "important relationships and laws" within my data (Mouly, 1978). My early research questions had shifted from being explanatory to exploratory and back again. Similarly, my analysis process involved moving back and forth between different types of data (e.g. Student 1's interview transcript and their worksheets) and different sources of data (e.g. observation fieldnotes from Ms-2 and Mr-4 classrooms), inductively developing hypotheses based from the data and continually testing them against the full set of data (Gold, 1997). This process was used because the data was "socially situated, and socially and culturally saturated," and therefore could not be understood except by examining different views of the same phenomenon within the same context and the same or similar phenomena occurring within different contexts (Cohen, Manion, & Morrison, 2007, p. 134). Through data triangulation (i.e. data from different sources or settings;

Santiago-Delefosse, Gavin, Bruchez, Roux, & Stephen, 2016) and method triangulation (i.e. collecting data using multiple methods; Kuper, Lingard, & Levinson, 2008; O'Brien, Harris, Beckman, Reed, & Cook, 2014), I was able to develop more theoretically and methodologically sound answers to my research questions (Twining, Heller, Nussbaum, & Tsai, 2017).

During all stages of my research – but especially during analysis – I aimed to be critically reflexive, acknowledging that my orientation towards the research was shaped by my own "socio-historical locations, including the values and interests that these locations confer[red] upon [me]" (Hammersley & Atkinson, 2007, p. 15). It was important not to allow personal bias that "comes from commitment to some goal that is extraneous to research – in other words, to some goal other than the production of knowledge" (Hammersley, 2004, p. 31) – to cloud my reading of the situations with which I was presented. At the same time, I sought to acknowledge personal beliefs and values that motivated to take part in this research from the beginning:

> Whenever I have tried to carry out a piece of theoretical work, it has been on the basis of my own experience, always in relation to processes I saw taking place around me. It is because I thought I could recognise in the things I saw, in the institutions with which I dealt, in my relations with others, cracks, silent shocks, malfunctionings... that I undertook a particular piece of work, a few fragments of an autobiography (Foucault, 1988a, p. 156).

While ethnographic methods benefit from their long-term engagement with sites and contexts, and focus on listening to participants' points of view, it is important to acknowledge that they flourished within a discipline that historically took advantage of unequal power relationships to gain access and extract data from underprivileged

communities, often with nothing of value given in return (O'Reilly, 2009). By practicing critical reflexivity (Daley, 2010), I have striven to capture the subjective experiences of others as accurately as possible, whilst also acknowledging that "there are no *pure* inductions," as I bring my own "theoretical point of view and a set of questions, explicit or implicit" to the field and to the data (Erickson, 1984, p. 51). I also gave serious thought throughout my field work as to how much I could ask of teachers and schools in terms of access, time, and effort, given how little of practical and immediate use they would receive in return.

3.5.1. Analysing teacher interviews

When I first began analysing my data, I start with the interview data as it documents the self-reported, lived experiences of participants in observed (as well as un-observed) events and absorbing those experiences as seen through their "eyes" first would help me to better understand what I observed and documented in my classroom observation field notes. Additionally, I chose to analyse the teacher data first as their interviews were longer and richer, they were better able to articulate their beliefs and interpretations of events and other phenomena, and they were exposed to more phenomena within the school in their role as teachers than the children were in their role as students. However, given that I had recently completed the student interviews and had typed up all of my handwritten observation field notes, the other study data – while not yet formally analysed – was very much in my mind as I began working through the teacher interview transcripts.

As this study's purpose was to examine how the introduction of a new educational policy (i.e. an observable process) was understood (i.e. the lived experienced) and interpreted (i.e. an unobservable process) by teachers and students, it was important to use the three sources of data to inform my analysis of one another (Gass & Mackey, 2000). I began my analysis of the teacher interview data by reading through the transcripts and writing up a summary of what was stated in a linked NVivo analysis memo, making note of any emergent themes and connections. I then re-read both the transcript and the summary, and wrote bullet points under three headings: *what* is interesting, *why* it is interesting (generally), and *why* it is interesting specifically as it relates to the research questions (Richards, 2009). The second point was included to make sure I captured any unexpected findings that were not related to my research questions but still of interest.

Once completed, I coded the analysis memos thematically and used the same themes to code transcript excerpts I thought might be useful to include in the thesis text. From the coded data I was able to create an outline of findings, including relevant quotes direct from the teachers, which assisted in answering all three research questions.

3.5.2. Analysing student interviews and activity sheets

Child speech which took place during the interviews was less constrained than that observed in the classroom, in large part due to the undefined social boundaries of the interview space (i.e. while I was an adult and the interviewee a child, I did not have an obvious disciplinary role in the setting of the interview room). During observations, I was always careful to not interfere with classroom behaviour management, even when witnessing off-task or "naughty" student behaviour, as long as it did not pose a

safeguarding or other serious safety issue. Students often looked around the classroom when breaking rules and on several occasions saw me observing but not correcting them. I believe this aided greatly in building rapport with the students over time (Irwin & Johnson, 2005) which then carried over into the interviews, especially with students who were often in trouble in the classroom but who then proved to be particularly forthcoming during their interview. Notes taken immediately after the interview on the students' affect were also useful for providing personal context to the transcribed speech.

The students' interviews were analysed in conjunction with the drawings and pieces of writing that they had submitted, as the literature recommends that data coming directly from the same participant be coded at the same time (Saldaña, 2016). The method used was almost identical to that used to analyse the teacher interviews, except a summary of the drawing was added to the analysis memo (informed in large part by each child's description of their drawing during the interview, which was critical in some cases where it was unclear what had been drawn or why), which was coded alongside the transcript data. An outline of findings and interesting verbatim quotes were integrated into the outline developed using teacher interview data and contributed to an overall theory around computing education policy and practice, helping answer Research Question #2 in particular.

3.5.3. Analysing classroom observations

The field notes taken down during classroom observations contained roughly four types of data: child and adult speech, nonverbal behaviour, contextual factors (e.g. seating

arrangement, special event, etc.), and my impression of the events witnessed. Particular weight was given to speech and nonverbal behaviour, but contextual factors were also important to understanding what influenced participant behaviour, as well as what influence participants had then back on their context.

Examining dispositifs through the observation of discourse (both verbal and non-verbal) and materials is a useful way "to make visible what precisely is visible, that is, to make appear what is so close, what is so immediate, what is so intimately tied to ourselves that because of that we do not perceive it" (Foucault, 1978); in short, to tease out the unspoken assumptions and beliefs behind individuals' and groups' actions, and reveal the woods hidden by our focus on the trees.

I inductively identified four broad themes from the interview data analysis and from re-reading my observation field notes: 1) computing lessons and technology use, 2) cultural training, 3) political and public influence on teacher and school practice, and 4) computing's "failure to disrupt." Each day of field notes was re-read again and summarised as applicable under these categories. I used Saldaña's (2016, p. 14) framework of *units* and *aspects* as a starting point for conceptualising units of data to categorise in my analysis memos:

Units of social organising:

1. Cultural practices
2. Episodes
3. Encounters
4. Roles
5. Social and personal relationships
6. Groups and cliques
7. Organisations

8. Settlements and habitats
9. Subcultures and lifestyles

Aspects:

1. Cognitive aspects or meanings
2. Emotional aspects or feelings
3. Hierarchical aspects or inequalities

Though the four themes I initially used to categorise my observation data were ultimately not used to structure my findings, they did provide an early framework for thinking about what I had observed within the classroom and what it meant in light of my research questions. New patterns and themes emerged over the course of the analysis of the observation data and upon review of this analysis in light of analyses of the other data. These findings were then integrated into the larger outline of study findings, contributing to the answering of all three research questions.

3.5.4. Analysing policy documents, journalism, and first-person accounts

I then moved on to analysing the items I had collected through desk research. The collected documents were read through and grouped according to whose voice they represented or reported: for example, official statements published by RAEng, statements made by representatives of RAEng to the media, and blog posts reporting a private letter sent by RAEng to Education Secretary Michael Gove were grouped together. Summaries of the narrative(s) produced by these groups of voices were written up in the form of analysis memos, though oftentimes one voice (e.g. BCS) would push different narratives towards different audiences, which was clarified in the memo.

A loose timeline was created, tracking how different narratives carried on over time and were used to a) project an organisation's perspective on an issue, and/or b) attempt to persuade others. Capturing this interweaving of narratives from governmental, NGO, academic, and industry sources demonstrated the significant influence that non-governmental actors had in this policy's creation and in how this policy was advocated for depending on the audience.

Analysing the differences in narratives aimed at teachers and families compared to those aimed at other stakeholders was particularly interesting. This provided a strong basis for comparing assumptions made by policymakers and industry about what the curriculum change would accomplish, the actual support and guidance provided to teachers, and the beliefs and experiences of students and their families with digital technology. Examining this "complex, evolving process" of education policy implementation (Viennet & Pont, 2017) has contributed to answering Research Question #3 and constitutes the majority of Chapter 4.

3.6. Conclusion

The computing programme of study was added to England's National Curriculum with the stated purpose of providing young people with the skills, knowledge, and ways of thinking necessary to participate in an increasingly digitalised knowledge society, as citizens as well as possibly as tech entrepreneurs or computer scientists. What actually motivated the creation and exact wording of the curriculum will form an important part of this thesis, as it forms the first stage of the three-stage process of education policy creation and change in schools (i.e. intended policy, actual policy, and policy-in-practice).

By utilising an ethnographic case study design plus conducting desk research, I will be able to explain what is happening in regard to computing education in English primary schools and why:

1. How are teachers translating the computing education policy into practice and why?
2. In what ways is England's computing policy-in-use influencing students' understanding of and disposition towards digital technology and why?
3. What does the computing education policy – and teachers' and students' response to it – say about the incongruity between public policy around digital technology and people's real-world experiences with and understandings of it?

Answering these three research questions will inform our understanding of how education policy functions and the importance of understanding dispositif to creating particular outcomes in schools.

4. Findings: "intended policy"

The UK has a long history of innovation in computing, with contributions made by individuals such as Charles Babbage, Ada Lovelace, Alan Turing, and Sir Tim Berners-Lee – as well as heavy investment in research and development made by the British government during World War II – leading to the development of many world firsts taking place between the 1940s and 50s[16]. British strength in computing began to weaken, however, by the late 1960s as British computing companies were forced to merge in an attempt to hold back the tide of American-made IBM computers entering the country. By the 1970s, the British government has ceased giving preferential treatment to British computing companies when purchasing computing equipment and openly bought American-made computers. By 1990s, the UK's home-grown computing industry had all but disappeared (Computer Conservation Society, 2018; Lavington, 1980).

Seeing how far this country has come, from standing at the forefront of innovation in computing to fading from view in the Silicon Valley's shadow, politicians and many others have become eager to return the UK to its glory days as a world leader of technological advancement. This growing interest in improving the country's tech industry left many organisations open to advice from their more recently successful counterparts in the United States, both in regard to structural investments (e.g. government support for startups, improving computing education in schools) and shifts in cultural values (e.g.

[16] This included Colossus, the world's first electronic digital programmable computer; Manchester Baby and EDSAC, the first two electronic stored-programme computers; LEO I, the first computer used for commercial business applications; the University of Manchester's Transistor Computer, the first transistor computer in operation; and Harwell CADET, the first fully transistorised computer in Europe and possibly the world.

pro-technology, pro-entrepreneurship, pro-accelerationism, pro-"move fast and break things"[17]). This Silicon Valley narrative – or "California ideology" (Watters, 2015; also see Williamson, 2017b) – combined with a nationalistic nostalgia for Britain's former status as an imperial power, has fostered a variety of competing narratives around technology, the economy, the workforce, and today's children.

This chapter will examine what the various actors involved in the creation of England's computing education policy intended for it to become (i.e. the intended policy) and how those intentions were translated into the actual policy written into law (Ball & Bowe, 1992). Utilising data from sources such as official policy documents, government speeches, publicly-available correspondence, and both journalistic and personal accounts of relevant events, I will explore the competition to create a new digital skills curriculum, and whose voices were heard or ignored during its development.

After this, I will analyse the exact wording of the computing programme of study, identifying key areas of focus and comparing it to England's old ICT curriculum in order to identify shifts in the government's educational priorities. I will then discuss how the wording of the actual policy aligns with global narratives tying computer science to issues of economic and political power.

[17] "Move fast and break things" was Facebook's company motto.

4.1. From intended to actual policy

The processes which resulted in the creation of England's computing education policy were "dispersed across borders, sectors, organisations, industries, technologies, actors, and objects" (Williamson et al., 2018, p. 1), and which of these forces wielded the most influence fluctuated across time and lace. This resulted in the curriculum passing through several stages of intended policy, followed by a radical shift in focus as it transitioned from an intended to an actual policy state.

4.1.1. Justification for abandoning ICT

Complaints regarding the timeliness, quality, and rigour of the ICT programme of study – included in the National Curriculum as a subject since 1988 – came from multiple outlets. There were concerns that the UK was producing significantly fewer computer scientists and IT professionals than were needed, and that school leavers had a dissatisfactory low level of ICT skills (BCS, 2011b). Various tech-related industries across the country complained of a lack of home-grown talent, blaming this on a dated education system focused on office skills rather than innovation, creativity, and computer science (Livingstone & Hope, 2011). The Education Minister at the time called the ICT curriculum "harmful," "boring," and "irrelevant" (Department for Education & Gove, 2012), whilst England's DfE confessed that the subject carried "strong negative connotations of a dated and unchallenging curriculum that does not serve the needs and ambitions of pupils" or employers (Department for Education, 2013a). Ofsted, England's inspectorate for schools, also reported their concerns over the quality of the subject as it was being taught (Ofsted, 2011) and an expert panel review of the National Curriculum reported that they were not convinced that ICT had "sufficient disciplinary coherence to be stated

as [a] discrete and separate" subject (James, Oates, Pollard, & Wiliam, 2011). Overall, a narrative of ICT as academically weak and vocationally useless prevailed.

Pressure to change England's ICT curriculum did not come only from within the UK and so it is important to "think outside and beyond the frame of the nation state to make sense of what is going on inside the nation state" (Ball, 2016, p. 1). From the early 2010s, the international tech industry took hold of this anti-ICT narrative to put pressure on the British government to increase the use and study of more advanced digital skills within schools and the government responded positively to industry's desires. Google's chairman and former-CEO Eric Schmidt (2011) made this cause the focus of his MacTaggart lecture at the annual Edinburgh International Television Festival, saying:

> In the 1980s, the BBC not only broadcast programming for kids about coding, but... shipped over a million BBC Micro computers into schools and homes... I was flabbergasted to learn that today, computer science isn't even taught as standard in UK schools. That is just throwing away your great computing heritage.

In response, then-Prime Minister David Cameron (2011) agreed that "we're not doing enough to actually teach the next generation of programmers... and I think that's a real wakeup call for us in terms of our education system, and we're acting on that." What action would be taken exactly was clarified two months later in then-Secretary of State for Education Michael Gove's (2012) speech to the annual BETT Trade Show in London, with the announcement that the DfE was planning to withdraw ICT from the National Curriculum whilst a replacement programme of study was developed.

Gove's speech was reinforced that same day by the release of the Royal Society's seminal *Shut Down or Restart?* report on the dire state of computing education in UK schools (2012). This report noted the limitations of the ICT programme of study and warned of a severe shortage of teachers with the training necessary to teach more than the most basic aspects of digital literacy. The Royal Society also called out a lack of CPD being made available to teachers, and the limited provision of school infrastructure needed to teach effective ICT lessons. The DfE was urged to "remedy the current situation" (p. 45), for the current ICT offering was, in short, "highly unsatisfactory" (The Royal Society, 2012, p. 8).

4.1.2. ICT, computing, or computer science?

Following the Royal Society's report and Gove's speech, CAS – part of the BCS Academy of Computing – began lobbying civil servants within the DfE and attending ICT curriculum consultation meetings organised by the same. Self-described as a "grassroots organisation," CAS quickly became the subject association for computer science in schools and they pushed for a new focus on computer science within the National Curriculum. This lobbying was a success, as the white papers they released with the endorsement of Microsoft and Google in March 2012 (Computing At School, 2012) and two years prior (Computing At School, 2010) were adopted as blueprints for the new curriculum.

The subject association for ICT in schools (Naace), the Association for IT in Teacher Education (ITTE), and CAS issued a joint statement later in the summer of 2012 stating their desire for ICT and computer science to both be taught from primary school onwards, and their intention to "work together to prepare future teachers effectively and

to support existing teachers with good CPD" (Naace, ITTE, & Computing at School, 2012). Mention of digital literacy was notably absent within this letter, due to a disagreement amongst the three organisations over how to define it, though CAS later clarified they did not mind how it was defined as long as computer science was added to the statutory curriculum (Twining, 2012)[18]. The letter also clarified that technology enhanced learning (TEL) – i.e. the use of digital technologies to teach other subjects – was not a substitute for teaching ICT or computer science, and that TEL should only be used and assessed in accordance with the needs of that second subject. This was a push back against years of criticism that many schools were using the technology at their disposal for TEL, often to the detriment (or in place) of discreet lessons in ICT skills and knowledges.

Given these three organisations' close relationships with schools and teachers, it was unsurprising that they should offer their professional opinion early on in the curriculum's development. They presented a united front at this stage, representing a democratically-minded joint interest in improving the digital skills curriculum by broadening it and by supporting teachers' continuing professional development.

[18] Professor Peter Twining, an academic at Open University, was at the time the director of Vital, "a CPD program designed to enhance the teaching of information communication technology in state-funded primary and secondary schools in England" (Bradshaw, Twining, & Walsh, 2012, p. 74). Vital was created at the Open University and later run by Jisc (formally the Joint Information Systems Committee), a UK non-profit that supports Higher Education, Further Education, and lifelong learning organisations so that they can make the most of modern digital technologies; Vital is now defunct. Twining, in his role as director of Vital, had insider access to information about the computing curriculum's development and shared regular updates on his blog, *PeterT's bliki*.

Following on from this letter, the DfE announced that they expected to have a draft ICT[19] programme of study for Key Stages 1 and 2 by the end of the year. However, while the DfE said the curriculum would be based "on advice from 'experts' in the field, including industry, academics, subject associations, and teachers," it appeared that they had little intention of coordinating or leading these experts themselves (Twining, 2012). Though Naace, CAS, and ITTE had come to a consensus early on, there were still other interested organisations with very different ideas of what reform of the ICT curriculum should look like and what subjects were a priority for inclusion, and who would fill the vacuum left by the DfE's hands-off approach (i.e. "The DfE policy on ICT is there is no DfE policy on ICT") (Harrison, 2013).

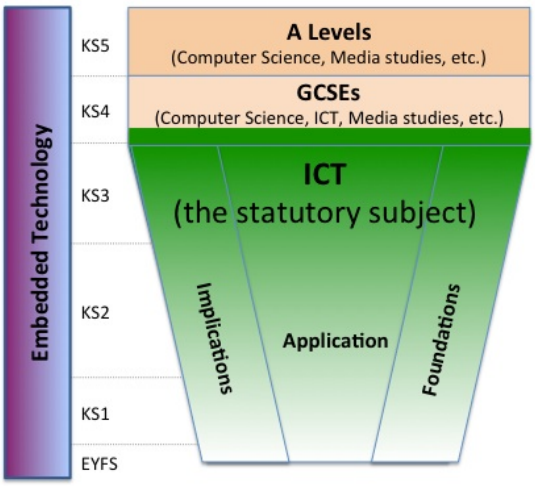
The question of how the replacement curriculum would be produced was settled when the DfE signed a memorandum of understanding with BCS and RAEng in September 2012, granting them power to coordinate the drafting of the new programme of study for all Key Stages. The memorandum insisted that it was "essential that the Programme of Study [be] developed in association with and [had] 'buy-in' from key stakeholders across the sector," suggesting that the draft due six weeks later would be developed with all of the relevant parties at the table (Twining, 2012). This consultation group, chaired by Simon Peyton-Jones (a computer scientist at Microsoft Research and chair of CAS), consisted of representatives from BCS, RAEng, Vital, ITTE, and NextGen Skills (a National Endowment for Science, Technology and the Arts [Nesta] campaign promoting education

[19] The subject was still referred to as ICT as it was initially thought to be legislatively too difficult to replace the ICT name with something else; it later became clear that no special dispensation was needed for the DfE to change the name unilaterally.

benefiting the UK's digital, creative, and high-tech industries[20]), as well as three computer science secondary school teachers, two academics from university computer science departments, and three academics from university teacher education programmes.

This group submitted a full draft of the curriculum to the DfE in September 2012 after their first meeting, focusing on three broad areas of ICT for school students (Figure 2).

Figure 2. Original plans for the structure of the new ICT programme of study[21].



Meanwhile, the Government's preparations for the addition of computer science to the ICT curriculum did not sit well with everyone. ITTE, Naace, and MirandaNet (a professional organisation supporting teachers' CPD in the use of digital technologies for teaching) issued a joint letter to Education Minister Michael Gove, expressing concerns regarding: new plans to remove funding for teacher training courses in ICT (even though ICT was still a part of the draft new programme of study); unrealistic plans to recruit top

[20] A campaign supported by BCS, the Association for UK Interactive Entertainment (UKIE) Facebook, Google, Sony, Nintendo, and TalkTalk, amongst others (NextGen Skills, 2011).
[21] Reproduced with author's permission (Twining, 2012).

computer science graduates to teach; an impractical timeline given to develop and establish new initial teacher training courses in computer science; and a serious underestimation of the number of new computer science teachers needed to meet the growing skills gap in schools (ITTE, Naace, & MirandaNet, 2012; Vasagar, 2012).

After a DfE and Department for Business, Innovation and Skills (BIS)-led roundtable involving members of the tech industry (e.g. Apple, IBM, Hewlett Packard, Microsoft, Toshiba, Cisco, Facebook), commercial associations (e.g. the British Educational Suppliers Association), professional associations (e.g. BCS, RAEng, NextGen Skills), school-focused organisations (e.g. Ofsted, Naace, ITTE, CAS), and one representative (i.e. the chair) of the BCS- and RAEng-coordinated consultation group, the Director of Vital reported the following (Twining, 2012):

> The key things coming out of the meeting from my point of view were:
>
> - "Utter confusion in schools about ICT"...
> - Agreement that having the three strands of Digital Literacy, Information Technology and Computer Science within the ICT PoS [programme of study] was important...
> - Agreement that there would need to be extensive supplementary material to support teachers in implementing the ICT PoS...
> - Agreement that there was a massive expertise gap in relation to ICT (the subject) and TEL – and that there needed to be extensive staff development to help address both these areas. However, it is highly unlikely that the DfE will fund this as their stance is to say that it is up to schools to decide where/how to allocate resources
> - Agreement that there needed to be incentives to "encourage" schools to prioritise staff development re ICT (the subject) and TEL – and recognition that this needed to include both carrots and sticks...
> - Agreement that assessment was a key driver and barrier to change, particularly in relation to the sets of skills that employers most need (what some might label "knowledge age skills") including being digitally literate citizens.

A consultation workshop – consisting of several new members – met a month later to provide new comments of the draft curriculum, followed by a second working group (consisting of many of the same members from the September working group) meeting to edit the draft with the new workshop comments in mind. This second draft was sent to the DfE where it sat for a few months with little said about ICT beyond the announcement that computer science was being added to the English Baccalaureate, a move immediately praised by Microsoft and Google (Coughlan, 2013).

The first sign that something unexpected was happening behind the scenes was when the DfE announced that the new curriculum would be rebranded as computing:

> After building a consensus for the draft ICT programme of study, the project has hit controversy. The British Computer Society and the Royal Academy of Engineering have gone behind the backs of their education partners in the group producing the draft Programme of Study for the new ICT curriculum... and made a personal plea to Secretary of State for Education Michael Gove MP to change the name of the subject from ICT to Computing... According to the draft programme of study that the BCS and RAEng [working group] has just submitted to Michael Gove, Computing is just one strand in the much wider ranging subject of ICT... As one school leader involved quipped, “It's a bit like calling a car a steering wheel rather than a car. Computing is just a component of ICT”... The secretary of state's decision to hand over development of the Programme of Study for the new ICT curriculum to the BCS and RAEng rather than the English education community was seen as unusual from the outset (John, 2012a).

It was not until February 2013 that the DfE put out a final draft of the computing curriculum for public consultation, revealing a significant change in the focus of the standards from a broad interpretation of ICT to a clear focus on computer science. The eleventh-hour letter sent by BCS and RAEng to the Education Secretary, asking him to change the name of the curriculum from ICT to computing and to increase its focus on computer science, had been a success. In response, the two organisations (rather than

the working group they had organised) were invited to rewrite the programme of study. Reporting the surprise change to his blog followers, the Director of Vital opined:

> I am dismayed. Even if you take the narrow view that our school system... is intended to prepare young people for the world of work, this proposed Computing Programme of Study is not fit for purpose. Most workers do not need to be able to program computers. They don't even need to have a deep understanding of how computers work... However, all members of our society need to be "digitally competent" - something that appears to be a minor consideration in this Computing Programme of Study (Twining, 2013).

While speaking with former members of the original consultation groups (who asked to remain anonymous), I was given the sense that they felt that teachers and their interests had been betrayed, and that the relatively democratic process through which the curriculum had initially been developed had been compromised by the actions of BCS and RAEng.

Oddly, the Education Minister attributed these last minute changes to not only BCS and RAEng, but also to the tech industry: "We have replaced the old ICT curriculum with a new computing curriculum, with help from Google, Facebook, and some of Britain's most brilliant computer scientists" (Department for Education & Gove, 2013). It is not entirely clear what direct role they played in the curriculum's writing, beyond their attendance at the DfE and BIS joint roundtable and their financial and strategic support of organisations such as CAS and NextGen Skills.

Our historical view of the curriculum's true authorship has further been muddied by claims made by various organisations since its creation. BCS-produced publications state that the curriculum was designed by CAS with support from BCS, the University of

Cambridge, Google, and Microsoft Research (Runciman, 2016), while Nesta said that its NextGen campaign had "influenced policy, rallied industry and galvanized educators to improve computer science teaching" by informing the curriculum's creation (Nesta, 2015). What is clear, however, is that many groups – particularly teachers and those interested in a broader interpretation of ICT or computing – felt that the time they had spent participating in the curriculum consultations had been in vain, or worse, that they had never been welcome at the table in the first place.

4.2. Response to the actual policy

Since the computing programme of study became statutory in September 2014, conflicting narratives have competed to define how well the actual policy was designed and how successful it has been in practice. Some say it is too early to tell what impact the curriculum has had (e.g. Professor Dame Wendy Hall, cited in House of Lords Select Committee on Artificial Intelligence, 2018), while many others (especially in the critical camp, including current and former teachers[22], tech journalists[23], and academics[24]) say it is already quite clear how well (or, rather, poorly) the curriculum is doing in schools.

4.2.1. Critical responses

Those involved directly in the first two drafting groups run by BCS and RAEng continued to express surprise – "I do have some serious concern..." – over how the programme had been unilaterally changed after the last consultation group met (Berry, 2012). All

[22] (Association of Teachers and Lecturers, 2013; Haigh, 2016)
[23] (Cellan-Jones, 2017, 2018; Cuthbertson, 2014; Harris, 2017)
[24] (Bresnihan, Millwood, Oldham, Strong, & Wilson, 2015; The Royal Society, 2017; Williamson, 2016, 2017a; Wohl, 2017)

reference to critical digital literacy and the importance of developing students' understanding of the implications of modern technology was removed (all the more confusing as, Miles Berry[25] rightly noted, "programmes of study [for other subjects in the National Curriculum] are allowed to develop criticality..., just not computing."). Additionally, "the draft submitted to Ministers [by the consultation groups] went 'much further' than the current curriculum does in addressing personal morality in relation to technology," an omission that led the House of Lords Select Committee on Artificial Intelligence (2018) to "recommend that throughout the curriculum the wider social and ethical aspects of computer science and artificial intelligence need[ed] to be restored to the form originally proposed" (p. 80).

The Association of School and College Leaders (ASCL), in its broad criticism of reforms being made across the National Curriculum, called out the new computing curriculum in particular as, "So technical and content heavy, it almost completely removes all the practical ICT skills that students will need for adult life" (Stewart, 2013). The Design and Technology Association, like most organisations with an interest in the design of the National Curriculum, found themselves not consulted at all during the development of the revised design and technology programme of study, which was written completely in-house by the DfE (as confirmed by the DfE's Assistant Director of the National Curriculum review, Matt White). They saw their subject area move chronologically in the opposite direction of ICT in the new National Curriculum, with the reintroduction of sock-darning

[25] Miles Berry is a lecturer in computing education at the University of Roehampton and was involved in the creation and promotion of the computing curriculum through his roles with BCS, CAS, and Naace (Berry & Leach, 2013). However, he has also been open with his concerns regarding the way the new curriculum was developed, what subject matter it is missing, and the mythos that had grown around the subject (Berry, 2016, 2018).

and flower arranging, leading the DTA to argue that the curriculum as a whole was becoming "'unambitious and incoherent', 'completely inappropriate for a technologically advanced nation' and [that it] would make England the 'laughing stock' of the Western world" (Stewart, 2013).

The overriding critical narrative of the National Curriculum reforms, particularly for ICT and computing, was that "the push to increase CS [computer science] has... resulted in a curriculum which is leaning too far in that direction, arguably failing to provide a technological education which has breadth and balance" (Berry, 2012). For example, the Roehampton Annual Computing Education Report found, according to 2017 data, a significant decline in girls enrolling in computing-related qualifications at GCSE and A-level, and a drop in the overall number of students enrolled in any type of computing qualification at Key Stage 4 since the introduction of computing to the National Curriculum. Authors of the report advised:

> Our findings lead us to call for an urgent inquiry into the long-term impact the removal of ICT will have on the digital education of young people. In particular, the analysis should examine if, and the extent to which, the current suite of available qualifications is truly inclusive and of benefit to all children. We believe there is a need for clarity on vocational qualifications and a need for a replacement for the ICT GCSE and A-level, or a "single subject" computing GCSE that encompasses the CS, IT and digital literacy elements recommended by The Royal Society... (Kemp, Berry, & Wong, 2018, p. 6).

Even though the computing curriculum had been in effect for multiple years by the time of this report, it had failed to lead to more students leaving their early education with an interest in pursuing computing-related subjects at a more advanced level (e.g. through taking relevant GCSE or A-level qualifications).

4.2.2. Positive responses

The tech industry, meanwhile, reacted positively once they realised there was a new market for their products, though this was perhaps an overly optimistic take given that schools would receive no additional funding for materials or training from the DfE to implement this new curriculum.

US-based Code.org began promoting its Hour of Code products in the UK that first year with the support of CAS and then-Mayor of London Boris Johnson. This was followed shortly by the Year of Code campaign, supported by tech-centric venture capital firm Index Ventures (Williamson et al., 2018) and with a board and advisors drawn nearly exclusively "from the fields of entrepreneurship, venture capital and computing" (plus one "educational advisor" from a pro-technology think tank) (Williamson, 2016, p. 46). The chief executive of another US-based proponent of the learn-to-code movement, Codecademy, crowed that by "forcing an entire country to learn programming," they had "struck oil, and we want to make sure we get all of it before we move on and look elsewhere" (Dredge, 2014).

Meanwhile, funding was granted to CAS by the DfE (£1million) and private tech companies (e.g. Microsoft, Google, BT; amount unknown) to create free educational materials to be published on the Barefoot Computing website. These organisations were also tasked with creating a nationwide Network of Excellence (with £2million from the DfE) by training and supporting "Master Teachers" of computing, though regional

distribution of these teachers was uneven at best[26]. The Master Teacher programme ran out of funding in April 2018.

Google gave Raspberry Pi a $1million grant to distribute 15,000 of their microcomputers to British schoolchildren, although the communications manager at the Raspberry Pi Foundation was unable to tell me in any detail how these were distributed beyond that their "six partners" helped then identify recipients [at least some of which were schools, as mentioned in passing in a recent Foundation report (Quinlan & Baloro, 2018)]. The BBC had also created its own modern microcomputer called the micro:bit "through formal partnerships with a mix of commercial, charitable and academic organizations and actors" (Williamson et al., 2018, p. 8), with the intention of giving one free to every Year 7 child in the UK. However, production was delayed, and these were only just released in 2016/17 academic year.

4.3. Four years (and as many ministers)

Teachers' confidence in teaching with and about technology in schools has historically been linked to their level of prior experience with technology, either outside of school or through professional development opportunities (e.g. out-of-hours training) (Bennett, Wragg, Carré, & Carter, 1992; Mueller, Wood, Willoughby, Ross, & Specht, 2008; Silvernail, 1996; Vanderlinde & van Braak, 2011). With limited prior experience of

[26] For example, Oxfordshire did not have a primary school Master Teacher until the programme's final year of funding. Teachers in other regions made similar complaints about the lack of availability and accessibility of Master Teachers (Staufenberg, 2015).

computing in modern British primary schools and no funding provided for CPD, teachers might instead turn to the DfE for guidance on best practices.

But here they found a Department for Education unwilling to dictate – or, consequently, scaffold – how to teach a barebones, novel curriculum for teachers who received their initial teacher training before computing had even been considered as a compulsory subject. Michael Gove spoke of the "notoriously flat-footed" nature of governments when it came "to anticipating and facilitating technical change... seduced into spending huge sums on hardware which is obsolete before the ink is dry on the contract" (Department for Education & Gove, 2012), as one reason why the government should step back from providing guidance on a digital technology curriculum. Similarly, Dr Vanessa Pittard, the former Becta director of evidence and head of the DfE's disbanded Technology Policy Unit, said that "the days of government control, intervention, ring-fenced funding and telling schools what they have to do is over" (John, 2012b). The DfE promoted this hands-off approach as "the brave thing" to do, telling schools that implementing the computing curriculum "is up to you. Do it, and then let the best happen" (Gothard, 2012). My research will explore whether this guidance proved sufficient to result in "the best happen[ing]" for students and teachers.

As teachers wrestled with interpreting the new National Curriculum, leadership of the DfE continued to shift. Michael Gove was moved from the Education Secretary position to Chief Whip of the House of Commons and Parliamentary Secretary to the Treasury in July 2014 (Table 5), two months before the computing curriculum became compulsory in schools. What followed was a series of Conservative Education Secretaries, all with the

same pro-technology and pro-deregulation of education voting patterns on education in Parliament as Gove. Despite the major rehaul of the National Curriculum, all four Education Secretaries followed the party line of being pro-free school, pro-academy, and pro-grammar school (most of which are now academies), despite free schools and academies being state-funded schools that are not required to abide by the National Curriculum.

Table 5. List of Secretaries of State for Education in England since 2010.

Name	***Dates of term***
The Rt Hon Michael Gove MP	May 2010 – July 2014
The Rt Hon Nicky Morgan	July 2014 – July 2016
The Rt Hon Justine Greening MP	July 2016 – January 2018
The Rt Hon Damian Hinds MP	January 2018 – present[27]

This confusing contradiction – between a major reworking of the National Curriculum by a government that also supported the conversion of schools so that they were no longer obliged to teach to it – culminated in a DfE announcement during Nicky Morgan's term as Education Secretary stating that all schools would be forced to convert to academy status if they had not already by 2022. Though this plan was later retracted (after many schools had already begun the conversion process, now too far along to be reversed; Richardson, 2016), this situation does call into question what the British government – which has been run in large part by the same political party since 2010 – had intended the new National Curriculum policy to accomplish.

Though a series of Education Secretaries had towed the party line, that line is confused and contradictory when brought into the education space: pro-business (and therefore

[27] As of the completion of this thesis.

pro-tech) which requires prescriptive legislation, whilst also pro-small government and anti-regulation, which requires minimising legislation. This has resulted in a pared down curriculum that imposes a narrow interpretation of digital skills and knowledges on schools, without providing the necessary funding or other support necessary to prepare educators to teach this new subject. The current party's knowledge of what makes for good governance appears to conflict with a widely accepted knowledge of what makes for a functional formal education system.

4.4. Policy analysis: "actual policy"

Here I will address the wording of the computing programme of study (Appendix I) as it is written in the National Curriculum, with a particularly focus on the requirements for Key Stages 1 and 2 (i.e. Years 1-6; ages 5-11 years old; primary school). "Actual policy" (i.e. the policy encoded into law) is often worded differently from how stakeholders involved in its creation hoped it would be phrased (i.e. the "intended policy"), given that they must use the appropriate local vernacular of government and law (Ball & Bowe, 1992). Actual policy documents "never come to us 'pure,' since they do not and cannot exist in a pure form; they are always refracted through the mind of the recorder" (Caulley, 1983, p. 20; also see Carr, 1961), meaning that policy as written into law never perfectly reflects the intentions of its creators, particularly when there are multiple creators involved, each with their own priorities.

Actual policy is similarly not a perfect predictor of "policy-in-practice," as this thesis will demonstrate. However, actual policies are "social facts" (Atkinson & Coffey, 1997, p. 47) that act as state-sanctioned signposting of a policy's function and purpose, and therefore

are deserving of close inspection if we are to fully understand a policy's other two states (that is, intended and in-practice). As Max Weber said of bureaucracy, "The modern world is made through writing and documentation" (Prior, 2003, p. 4) and so the wording of such documentation must be examined.

In this policy, it is clear that the focus is on preparing young people for a world that policymakers have perceived as having changed in significant ways and which the best answer for is computer science. Computer science is the new hot topic, and while it is a set of skills and knowledges rather than just a single device, it is still a very particular way of viewing "the digital" and how "the digital" interacts with and within society. Whether the ability to "do" computer science carries with it the unique affordances claimed by some supporters remains to be seen. This section will explore what is gained by the National Curriculum for its focus on computer science and, in turn, what has been lost.

4.4.1. Purpose of study

National Curriculum programmes of study first begin with a section on the "purpose" of studying a particular subject. With computing – for all four Key Stages, not just primary school – the stated purposes include equipping students with computational thinking and creativity. These two abilities will enable them "to understand and change the world."

While computing's "deep links" to STEM subjects such as "design and technology," science, and mathematics is acknowledged, the programme makes it clear that the "core of computing is computer science" and those skills and knowledges critical to CS (e.g. digital systems, information, computation, and programming) will be the focus of what

students are taught. These abilities – so the curriculum says – will leave students equipped to tackle creating computer programmes and systems, as well as digital content.

Lastly, it is stated that the purpose of computing is to make students digitally literate – what this means exactly is unclear – so that they can use ICTs and express themselves as digital citizens and "at a level suitable for the future workplace." The final line of this section on purpose acknowledges the economic aims of computing's addition to the National Curriculum.

4.4.2. Aims

The next section of the programme outlines what the computing curriculum for Key Stages 1 and 2 aims to ensure each student can do. This includes:

1. Understanding and applying the fundamental principles of computer science; to what end is not clarified.
2. The ability to "analyse problems in computational terms." This aim also calls for students to have repeated practice in writing computer programmes to "analyse problems."
3. Evaluating technology, including new and unfamiliar technologies, and using the to "solve problems in computational terms."
4. And that students become "responsible, competent, confident and creative users" of ICT.

This section is significantly shorter and less details than the “aims” for what are labelled the “core” subjects (i.e. English, mathematics, and science). However, it is comparable in length to other mandatory non-“core” subjects such as languages, art and design, physical education, and geography. The wording of the programme’s aims suggests that ICT, computing, and computer science will be covered by this curriculum. However, the more detailed explanation of the curriculum’s attainment targets suggests a much narrower content focus.

4.4.3. Subject content and attainment targets

Attainment targets for each Key Stage are outlined in this section, beginning with the phrase, “Students should be taught to...” These targets are to be met by the end of each key stage, with students knowing, applying, and understanding the “matters, skills and processes” covered by the subject content section.

4.4.3.1. Algorithms and programmes

Algorithms and their implementation as computer programmes are first introduced in Key Stage 1. Students at this age are taught how to create and debug simple programmes, while at Key Stage 2 they are expected to plan and design programmes, as well as write them out. Key Stage 2 students are also expected to understand how to use sequences, selection, and repetition in programmes, how to work with variables, and the different forms of input and output produced by algorithms. The addition of coding, as well as computational thinking, are two of the biggest changes from ICT to computing and have also been heavily advertised as the focus of the new curriculum (Department for Education & Gove, 2014).

4.4.3.2. Logical or computational thinking

Both Key Stages are expected to be able to use "logical reasoning" to predict what the execution of a particular programme will do. Older primary school students are to know how to explain how an algorithm works, which is supposed to lend itself to their ability to "correct errors" or debug algorithms and more complex computer programmes.

Though not explained explicitly in the programme of study, it would not be unreasonable to assume that "logical reasoning" is the same ability as the "computational thinking" mentioned at the start of the programme's *Purpose of Study*. What the exact definition of these concepts are is unclear, despite later publications by the curriculum's creators citing computational thinking as "essential for children to understand the foundational ideas and concepts that underpin the digital world, and to thrive as creative digital citizens capable of shaping their own future" (Runciman, 2016, p. 19). The unclear alignment between these two concepts gives readers the impression that the curriculum is still an early draft in need of further refining.

4.4.3.3. Digital content and potential uses for digital technology

There is limited coverage of what students should be taught about the content that they might be exposed to while creating, debugging, or otherwise interacting with computer programmes. Key Stage 1 students are expected to learn how to "create, organise, store, manipulate and retrieve digital content," while at Key Stage 2 they will use a variety of software and hardware to design and create "content that accomplish given goals." This will require older students to collect, analyse, evaluate, and present data and information, including content that they access through "internet services."

Older students are to be taught how to use a variety of software and hardware, while younger students will learn to "recognise common uses of information technology beyond school." However, there is no mention made of media or information literacy, despite growing calls for its inclusion in schools due to issues of growing importance such as: misinformation, disinformation, and other forms of propaganda ("fake news"); cyberbullying; online grooming; exposure to disturbing and otherwise inappropriate content; and the exploitation of personal data by companies, states, and other bad actors (Children's Commissioner, 2018; Livingstone, 2018; Livingstone, Haddon, & Görzig, 2012; National Literacy Trust & All-Parliamentary Group on Literacy, 2018).

4.4.3.4. Safety and citizenship

E-safety continues on from the ICT curriculum into computing, with an emphasis placed across the primary years on reporting concerns regarding content or contact with strangers to the appropriate adult. All years are expected to use technology safely and respectfully, while Key Stage 2 is also expected to use it responsibly and to be able to recognise the difference between acceptable and unacceptable behaviour (examples of these behaviours are not given). Key Stage 1 students are taught to keep their personal information private, but these lessons are not required from Year 3 onwards. The absence of any mention of learning to identify truth and fiction online in a curriculum that is supposed to support Internet safety and digital citizenship is a particularly stark oversight, given the clear relevance and timeliness of these skills.

4.4.3.5. Systems, search, and software

Students in Key Stage 2 begin to learn about digital networks – such as the Internet – and the uses of networks for activities such as communication and collaboration. At this age they are also expected to begin using search engines. Given that students in Key Stage 1 are learning how to "retrieve digital content" – and in the lessons observed during my research, this included using Google and in-website search engines to find content online – it does seem belated to wait until Key Stage 2 to teach about the role of algorithms (rather than truth) in ordering search engine results.

Students at Key Stage 2 are also taught how to select, use, and combine a variety of digital services across different types of devices to "design and create a range of... systems." While the meaning of this is not immediately clear, it could be presumed to mean that students in Years 3-6 will learn how to navigate the Internet and other networked devices using different proprietary products (e.g. Google Search).

4.4.4. Computing and "computing"

The Association for Computing Machinery (ACM), Association for Information Systems (AIS), and IEEE Computer Society (IEEE-CS) define computing in the following way:

> In a general way, we can define computing to mean any goal-oriented activity requiring, benefiting from, or creating computers. Thus, computing includes designing and building hardware and software systems for a wide range of purposes; processing, structuring, and managing various kinds of information; doing scientific studies using computers; making computer systems behave intelligently; creating and using communications and entertainment media; finding and gathering information relevant to any particular purpose, and so on. The list is virtually endless, and the possibilities are vast (Shackelford et al., 2006, p. 9).

These three organisations also define computing as consisting of five major disciplines:

Table 6. The five computing disciplines[28].

Discipline	***Definition***
Computer engineering	"...concerned with the design and construction of computers and computer-based systems. It involves the study of hardware, software, communications, and the interaction among them. Its curriculum focuses on the theories, principles, and practices of traditional electrical engineering and mathematics and applies them to the problems of designing computers and computer-based devices. "
Computer science	"We can think of the work of computer scientists as falling into three categories. • They design and implement software... • They devise new ways to use computers... • They develop effective ways to solve computing problems... Their theoretical background allows them to determine the best performance possible, and their study of algorithms helps them to develop new approaches that provide better performance."
Information systems	"This discipline's perspective on information technology emphasizes information, and views technology as an instrument for generating, processing, and distributing information... [S]uch professionals require a sound understanding of organizational principles and practices so that they can serve as an effective bridge between the technical and management communities within an organization, enabling them to work in harmony to ensure that the organization has the information and the systems it needs to support its operations."
Information technology	"In the previous section, we said that Information Systems focuses on the information aspects of information technology. Information Technology is the complement of that perspective: its emphasis is on the technology itself more than on the information it conveys... These systems must work properly, be secure, and upgraded, maintained, and replaced as appropriate."
Software engineering	"Software engineering is the discipline of developing and maintaining software systems that behave reliably and efficiently, are affordable to develop and maintain, and satisfy all the requirements that customers have defined for them... Software engineering students learn more about software reliability and maintenance and focus more on techniques for developing and maintaining software that is correct from its inception [compared to computer science students]..."

[28] Adapted from Shackelford et al. (2006, pp. 13-15).

Using these definitions, the National Curriculum computing programme of study does appear to provide an appropriate preparation for further study or work in at least some of the computing disciplines. If educating children age 5-11 years in the subject of computer science in particular is truly a national priority for England, then this curriculum on its face appears to be appropriate; that is, if the curriculum is implemented with high fidelity by knowledgeable teachers with access to the appropriate facilities and tools necessary to teach it.

4.4.4.1. The old ICT curriculum

The ICT curriculum (Appendix J) that computing replaced had a number of elements that do not appear in the new, computing programme of study, nor have these elements been moved into any other subjects' programmes of study. It is important to examine what a policy omits as much as what it contains, for policy "is tied to ideology not so much by what it says as by what it does not say. It is in the significant *silence* of a text, in its gaps and absences, that the presence of ideology can be most positively felt" (Eagleton, 1976, p. 34). This missing content falls into four different categories:

4.4.4.1a. Finding things out

For Key Stage 1, this included gathering information from different sources (for example databases, videos, and people), data entry and storage, and data retrieval. At Key Stage 2, students were taught how to figure out what information they needed for a task, how to find it, and then how to use it. They also studied how to process information (e.g. sourcing it, classifying it, and checking it for accuracy) before interpreting it, which included checking the information's relevance to their task. While the new computing

curriculum does cover the creation and collection, storage, manipulation, and use of digital content for a specific task, it does not address these issues of information and media literacy in as much explicit detail.

4.4.4.1b. Developing ideas and making things happen

In this section of the ICT curriculum, teachers were instructed to teach students how to bring together different types of materials (e.g. texts, tables, images, sound) to "develop and refine ideas." These types of tasks are much more vague in the computing curriculum, with students expected to use a "variety" of hardware and software to "design and create a range of programs, systems and content that accomplish given goals." ICT had also addressed the use of simulations to experiment and explore, two types of learning activities that are not covered at all in the computing actual policy. Lastly, this section covered planning and giving instructions (i.e. creating algorithms), with offline computing ("placing instructions in the right order") and the programming of robots given as example activities; first included in Key Stage 1, this clearly meets the aims of computing and has been carried over from ICT to the computing curriculum.

4.4.4.1c. Exchanging and sharing information

The old ICT curriculum was often criticised (or, at the very least, its policy-in-practice state was criticised) for reducing a broad subject into the use of PowerPoint presentations for other subjects and nothing more. Those activities likely came from this section, in which teachers were instructed to teach students how to use technology to "share and exchange information in a variety of forms" and to "present their completed work effectively (for example, for public display]." However, this section of the

curriculum also called for Key Stage 2 students to be taught to consider the needs of their audience, as well as to consider the content and quality of the information that they shared. Mentioned in passing in the computing programme as "evaluating and presenting data and information," these information literacy skills had more space and detail devoted to them in the ICT curriculum. It will be interesting to see how teachers interpret this abbreviated content in their implementation of the computing curriculum.

4.4.4.1d. Reviewing, modifying, and evaluating work as it progresses

Relevant across all subjects, this section of the ICT curriculum addressed students double-checking their work in order to develop new ideas, consider their work's impact, and to discuss possible changes they would make in the future. At Key Stage 2 this was applied more explicitly to ICT, as students were asked to consider whether they had chosen the most appropriate technology for their task, and to consider what effect those choices and their work had on other people. While computing does cover the inputs and outputs of computer programmes, and issues of safe and respectful behaviour, it does not so clearly address the impact that students' use of ICT can have on other people. This seems especially problematic when it comes to issues of cyberbullying and misinformation, both of which take place on social media platforms used readily by young children (regardless of supposed minimum age requirements).

4.4.4.1e. ICT breadth of study and cross-curricular implications

Across both Key Stages, students were expected to use and learn about a variety of digital devices in ICT lessons, to work with a wide range of information in different formats, and to learn about the uses of ICT both inside and outside of school. Key Stage 2

students were also expected to collaborate with others while exploring information sources and ICT tools, a way of working not addressed by computing (which could, in theory, be taught solely through solo activities).

The old ICT curriculum noted several overlaps between ICT and other subjects, particularly skills and knowledges shared with English and mathematics. This, unfortunately, has not continued on in the formatting of the overhauled National Curriculum, with no cross-curricular content noted in computing and no mention of technology (beyond the use of calculators starting at the end of Key Stage 2) in the programmes of study for English and mathematics. Despite how much the ICT curriculum was publicly disparaged for its reduction to the mere use of ICTs in other subject lessons, the ability to use a wide variety of ICTs outside of "doing" computer science does have clear uses for both future educational and workplace settings. Whether the reduction of the importance of becoming familiar with ICTs in the computing curriculum has had a negative impact on school leavers' digital skills and knowledges (one of the reasons given for removal the ICT curriculum) needs to be evaluated.

4.4.4.1f. ICT attainment target levels

Another structural attribute unique to the former National Curriculum was the outlining of levels for subject target attainment, ranging from Level 1-8, topped by a category of "exceptional performance" for each subject. The lower levels of ICT were focused on using digital tools to work with content (e.g. media, data) while higher levels engaged more critically with ICT and increasingly focused on "the social, economic, political, legal, ethical and moral issues raised by ICT." While the computing curriculum does address

safe, respectful, and responsible use of technology, it does not address these wider issues of impact or influence, nor does it delineate what different levels of achievement in computing might look like. Given that the new computing curriculum is also not addressed by national testing or school inspections, there is no clear rubric for implementing computing that teachers can measure their students' performance against. How are teachers to know if their class is truly "getting it?"

4.4.5. Important skills, gained and lost

The government has been clear throughout the development of the computing curriculum that they wanted the updated National Curriculum to no longer tell teachers how to teach, but instead solely to define the subject(s) that teachers are required to teach about (Bacon, 2014, p. 63):

> When the curriculum was being developed, DfE were very clear that it should define only what a school subject discipline is, and it should not include anything about how it should be taught; that is, it should be seen as a technical specification of the essential subject knowledge that defines what a discipline is.

Therefore, it is not unreasonable to take the new computing curriculum as clear signposting of the government's definition of computing and (given its replacement, wholesale, of the ICT curriculum) what digital-related skills and knowledges young people need in general.

With this in mind, the move from ICT to computing truly is a "fundamental shift" in what the government says students should be taught about digital technologies (Younie & Bradshaw, 2016). The phrasing of the computing curriculum makes it clear that the

principles of computer science should be the main focus of students' digital education from primary school onwards. This is further supported by statements made by the DfE that they consider computer science to now be "the fourth science alongside physics, chemistry and biology" (Runciman, 2016, p. 18).

The omission of several elements of the ICT curriculum, such as more nuanced approaches to teaching media and information literacy, and the integration of ICTs into other subjects, signals that these skills and knowledges are no longer considered a priority by the British government. This may prove to be problematic as experts call for an increase in broad digital literacy skills, not limited to computer science but also addressing the social implications of technology, which is needed "alongside reading, writing and mathematics as the fourth pillar of a child's education" (House of Lords Select Committee on Communications, 2017, p. 3) in a knowledge society.

Additionally, the removal of most of the digital skills and knowledges which primary school teachers had become accustomed to teaching through the ICT curriculum – as well as the addition of specialist computer science skills which teachers will not have received training in (unless their school pre-emptively found and provided an appropriate CPD course, paid for out of the school's regular operations budget as no additional funding was provided to implement the new curriculum) – then teachers are being asked to neglect material that they had previously been told was valuable in favour of material that they may very well be grossly unfamiliar with. This major shift in government-signalled values will require not only a shift in lesson content, but also in teachers' professional beliefs and practices.

The actual policy for computing education in England is well-aligned to the industry standard definition of computer science and in that sense it is well-designed to meet the beliefs of policymakers and members of industry that there is a desperate need for more computer scientists in the UK. However, it does not cover a number of interesting and potentially significant skills and issues around digital technology which were addressed in the former ICT curriculum, nor does it address digital issues with as much depth or complexity (Kemp et al., 2018; The Royal Society, 2017). Given that the content lost during the transition from ICT to computing has not been picked up in other areas of the National Curriculum, this change in actual policy is indeed a wholesale shift in the government's educational goals and focus (Department for Education & Gove, 2014; John, 2012b).

4.5. Conclusion

Computing has, in retrospect, been promoted as a subject added to England's National Curriculum with the intention of providing young people with the skills, knowledges, and ways of thinking necessary to participate fully in an increasingly digitalised world, as citizens as well as potential tech entrepreneurs and computer scientists (N. C. C. Brown, Sentance, Crick, & Humphreys, 2014). However, further research into the voices not represented by this publicly-aimed narrative tell another story. In this story, computing was added to the curriculum to appease the needs and desires of a tech industry wishing to develop both a market for their products and a future workforce; politicians looking to boost the economic prestige of their country and to leave a positive legacy of their time in office; and a nostalgic public that currently supports pro-business, pro-economy political messages through their votes.

Dr Vanessa Pittard said at the 2012 Westminster Education Forum: "The central government is not best placed to define what skills pupils need to acquire. The world is moving fast, the technology is moving even faster, hence the proposal to disapply the existing ICT curriculum" (Smolaks, 2012). Clearly, the British government was happy to abdicate its role to what it saw as a more natural leader in the tech industry, in hopes of appealing to their electorate (and possibly their allies in business) by letting market forces shape public (i.e. state-funded) education.

However, what was not accounted for by government officials and others during the intended and actual policy phases of this curriculum was whether there might be a mismatch between the values reflected in the new programme of study and the professional beliefs and practices of classroom teachers, as well as the experiences and understandings of students. While teachers at state-maintained schools are required to follow the National Curriculum[29], such a clash is bound to influence how teachers create policy-in-practice in their schools.

Whilst the DfE, by design, did give schools room to make decisions regarding how to teach computing, the Department did this with both the intended and actual policy in mind. Schools and most teachers were not privy to the process that the programme of study had gone through during its development and no school teachers were involved in its final revision. What had been broadcast to schools was the final policy wording, as well as pro-technology messages from policymakers and private industry; if teachers do

[29] A growing number of state-funded schools are not required to follow the National Curriculum, such as those that have free school or academy status. Private schools are also not required to abide by the National Curriculum.

not support the actual policy (and these official signals from the DfE and others are unlikely to broadcast earlier, intended versions of the policy which teachers might find more palatable), then teachers may reject the subject outright.

5. Findings: “policy-in-practice”

This chapter presents findings from the empirical data collected in four state-maintained primary school classrooms. Data from teacher interviews, student interviews, and writing and drawings produced by students for this study was used to illuminate “policy-in-practice”: that is, the computing education policy as it is experienced and engaged with by schools and families. Using ethnographic methods, I will first identify how students understand and are disposed towards digital technology, and how both their home- and school-based exposure to technology and computing concepts have shaped those understandings and dispositions. Next, I will elucidate the internal factors and external forces that influence teachers’ translation of the computing education policy into practice (Sentance & Waite, 2018). Finally, I will discuss the dissonance between England’s intended computing education policy, actual policy, and policy-in-use, and the reasons for the tensions between these three policy states.

5.1. Positive disposition

The student interviews and student writing and drawing exercises revealed that children have a largely positive but limited understanding of what digital technology is and what it can be used for. Across both schools and all four classrooms, students said they liked these technologies for two primary reasons:

1) Digital technology is entertaining:

> *"It is fun and you can play different games on it and there is new games and you can play with your friends... And you can talk to them via typing and stuff*" (School 2, Year 3, child interview, Hugh)[30].

> *"I enjoy those ones [Xbox games] because they are fun and they are just fun"* (School 2, Year 2, child interview, Cecilia).

2) Digital technology (or digital content) is educational:

> "*You can watch things that you might not even know [on a tablet]. It has only got facts and stuff on it. It has got some games but it also helps you learn more things*" (School 2, Year 2, child interview, Jill).

> *"I like it because today... my brother said it was the ninth, I said it was the eighth, and I checked on my iPad and it was the ninth"* (School 1, Year 2/3, child interview, Elizabeth)[31].

A device's entertainment value was generally linked to its ability to be used to play games or watch video, but some children also enjoyed reading text (including books), listening to music (on Spotify or YouTube), creating presentations (e.g. using Microsoft PowerPoint), creating art, and taking digital photographs. Devices (or content) were identified as educational for various reasons, including its ability to answer questions (e.g. the example above using a tablet's digital calendar) and the provision of explicitly educational material (e.g. clips of the children's television programme *Horrible Histories*).

The students interviewed also identified some digital content as educational based on comments made by the adults in their lives, such as in the case of a child-friendly gaming website visited frequently by students across all year groups (besides Reception) in

[30] Verbatim speech written down in field notes (as opposed to being captured by audio recording) is italicised.
[31] A brother and sister disagreed regarding the current date so the sister, Elizabeth, looked up the date on her home tablet.

School 2. This website's name and URL suggested that the Flash-based games it hosted offered instruction and practice in mathematical concepts. However, the game played most often by students was a classic side-scroller game (i.e. like an early Mario Bros. console game) with no mathematics or other educational content whatsoever. Students at School 2 accessed this specific game more than any other website or application when allowed free-time on the school desktop computers and students in Year 3 played this game repeatedly for the duration of their twice-weekly computing (still called "ICT") lessons.

When asked how the game was educational, students would repeat jumbled snippets of explanation given to them by their teachers and other adults, such as, "[it] makes your brain like react to things" (School 2, Year 3, child interview, Flora). Students also repeated these claims at home, often in an attempt to persuade their parents to allow them more frequent access to family-owned digital devices: "...this morning I asked my dad if he had Google and I showed him this game what is on Google, it's called [maths games website], and I know, I am pretty sure I am going to go on the computer more often [now]" (School 2, Year 3, child interview, Rachel). However, student reports suggest these parroted narratives had minimal influence over parents' and guardians' control of their home use of digital technology, which will be elaborated upon in coming sections.

5.2. Constrained use at home

Students bring their home experiences with them into the classroom, so it is important to see what influence these have had on their understanding and dispositions toward digital technology. Students reported that the adults in their lives (and particularly at home) had

concerns around the potential dangers of online content and contact with strangers, the physical and psychological risks of extended screen time, and the prioritization of other activities (e.g. outdoor and social play, other academic subjects) over technology-use.

One boy said that his father would limit how long he could use digital technology at home because he thinks he is spending too much time on it; in his defence, the boy argued to me, “but I do read and go in the garden a lot.” His impression of why he is not supposed to spend too much time on digital devices is because “it just doesn’t really help my brain too much,” as presumably an offline pursuit could or would (School 2, Year 3, child interview & interview notes, Teddy). Another boy was given a set amount of time to use any digital devices at home but was allowed to split that time over multiple devices. He said he would usually spend an hour on the family laptop or, instead, a half hour on the laptop and a half hour on his Xbox (School 2, Year 4, child interview notes, Kellen).

Many students wanted access to devices that they were aware of but that their family did not own; for example, one girl said she wanted an iPad like her cousin had because she enjoyed using its touch screen, but her mother would always repeat, “when you are older” if she asked for one (School 1, Year 2/3, child interview & interview notes, Rudrani).

5.2.1. Limited range of devices

The use of technology at home was reported to be heavily constrained by adults and older children, namely parents but also grandparents, aunts and uncles, and older siblings. At home, children have to share digital hardware with parents who use it for

work or social communication, and siblings who use it for entertainment and schoolwork. Most children across all classrooms reported having to ask permission to access particular content or use particular devices, and some had to request permission before each and every use. Families often set limits on the frequency and length of use of a device, often reducing these allowances on schooldays or when sufficient homework had not yet been completed.

These concerns translated into exposure to an unexceptional range of popular consumer products at home, as well as a similarly limited range of technologies at school. Devices that students were allowed access to at school[32] included desktop computers, laptops (and smaller, simpler netbooks), and tablets. Use of these devices was largely restricted to assigned academic activities and free-play was rarely allowed, with off-task use of computing devices punished even if the use was age-appropriate and requiring more advanced skills than the current lesson asked for. All in all, students were exposed to a limited range of devices for a limited range of uses and with short periods of exposure:

> *Home tablet*: Usually iPads, occasionally belonging to the child or a sibling, also sometimes primarily used by a parent:
>
> *School tablet*: Every classroom in School 2 had a class set, which was heavily used in Year 2, occasionally used in Year 4, and never used in Year 3. School 1's Year

[32] Schools also owned other devices which were either controlled or exclusively used by teachers [e.g. interactive whiteboards (IWBs)].

2/3 teacher occasionally brought out two or three tablets to be used by individuals to practice their multiplication tables using an app.

Smartphone: These were rarely used by children at home and never at school. In the rare case of a student being allowed to use a smartphone, their parents would first remove the phone's SIM card and disable its ability to connect to Wi-Fi [e.g. for fear of them accessing "adult" games (School 2, Year 3, child interview notes, Wallace)], meaning it could not send or receive messages, or connect to the Internet. Texting or messaging was not allowed, except in one case where the child was instructed to text a family member by her parent while they were driving. Only one child (from School 2, Year 3) owned their own smartphone.

> Smartphones were sometimes used by adults to assist students with their homework. During a Topic lesson, the class watch some of the videos (on the IWB) that their peers have made about famous individuals. The videos appear to be filmed by a parent (vertically) on a smartphone at home (School 1, Year 2/3, 19.09.2016 observation field notes).

Home laptop or desktop computer: This usually belonged to a parent, though occasionally it was owned by a significantly older sibling. These devices usually required more sharing within the family than tablets and students were more likely to be required to gain parental or sibling permission before each use:

> One girl says that, "*Daddy bookmarks them [websites], so, there is one for CBeebies games for [her sister], one for Mathletics for me and one for Scratch for me*." She is only allowed to go on the websites that her father has bookmarked on their laptop, and only watch videos that he has watched first. She is also only allowed to go on it in the morning before school (School 1, Year 2/3, child interview & interview notes, Flora).

> Another girl plays games and watches videos on her sister's computer, but first she has to get her parents' permission regarding the content she wants to access and get her sister's permission to use the laptop; she always has to use it with her sister present (School 1, Year 2/3, child interview notes, Rudrani).

School laptop or desktop computer: School 1 had one class set of netbooks which the Year 2/3 classroom would sometimes use for computing lessons; the class also had three desktop computers that the teacher would rotate students through daily to use a gamified maths desktop application. School 2 had a computer room which was used by Year 2 and 4 for programming in Scratch and creating presentations in PowerPoint, and by Year 3 for online free-play during ICT lessons.

Television: Used at home only, this was many children's favourite piece of technology. Some had access to non-traditional content (e.g. on-demand educational videos with built-in quizzes). It was more common for children to use a television unsupervised compared to devices that could connect to the Internet.

As for software and other digital programmes, students were rarely allowed to access information (e.g. YouTube or Google) freely without supervision. There were limits placed on the number of games and other apps children were allowed to download (or that the parent would download for them) and a limited range of online programmes were assigned by teachers for homework. Even when a child did have access to a device or programme, they were only allowed to use it for particular purposes, such as searching for specific information for a homework project.

Students are exposed to a limited number of uses of digital technology and rarely allowed the sort of free play (or given the skilful training) needed to use it in agentic ways (Anderson, 2008; Popat & Starkey, 2019; Webb et al., 2018; Wing, 2006). The students interviewed reported that the adults in their homes placed these restrictions in part due to concerns about their child's safety, as well as the physical, psychological, and academic impact of screen time, and a belief in the priority of non-digital activities such as outdoor play and homework. These reasonings demonstrate that narratives around the power and eminence of digital technologies have not penetrated the home in many communities. Instead, the local dispositif of the home maintains more established power relationships and structures between and around adults and minors, and it values safety, traditional forms of academic achievement, and offline activities for children.

5.2.2. Limited range of uses

Students were not only exposed to a limited number of devices, but also a limited range of uses of digital technology. Many of the devices they saw in the home or the classroom were used solely or predominantly by adults (e.g. for work or teaching), and the ways in which they were allowed to use devices themselves was typically tightly constrained.

Beyond one student commenting that "you might hear of someone being sick and then you might go on the computer and get, like, the right medicine" (School 2, Year 2, child interview, Nikolai), the other students' understandings of what technology could be used for was largely limited to how they had been allowed to use it themselves, rather than any other potential uses inside or outside of the classroom:

Playing games: This was mostly done solo when on a desktop, laptop, or tablet computer, but would occasionally be multiplayer with friends or family members while playing on a gaming console (e.g. a PlayStation). Only three students said they played multiplayer games online with strangers (all on a website called Roblox), which may have only been possible as their parents were not aware that they were playing against and communicating with strangers through in-game text chat.

Sourcing information: It was not uncommon for students to use Internet search engines (namely Google) as a dictionary, clock, calendar, or encyclopaedia, looking up information such as the definition of words. Students also used the Internet (either through Google or a specific child-friendly website assigned by the teacher or a parent) to research topics for schoolwork, look up photos (e.g. of favourite animals), watch educational videos, or investigate a personal interest (e.g. gardening). However, engagement with this information was non-critical, i.e. students accepted the information they came across online as true. This was the case both for websites recommended by a trusted adult and those that appeared as top results on the Google search engine.

> One girl, when using the family tablet, doesn't search for things on her own but does it with her mother's help: "*My mom [is there] to help me just in case I go on something rude*" (School 2, Year 3, child interview & interview notes, Sarah).
>
> During their science lesson, students are instructed to pick an animal to classify (e.g. mammal, reptile, bird, etc.). They work in pairs, using the class tablets to find info on their animal. They are Googling images and questions (e.g. "*Do bats have fingers?*" "*Is a camel an herbivore?*" "*How much does a crab weigh?*"). All natural language searching, not key words

> (and certainly not Boolean!), but isn't this what modern search algorithms were built for, natural language processing? Key word searches seem dated and natural language is more likely to find your question being asked by others before you; in other words, the tech has been adapted to meet the natural inclinations of users (including children), which means some older, classically taught tech skills like Boolean search have become obsolete (School 2, Year 4, 17.05.2017 observation field notes).

Entertainment: This usually consisted of watching videos (one-off videos, television programmes, or films) on YouTube or Netflix, but also included listening to music (typically on YouTube), watching films and television programmes on a television set (both smart TVs and more traditional, non-smart TVs), the use of online Advent calendars around Christmas, and looking for images of their home on Google Street View. One student even said that watching videos of football online would make him want to get off the computer to play football outside.

> One girl likes to play games and watch full-length films on her iPad and will occasionally watch them with her older brother, but usually just by herself. However, she doesn't like watching shorter videos on YouTube, as "*they post inappropriate things that people can see*" (School 2, Year 4, child interview & interview notes, Caroline).

Capturing moments: A handful of students were allowed to take photos or videos when given access a family smartphone or tablet. However, they did not have the permission or know-how necessary to send or share these images online or outside of their immediate family.

Reading: Some students read using tablets or e-readers, but most preferred to read longer texts (e.g. books) offline. Reasons given included that they enjoyed flipping through the book's pages, that (as ESL students) they found it easier to

stop and look up unknown words, that text on a computer screen was too small to read comfortably, and that they believed that looking at a screen for too long strains your eyes, e.g. they did not want to spend too much time reading online material "...so I don't, like, get square eyes" (School 2, Year 3, child interview, Frank).

Art: Students were sometimes asked to produce a creative piece digitally in class (e.g. an illustrated poster for the school fête). While some students liked how clean the erase function was when drawing digitally, most preferred to work with non-digital media, either because they found traditional art tools easier to manipulate than a mouse or trackpad, or because they enjoyed the physical act of using non-digital materials.

Homework: Students in some classes were assigned homework on gamified educational websites that the school had a subscription to, while others were assigned research activities that could be completed either online or with access to a library or encyclopaedia. However, most homework was paper-based and, while students said they found their online homework to generally be more fun (i.e. game-like), they preferred offline work as their teacher could more easily go over the assignment in front of the class before sending it home with them to complete.

> The rules one girl has to follow when using the family laptop are: "*You are mostly allowed to use it on the weekends. If you have to use it on the weekdays it is mostly for school work, you have to use it on school days for*

> *school work*" (School 1, Year 2/3, child interview & interview notes, Roshita).
>
> When asked what she does on the home desktop computer, one girl says: "*I only do one thing because my mom doesn't let me do loads. The only thing we do is go on [maths homework website]... You play math things. Some of them [are] maths, but fun, some of them are just normal games*" (School 2, Year 2, child interview & interview notes, Georgie).

Roleplaying: One student said she used PowerPoint at home to prepare presentations to use when pretending to be a teacher during play. No other students mentioned roleplaying as a motivation for using technology.

Communication: This is a use that students are familiar with, but their own use is quite limited. Two boys mentioned that they liked virtual assistants such as Apple's Siri and Amazon's Alexa because they are "as smart as the Internet" (School 2, Year 4, child interview, Reese) and have unique personalities, e.g. Siri is "sillier" than Alexa (School 2, Year 3, child interview, Wallace). A Year 4 girl kept in touch with friends and family abroad through the text chat and video call features of Skype. The only child with their own smartphone (School 2, Year 3, Flora) used WhatsApp, Snapchat, and WeChat when possible, but was overall very rarely allowed to use her phone at all.

> One boy's older sister can use a messenger app on the family computer (and she does this a lot), but he can only use it for homework (i.e. an online maths homework website) (School 2, Year 2, child interview notes, Nikolai).

"Off-limit" uses: The students were aware of other uses of tech (e.g. Snapchat, messenger apps, downloading "adult games," accessing "rubbish" content or

other “inappropriate things,” and talking to strangers), either due to seeing older siblings participate in these activities or by being warned by adults against then. Most students dutifully avoided off-limit uses, with the exception of three boys (mentioned previously in *Playing games*) who used gaming website Roblox, which allows users to text chat one another. Two of the boys said that other users used bad language in the text chat, but that they either ignored it or, in the case of one boy, they would chastise the offending user, e.g. “Why are you saying the F-word, the A-word?” (School 2, Year 3, child interview, Mustafa). Two boys also said that they used technology to watch “scary” television or film; however, the one example given (2015’s *Goosebumps*) was not grossly age inappropriate so this may not actually be an example of an unpermitted form of use.

> One boy will “*beg*” his parents to let him search for things on Google or watch videos on YouTube using their shared work laptop, but they both say no: “*My dad says [YouTube], it’s full of rubbish. Some things in there are full of rubbish*” (School 2, Year 4, child interview & interview notes, Sam).

It is clear that students were not “talking about” and “investigating and comparing the uses of ICT inside and outside school” like they once had been required to when the old ICT curriculum was in force. The lack of a basic familiarity with other potential uses for technology – such as those in school (e.g. for science lessons, using HTML to contribute to the school website), home (e.g. more sophisticated uses of home computers, such as for finding reputable information on a search engine; the fact that many home appliances contain a computer), and the workplace (e.g. computer game design, medicine, manufacturing, the office) – suggest that these uses (not necessarily the mechanics of their use, but the potential of their use for these purposes) have not been introduced

sufficiently. Because of this, children are first and foremost missing out on the opportunity to become familiar with the ubiquity of digital technology in their lives, which is the first step they are required to take before they can be expected to successfully and healthily engage with it, let alone build or modify it.

5.3. Constrained use at school

Given that all of the teachers observed had been teaching the new computing curriculum for three years (including the year of this study), and the participating students would have had two-to-three years exposure to the curriculum in previous classes, this narrow appreciation for technology is perhaps surprising. It would not be unreasonable to expect students – especially those in Years 3 and 4 – to value the utility of digital technology and appreciate some of the potential applications of computing skills and knowledges across a variety of devices and contexts given the pro-technology message behind the new curriculum.

Schools as well have been subjected to a more consistent and sustained narrative around the importance of technology and the subsequent need to provide an education in its design and use, compared to those messages directed at families. However, the use of technology observed in participating classrooms and mentioned by teachers and students in their interviews demonstrates that in-school use of digital devices is seriously constrained as well. Students, coming to school with a limited baseline understanding of digital technology, then continued to receive limited exposure to its potential uses at school.

In order "to understand why the enacted curriculum is so slow to change, we must [first] gain a better understanding of the reasoning of teachers and the circumstances surrounding their choices" (Gehrke et al., 1992, p. 101); that is, how and why teachers are translating the actual computing education policy into such an unexpected policy-in-practice.

5.3.1. Limited access to resources

Schools have limited and shrinking budgets (Perera, Andrews, & Sellen, 2017; The Comptroller and Auditor General of the National Audit Office, 2016, 2017), and with no additional funding given to schools by the government to support the introduction of the computing programme of study (John, 2013, 2015; Norrish, 2013a, 2013b), school finances have played a role in the range and quality of devices that teachers can integrate into their lessons.

Teachers and school administrators have been compelled to either fundraise from students' families (where possible) or make do with what equipment they already have to hand. Both participating school sites had raised significant sums through their parent-teacher association by the start of this study, raising enough to buy one class set of netbooks in School 1 and near one-to-one tablets for all students in School 2. These schools also continued to use legacy equipment, with School 1's Year 2/3 teacher assigning students to the classroom's desktop and two significantly older laptop computers for supplementary maths activities, and all year groups in School 2 making use of the school computer room for activities that required the use of a mouse and keyboard. Both schools also owned child-friendly programmable robots (i.e. at least two

Bee-Bots in School 1 and three Roamers in School 2) but were limited by the quantity and quality (e.g. School 2's robots had an extremely short battery life) of these older, oftentimes expensive[33] resources.

As is commonly seen across the literature on the integration of technology into schools, teachers and students frequently encountered technical and logistical challenges:

> During maths, the teacher leads the class in playing Place the Penguin on the IWB. When she first starts it, the game doesn't work because the board needs to be recalibrated (it is usually used solely as a projection screen; quite likely the board was moved a bit at some point since the last calibration as it's on a stand with wheels). She has to recalibrate the board as the class waits. She then explains the game and has students come up to drag the numbers to the correct place (i.e. units, tens, or hundreds), with Year 2 students assigned 2-digit number problems and Year 3 3-digit problems... The IWB game is no different from a [non-digital] whiteboard game and it was simply a group introduction to paper maths worksheets (School 1, Year 2/3, 09.09.2016 observation field notes).

This has been exacerbated by cuts to staff funding, with School 2 only able to afford an IT specialist to service all of their devices (including technologies such as projectors, intranet, and the digital school register) for two-and-a-half days a year. Technical problems often led to delays in starting lessons as the teacher could not leave a student out of an activity with a non-functional device and there were not never enough extra functional devices to replace those that had malfunctioned. Negotiating the use of shared devices often meant that planned computing lessons were delayed while another teacher used the devices in their classroom. Issues of space also came up in observations, with School 2's computing room becoming inaccessible without announcement for a one-

[33] The Roamer retails at £109 plus the cost of accessories (e.g. batteries, etc.); one Bee-Bot costs £59, plus accessories. The head of computing in School 2 said she wished she could buy more complex robots, such as the Lego Mindstorms kit (starting at £270), but that the school could not afford them.

week period as the extra room was needed for the Year 6 Sats, resulting in the Year 2 teacher having to cancel a week-long set of lessons on computer programming that required the use of desktop computers.

Free time outside of outdoor breaks and a weekly "Golden Hour" period is rare in primary schools and so there were limited opportunities for the children to use technology outside of their lessons. Three out of the four teachers were observed using digital technology while teaching lessons in other subject areas (e.g. reading about the Great Fire of London on an educational tablet app); two taught programming; two taught robotics; and only one explicitly taught computational thinking and offline programming. Most of these lessons were one-off (i.e. did not build conceptually off of previous lessons) or involved working on the same project infrequently over a long period of time, with students' prior work sometimes lost in between sessions.

5.3.2. Frequency of computing lessons

All of the observed classrooms integrated ICT into other subject lessons and had distinct, self-identified ICT lessons (e.g. a lesson on using a word processor). Computing lessons, alternatively, occurred much less frequently. Next is an accounting of lessons incorporating the skills and knowledges covered by the National Curriculum computing programme of study that I observed during classroom visits.

School 1

Year 2/3: Of 26 full days observed, computing lessons only took place on two days: one offline lesson about e-safety and one small-group robotics lesson (Figure 3) led by a teaching assistant.

School 2

Year 2: Five out of the eight days observed included a computing lesson. Two of these were offline lessons on computational thinking and algorithms, two were on programming floor robots, and one involved the use of Scratch in pairs to develop a basic video game using written instructions.

Year 3: No content from the computing programme of study was covered during the seven days spent in this classroom.

Year 4: One of the eight days observed contained a computing lesson, in which Scratch was used by the students to plan and build a short science quiz using skip logic.

Figure 3. Robotics for beginners: a vignette.

School 1, Year 2/3, 29th September 2016

Today, the teacher has asked the TA to lead a robotics lesson with the Year 2 students. This group heads to an empty neighbouring classroom, where the TA reviews "left" and "right" with the students, with a particular emphasis on how what direction you're pointing left or right at changes depending on your body's orientation. They also practice making "quarter" (90°) turns.

The students struggle with turning left and right, but the instruction from the TA is also a bit confusing and authoritative (TA: "What did I say to do?!") rather than explanatory or conciliatory.

The TA takes out a single Bee Bot from a box holding a class set (there was also a second box sitting in the corner of the main classroom this morning). Ben: "I remember this at [Year 1] class." Allan: "It's so hard." The group is told to start by planning and executing step-by-step instructions in order for the bot to navigate a paper grid maze laid out on the floor. This is done by counting the number of squares in a stretch of the maze, how many quarter turns and in which direction to turn a corner, and so on, all documented by the students on small whiteboards.

The students read out the newly planned set of directions to the TA as she programmes them into the BeeBot using the buttons on its back. However, the size of the maze's squares is significantly smaller than the "steps" the BeeBot takes, resulting in a single move forward by the bot covering close to three squares. This makes it incredibly difficult to demonstrate what they are supposed to be learning, as the students believed (based on the use of this particular maze and the TA's instructions) that one maze square correlated to one bot step.

Some students – Rudrani in particular – suggest an alternative approach of programming in the number of steps necessary to navigate the map rather than the same number of steps as the number of squares. The TA initially won't agree to this as she is not convinced that this is how the activity is supposed to work. She eventually agrees, but as they try the new method, the BeeBot doesn't appear to be following their new directions at all. After a few failed attempts, I step in to quietly explain to the TA that you need to clear the programmed steps between runs, otherwise the new commands are simply added to the end of the list of old commands.

TA: "I'm learning today and I'm an adult." Girl: "And you're being taught by children!" TA: "I know, it goes both ways."

The students seem to be picking this up faster than the TA and have attempted a bit of troubleshooting, but these attempts (when noticed) are squashed by the TA's inflexibility regarding the task (e.g. matching moves to squares is the task so we'll do that even though the result is confusing and the ultimate task [i.e. navigating the maze successfully] isn't accomplished by it).

They find a bigger grid maze with appropriately sized squares in the activity box and begin planning out instructions again. The students take turns saying what the next move should be and then programming it into the bot. This is largely better, but sometimes the students make minor errors which the other students are documenting in their code lists and the TA isn't correcting so ultimately, when they plug the whole code into the bot, it isn't able to complete the maze. The TA doesn't quite seem to grasp how important precision is in coding. To be fair, she is also still figuring out how to programme the bot herself, let alone knowing how to make it navigate a maze.

After about thirty minutes, the lesson is over, and they join the Year 3 students in the main classroom for a maths lesson.

Computing lessons were also often limited in scope, with the exception of School 2's Year 2 teacher (also the school's head of computing) who taught a variety of lessons on computer programming, robotics, offline computing, and ICT. Given the infrequency of computing lessons, the same devices were often used for the same task over the course of several weeks and months (e.g. building a game in Scratch using the school's computer room). In School 2's Year 3 class, the only time technology was used by students was during a weekly ICT lesson in which they were allowed to play a variety of online, child-friendly games, most of which contained no educational content. Students sometimes expressed boredom at this repetition and teachers expressed a wish for more resources or time to delve more deeply into technology-based activities for more sustained periods of time. Ultimately though, there were limiting factors that impacted how technology could be incorporated into lessons, and even more significant justifications for why the computing curriculum was deprioritised, which will be explored later on in this chapter.

5.3.3. Computing clubs

Both schools, either in the past (School 2) or at the time of this study (School 1) offered optional, extracurricular exposure to the concepts covered by the computing curriculum. Only one student, previously enrolled in School 2's now-defunct computing club, mentioned a component of the new computing curriculum (i.e. computer programming) unprompted in her interview. Other students – when prompted to share their feelings towards computing lessons and specifically toward programming, robotics, computational thinking, and offline computing activities – generally responded positively. However, none of the students identified computing as their favourite class; some

mentioned that they preferred their ICT lessons to other subjects, but only in School 2's Year 3 classroom, where ICT lessons consisted of free play in the school's computer room.

School 1 offered an optional lunch-time computing club for the first time during the academic year in which this study took place, which I attended. It was led by the school's head of computing, with assistance from Year 5 and 6 student volunteers. It was held once a week at lunch time (approximately 20-30 minutes in length) and restricted to one year group at a time due to the limited number of netbooks, mentors, and classroom space available, with each year group allowed three-to-four consecutive weeks each. However, the club meetings observed only covered word processing.

School 2 previously held an after-school computing club – run by an external company – which was no longer running at the start of this study. The contract was cancelled due to a significant increase in fees charged to the school, unworkable requests by the provider to access the school's server and IT support technician and increasing repetition of the lessons offered (which one Year 4 student with an interest in computer programming mentioned as a complaint in her interview). However, the head of computing also noted that the presence of the computing club led to a greater disparity in computing ability between students within the same year, which suggests that at least some of the students attending the club did learn from it.

The failure to mention any of the content covered by the new programme of study unprompted raises concerns around the impact that the new curriculum is having on children's awareness and understanding of computing's potential applications, both

within the participating schools and within those schools sharing teachers with similar beliefs and values. ICT-related content and activities was mentioned frequently by students during their interviews, often unprompted as many found playing games on the school computers to be their favourite non-academic activity. The content covered by the computing curriculum, however, was rarely at the forefront of children's minds when discussing the use of digital devices at school and at home, suggesting that it has made less of a positive (or any) impression.

5.3.4. ICT: no substitute

With such a low uptake of the new computing curriculum, it would not be unreasonable to expect the old ICT programme of study to be offered in its place. However, the cause for complaint about ICT had not been rectified by the introduction of computing as no additional resources or training was provided, leaving teachers to squeeze aspects of an under-resourced subject into a busy school week.

At the participating schools, technology was predominantly used by teachers. Every classroom observed had a computer used solely by the teacher and an interactive whiteboard with a projector which all teachers used to display images such as learning objectives and activity instructions, questions or answers to a paper student worksheet, and educational videos:

> The IWB is used as a normal whiteboard (e.g. to display instructions for the morning activity). It's also used to display slides and videos. The classroom has Internet connectivity, with the teacher able to stream a YouTube video for the class (School 1, Year 2/3, 06.09.2016 observation field notes).

> The digital image projector (like an overhead projector, connected to the interactive whiteboard) is used to display students' writing and the teacher uses the interactive whiteboard to mark the work in front of the class (School 2, Year 2, 09.05.2017 observation field notes).
>
> The teacher uses an online number generator to give students numbers to use for a maths problem, which is displayed on the interactive whiteboard. A squat green and orange robot shoots lasers from its eyes to zap five two-digit numbers onto the screen. There is no fundamental difference between this and the teacher making up his own numbers and writing them on the whiteboard by hand (School 2, Year 4, 04.07.2017 observation field notes).

In School 1, the interactive whiteboard was also used regularly to display the class's ClassDojo profile, so that students could see how many house points (added daily based on good behaviour and academic performance) they and their classmates had earned. Students' individual profiles were also visible to parents by logging in to the ClassDojo website at home:

> At the end of the day, students are reminded that they can log on to ClassDojo – used by this teacher previously to record "*stickers*," now to record "*house points*" for the new schoolwide house points system – at home to change their avatar, and that a letter explaining how to do so will be sent home to their parents (School 1, Year 2/3, 05.09.2016 observation field notes).

Teachers almost exclusively controlled these devices when they were being used. On rare occasions, an interactive whiteboard game would be displayed and students would be called upon by the teacher to move an image or select an answer, but it was not uncommon for teachers to instead elicit verbal answers from seated students and then touch the whiteboard themselves. These games were never about technology, but instead about other subject areas (e.g. maths, history).

When students were allowed free use of digital devices in School 2 (this was never observed in School 1), they were limited to accessing a small range of desktop-based educational games and child-friendly websites. While the school-owned software did contain explicitly educational content, the educational content of whitelisted websites (i.e. those marked as appropriate for young children to use at school) varied. The Year 3 teacher in particular relied on one supposedly-educational website's whitelisted status, allowing her students to use it for most of her twice-weekly ICT lessons and during free play. However, the game played by most students in this class (as well as most students in the Year 2 and Year 4 classroom, when they had access to the website) had no educational content whatsoever, despite what was suggested by the website's title and URL.

> This class (Year 3) has ICT twice a week. In today's "ICT" (note: not "computing") lesson, students are allowed to do what they like, it seems. Many go straight to games: [non-educational, supposedly maths-based game website], checkers website, educational desktop computer software, and an online sticker game (like a sticker book, but digital; doesn't appear to be educational). Most end up on the not-maths games site. This is not a computing lesson, it is free play with computers. At most it's a maths or strategy (i.e. chess) games time, unstructured (School 2, Year 3, 09.06.2017 observation field notes).

Both schools maintained websites containing individual class pages that were used to display termly curriculum topics, reports on student work, and photographs of school trips or special events. Parents were the main target for these websites, though the students were aware of them and were encouraged by their teachers to go on them with their parents at home when new photos were uploaded. However, none of the classes had students create content for the school website, or manage or manipulate the site

with newly learned skills (also, no web design skills were taught in the lessons observed, or mentioned in interviews with teachers).

Two teachers occasionally used an online maths website produced by the same publisher as their class maths workbooks to assign homework. However, these assignments were infrequent and sometimes had to be repeated in class, either because some students were not allowed to use (or did not have access to) a compatible digital device at home or because both the students and their parents struggled to answer the problems assigned (e.g. the website would only accept answers formatted in a particular way and not a differently expressed, equally correct response).

> Some students' parents won't help/allow their children to do their online maths homework at home, according to the teacher (since they don't allow any screen time and/or computer use at home). Teacher tells the students that "*that's what the [school tablets] are for*" and they can complete their homework in school (School 2, Year 2, 12.05.2017 observation field notes).

Technology was sometimes used by teachers to support students with special educational needs. In one class, a student had a personal (school-housed) laptop purchased by the county council that had supportive software (e.g. a specially adapted word processor) installed; unfortunately, the council refused to allow the school's IT support worker to have administrative access to the laptop as it was technically council property, meaning that it could not be connected to the school's intranet. This meant that the student's work was frequently lost through the computer crashing with no intranet-based backup available. In another classroom, a student with behavioural challenges who would not participate in class maths lessons was often allowed to use an online maths programme instead. Lastly, a teaching assistant in one class used a tablet to

photograph a student's handwriting to share with visiting support staff regarding the child's academic progress and needs.

These uses – administrative, replicating non-digital pedagogical practices and processes, etc. – are not new, nor are they a part of the computing curriculum. Given that field work for this study took place in the third year of the curriculum's implementation, one might expect to see more computer science, more diversity of tasks, and more sophistication of use (Figure 4). However, the limitations witnessed in the classroom were not due to malice, ignorance, naiveté, or professional malfeasance. They were a logical result of teachers – situated in the local dispositif of their school and community – translating an inapposite policy into their teaching practice.

Figure 4. A week of computing and ICT in the head of computing's classroom.

School 1, Year 2/3, observation field notes:

5th September 2016

- Students did not use technology at all today and were not taught any computing concepts (just the identity of Ada Lovelace in a Topic lesson about famous British people).
- Teacher used IWB with attached laptop and projector but not in ways different from how a non-digital whiteboard and printed out images/text could be used.
- Students introduced to ClassDojo but only so far as to be told that their account has an avatar that they can change with their parents' help at home. No discussion of what ClassDojo is for. It's no different from a sticker chart except that parents (with Internet access) can view it themselves without coming into the classroom.

6th September 2016

- The only "computing" done today was that an upset child was allowed to use a gamified maths website during part of the Topic lesson. He didn't know that the key with an arrow is the same as the "Enter" key that the website was telling him to push and he had to ask me for help (the teacher was busy with the class at that point).

7th September 2016

- Student house point counts are displayed to everyone at once on the IWB using ClassDojo. However, when the class votes for who will be the class reps for the student council (later in the day) they are asked to close their eyes and raise their hands - no use of tech for voting.
- Teachers used to like [gamified maths website] because each student had a log-in and it stored their scores so progress could be tracked by the teacher over time. However, once the school computers were upgraded to Windows 10, all of the scores were deleted and it can no longer store new scores, completely eliminating this affordance.

8th September 2016

- School librarian tells me that Minecraft books were very popular with boys at the school last year, so the school purchased a number of these. Unfortunately, they are now out of fashion, so the library has too many copies of something nobody wants to read any more.
- No computing or ICT use today.

9th September 2016

- After several rounds of Place the Penguin on the IWB with the whole class watching and select students called up to move the numbers, the class is sent back to their desks to work independently on maths worksheets with the same types of problems. IWB game no different from a whiteboard game and it was simply a group introduction to paper maths worksheets.

5.3.5. External influences

The impact of changes in educational policy is not unidirectional; policy changes schools just as schools change policy by uniquely interpreting it through their local, contextual worldview (Ball, Maguire, Braun, & Hoskins, 2011). Teachers play a critical role in the creation of policy-in-practice, so knowing what influences their decision-making (both conscious and unconscious) is crucial if our society desires a different policy-in-practice for our children (though this study found no conclusive evidence that this is actually the case).

In the example of computing education, there has been limited external motivation – either positive or negative – to remain faithful to the National Curriculum computing standards or to teach the subject with any great frequency. The curriculum itself is light on guidance – "Yes, the computing, I mean, it is very slim compared to everything else [in the National Curriculum]" (School 1, Year 2/3, teacher interview) – and the usual processes that structure the translation of policy into practice (e.g. assessment, inspections) are either not present or weakened compared to those for other primary school subjects. This has given teachers more leeway to use their professional judgement when producing policy-in-practice.

In the case of the School 2 head of computing's classroom, this meant that some components of the computing curriculum were integrated into her teaching throughout the week. However, she also said that, "as a separate subject, I'm not overly keen on it in primary school," given the difficulty in getting teachers to translate the subject into more nuanced lessons:

> Really, our whole world is full of algorithms, and just making sure we're aware of that, but actually to formalise that into computing in the way that I think most teachers understand it to be is not particularly healthy at primary school. Because I think then they just rigidly stick to things like programming (School 2, Year 2, teacher interview).

In this way, teachers were understanding computing as either 1) a more philosophical or conceptual way of understanding the world that could be integrated into other subjects and did not necessarily require the doing of computer programming or robotics, or 2) a skills-based subject that required doing activities that were specific in their contribution

to learning and had the potential for future use, and therefore was not more broadly educational like subjects such as maths, English, or science.

Teachers located in schools that had invested in new devices – especially when they were paid for by local parents – felt obliged or duty-bound to use it: "I think I've used technology because I know I had to do something... I don't think I do it enough justice" (School 1, Year 2/3, teacher interview). In School 2, tens-of-thousands of pounds had been fundraised by parents over the previous few years to purchase class sets of tablets. Most classes (excluding Year 3, whose technology use consisted solely of an interactive whiteboard for PowerPoint slides and the school's computer room desktops for online games) used the tablets regularly, though there was at time jostling for the more recently bought sets as the relatively older tablets had already begun to run slowly and malfunction regularly.

The DfE, in turn, does not mandate any particular frequency or variety of use, further leaving teachers without guidance on the appropriate "dosage" of computing instruction. Computing is not included in either the Key Stage 1 (i.e. Year 2) or Key Stage 2 (Year 6) Sats as a stand-alone test or the subject of teachers' student assessments. Ofsted as well have been clear that, while they do want to see e-safety taught and technology integrated well into lessons when it is used, they are not specifically looking at any particular utilisation of digital technology or method of teaching during school inspections (Nixon, 2018). Additionally, hundreds of schools are long overdue their regular Ofsted inspection (Ofsted, 2016; Scott, 2016; Yorke, 2017), as was the case with both schools participating in this study, meaning that even e-safety and pedagogically-

appropriate use of technology is not being evaluated officially in many schools. In the meantime, teachers are struggling to prepare their students in those subjects to be covered by upcoming testing and overdue inspections:

> Yesterday, TA mentioned that the school was "two years behind due" for an inspection from Ofsted so everyone is a bit on edge, expecting inspectors to arrive any day. This was said to me after she listened to Teacher say how stressed she was over fitting in all of the Year 2 maths curriculum before the spring Sats (School 1, Year 2/3, 20/09/2018 observation field notes).

As a result of this limited surveillance – much of it by design (Department for Education & Gove, 2012; Gothard, 2012; Harrison, 2013) – teachers have had significantly more freedom, in some sense, to teach computing as they saw fit compared to other compulsory National Curriculum subjects. However, whether they feel they have the resources (including time) necessary to teach computing to their professional standards, or indeed whether the computing curriculum is developmentally or pedagogically appropriate according to their local episteme, is another matter.

5.4. Neglect as a form of agency

With little guidance or additional technical or pedagogical support, teachers must rely solely on the three pillars of professional training, experience, and beliefs when planning how to teach this new subject. Since the National Curriculum was first created in England by the 1988 Education Reform Act, teachers have consistently assessed themselves as lacking a strong background in certain mandatory subjects, feeling themselves to be least

competent in teaching "technology," later called ICT (Mueller et al., 2008; Silvernail, 1996)[34]. This is problematic, as:

> ...in computing, it is one of the few subjects that I think you have to be multi steps ahead of the children. Not only because you have to be competent at what you're teaching, but often the technology doesn't work. So, within the frustrations of that, if you're also only one step ahead of a child, it's a pretty insecure place to be. That's why I say technology doesn't actually work for the pupils in the way that it should, because you spend most of your time fixing the glitches... The things that I know, I know because I've spent an inordinate amount of hours just trying to play with stuff and work it [out]. That's why I can do it, and that's what everybody should do, but there isn't the time to do so (School 2, Year 2, teacher interview).

With minimal professional training available or opportunities for prior experience in computing, teachers are then left to rely on the final pillar, their professional beliefs or judgement (Cuban, 2002). This means that their attitude towards computing as a subject (or what they perceive it to be as a subject) will have all the more impact on how it is taught or not taught. Teachers' expectations for students' performance on a certain task or subject area can influence how those students do, in fact, perform (Vekiri, 2013) and if teachers hold a particularly negative view towards computing and its place in the school curriculum, they may be more likely to be dismissive of the subject while teaching it and so convey low expectations for student performance. Similarly, a teacher who is indifferent towards computing or sees it as a low priority subject compared to other disciplines will act accordingly. This is equally true if they do not see computing as providing important "collateral learning" that might be more evident in other subjects (Dewey, 1963, p. 48):

> Perhaps the greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he is studying at the time. Collateral learning in the way a

[34] The Silvernail (1996) paper covers studies taking place in 1989, 1991, and 1996.

> formation of enduring attitudes, of likes and dislikes, may be and often is much more important than the spelling lesson or lesson in geography or history that is learned. For these attitudes are fundamentally what count in the future.

In the case of the schools involved in this study, teachers are using their professional judgement to modify or reject outright the National Curriculum computing requirements by minimizing or ignoring subject content and skills that they see as redundant or less than critical to their students' success, or that they feel they do not have the training, experience, resources, or time necessary to teach. Neglect of the computing curriculum – though perhaps not seen as ideal by participating teachers – was selected as the best choice of a bad set of options to meet their students' needs.

There are many reasons these teachers gave as to why they are excluding content, including: a) their professional beliefs regarding what is developmentally appropriate for this age group; b) parental concerns regarding screen time and a perceived hierarchy of academic subjects, of which computing often sits on the "too vocational" end; c) issues of access to teacher training and technological resources; and, d) the low-prioritization of computing in regulatory mechanisms such as Sats and Ofsted inspections, resulting in their neglect in favour of more readily surveilled subjects (e.g. English, maths, science).

5.4.1. Examples of choice

At School 1, the Year 2/3 teacher left the school and the state education system mid-academic year in order to teach in a private primary school. The reason she gave was because she was fed up with the 2014 (and ongoing) changes to the National Curriculum and national assessments, which she felt were harming children's education and further burdening already overwhelmed teachers:

> I think last year I had really had it with all the changes to the assessment and curriculum. I just saw it making everything worse for teachers and for children, and I will be very relieved to be out of that (School 1, Year 2/3, teacher interview).

The head of computing at School 2, who did include more computing curriculum content in her lessons than any other observed teacher, still preferred offline methods for many of her lessons. In maths especially, she found that physical (i.e. non-digital) manipulatives (e.g. geometric shapes, stacking cubes, abacuses) had certain affordances that could not be replicated by the technological tools available on the market:

> During a lesson on fractions: "*It starts so easy and then you realise how difficult it is. That's why – shifting things around; they need to physically shift things* [e.g. plastic cubes, magnets, etc.] *around to do it* [i.e. learn fractions]" (10/05/2017 observation field notes).

The least experienced teacher, who taught Year 4 at School 2, said in his interview that when he completed a PGCE two years prior (i.e. during the 2013-14 academic year, when the computing curriculum was being finalised), his instructors and the teachers he shadowed "were just [as] in the dark about it as anyone else." He saw the value in teaching advanced digital technology skills as:

> ...there is technology everywhere and it's only going to become more and more advanced. But I think, if that is the case and it is so important, I think there should be – and obviously the government is seeing that as an important thing for kids to learn – then I think there needs to be some sort of support for teachers who don't know that much about computers. I can vouch for other people in the school might not have much knowledge at all about computers and how to support children where I think it's really needed.

He may very well have been talking about the Year 3 teacher at that same school, who never taught computing and, during twice-weekly "ICT" lessons, allowed students to free-

play in the school computer room using a limited number of gaming websites. This teacher spoke fondly of the resources she had been given as a teacher during the time when schools taught "Technology" (the predecessor to ICT on the National Curriculum), including televisions, radios, and Research Machine (RM) microcomputers. However, since School 2 had received an inspection result of "Requires Improvement"[35] from Ofsted several years prior to this study, she felt obliged to "to hone in on perhaps a more limited curriculum to some degree" in order to meet school inspectors' expectations. Given Ofsted's limited interest in capturing computing as part of their inspections, it is no surprise that the Year 3 teacher should neglect it in favour of other subjects.

At both schools, teachers would use technology for one-off student support, both for those with SEN and those without. A boy at School 1, for example, was allowed to use a gamified maths programme to help him calm down after becoming upset when his classmates teased him, and a child with serious special educational needs in School 2's Year 3 class would be given his council-approved laptop with an adapted computer mouse and special educational software to use when there was no teaching assistant available to help him integrate into the class lesson (i.e. due to a shortage of funding and staffing, technology provided a child who required a one-to-one aide with some educational support when an aide was unavailable).

Even when the computing actual policy (e.g. programming, computational thinking) was consciously valued by teachers, there were obstacles of practicality that limited the time

[35] School 2 had since been revaluated as "Good," shortly before the start of this study.

that students were exposed to the subject and the variety of ways they were given to engage with it. The Year 2/3 teacher at School 1 said in her interview that the new computing curriculum "is going in the right direction" and that she appreciated that it contained "more about actually programming, rather than just using it [ICT] as a tool for doing other things." However, she found other recent changes to the National Curriculum and National Curriculum assessments (i.e. Sats) incredibly frustrating, stating that:

> [These] high stakes [measures did] not benefit the children at all. It is just purely a measure of weighing up the teachers and the schools to see if they can deliver the undeliverable and get them to succeed on tests that they will then forget everything about or will never need again when they could be learning something stimulating and useful.

She found herself required to teach subject content she thought was developmentally inappropriate or academically insignificant (e.g. advanced grammar), but since this content was assessed through school inspections and national standardised testing, she had to focus her teaching on these subjects rather than ones she valued more but which were not assessed by high-stakes measures, like computing.

Ultimately, these were cases of teachers making rational choices in order to support the needs of their students; or, in one case, to reject a system they saw as flawed beyond their capability to repair. They were responding to their local dispositif – as "policy 'enters' contexts, it does not destroy them" (Stephen Ball in Avelar, 2016, p. 6) – by rejecting the inappropriate and unfeasible in favour of the achievable.

This echoes a larger feeling of disquiet around the state of state-funded compulsory education in England, as framed aptly by Twining (2013) in his recounting of the creation of the computing programme of study:

> For quite some time now I have been saying that the National Curriculum [NC] is actually pretty irrelevant, and yet I, along with a vast number of other people, have been investing a great deal of time "debating" what it should contain. I say that the NC is pretty irrelevant because:
>
> [1] I suspect that the majority of teachers won't actually read it in any detail (if at all) – what they will do, very sensibly, is find a scheme of work that someone has produced and use that to save them time in preparing their own plans.
>
> [2] A growing number of schools (e.g. academies and free schools) aren't required to teach the NC.
>
> [3] The real driver for schools are the accountability measures that they are assessed against – these tend to focus on a subset of the curriculum (e.g. Maths and English in primary schools) and once you get to Key Stage 4 the exam syllabi are more important than the NC.

It would appear that, despite attempts to make it otherwise (Blower, 2014; Hargreaves, Cunningham, Hansen, McIntyre, & Oliver, 2007; Whitty, 2006), primary school teachers still see themselves as professionals and those best positioned to make the final decision on what educational content their students should be exposed to. While teachers broadly see a role for technology in education – both as a tool and as a subject of study – they do not feel the same way about the narrow content of the computing standards and have adjusted their practice to reflect this.

5.4.2. Scaffolding and stepping stones

Without the usual external motivators, teachers look inward to the needs of their school, classroom, and individual students, and teach accordingly. There, they must consider the

steps needed to reach the goals outlined by the new programme of study. At the student level, there are several preliminary skills, knowledges, and physical and cognitive abilities (Figure 5) that are needed in order to use digital technology independently (i.e. without one-to-one guidance and support during an activity).

Figure 5. Technology and students with special educational needs: a vignette.

School 1, Year 2/3
26th September 2016

Mattie, a girl with special educational needs, is assigned a classroom laptop to use every morning to access a gamified maths website during the class's offline maths lesson. Today, the teaching assistant has typed Mattie's username and password into the website, something Mattie struggles to do herself. Something goes wrong with browser's Flash plug-in during this process; I am able to fix it, as well as the browser zoom (it is super zoomed in, nearly impossible to navigate), and the TA begins working with Mattie on the first set of maths questions.

Early on, they use the browser's back button and it logs them out of website. The TA tells Mattie to return to her seat to practice the same maths worksheet as the rest of the class. Mattie grows increasingly upset, saying she doesn't want to do the worksheet, but eventually she leaves the laptop and goes to her desk while the TA continues to troubleshoot.

Later, after the TA has logged her back in, Mattie is allowed to use the maths website again. However, she quickly manages to log herself out (clicking one of the links at the top of the webpage can do this, a serious design flaw in a supposedly child-friendly website). The TA comes back, chides Mattie for logging herself out, and then sends her back to her desk to read as there isn't enough time left before the next lesson to log her back in. Mattie returns to her desk but refuses to do any more work, resulting in her getting detention for the whole of lunch. Mattie: "I hate this day and I want to go home."

They need to be able to log in to the school's laptop, desktop, or tablet computer: this requires a firm understanding of the alphabet and the differences between upper- and lowercase letters; they need sufficient manual dexterity to accurately type letters on a keyboard (both physical keyboards and digital, touchscreen keyboards, depending on the device they are assigned); to use a mouse (possibly wired, possibly wireless), a small

laptop touchpad, or a touchscreen. Computer passwords are almost universally converted into asterisks as they are typed, meaning that students must both be accurate typists and emotionally resilient when their attempts to enter a password (and, oftentimes, a student-specific username) fail.

Success once all of these steps have been accomplished requires that the devices they are using are charged (as most devices observed were portable and, therefore, battery-powered), connected to a Wi-Fi signal, intranet, or cloud-based server, and not experiencing the ill effects of ageing hardware or buggy software. If all of this is in place, then a student can log into a digital device at the start of a lesson that uses digital technology. What is needed beyond this – to use programmes not designed with children's needs and abilities in mind (e.g. popular word processors with their many drop-down menus and symbolically-labelled buttons), non-"walled garden" websites that students can easily navigate away from (even by accident), not to mention the educational content that they will be asked to engage with – is vast.

Today's primary-age children are not digital natives (Bayn & Ross, 2011; Helsper & Eynon, 2010; Selwyn, 2009) and so cannot be expected to have gleaned or absorbed the necessary attributes simply from having grown up in the "digital age." They need explicit instruction (Garcia, 2013) and, as evidenced by this study, for many that will not come from the home environment. Expecting teachers to have 1) successfully taught all of these skills before using digital devices with a class, 2) received a class of students who have all already been sufficiently educated before the start of the school year, or 3) provide the one-to-one handholding necessary to teach these skills at the same time as

they are trying to teach a subject (including computing) using digital devices (with infrequent or no support from teaching assistants due to budget constraints) are impractical, if not unreasonable.

All of the stages I have just described as necessary to accessing a password-protected device I observed acting as barriers to access for one student or another during a lesson. Many other obstacles were also observed, as unattended devices went to "sleep" and the entire logging-in process was required to be repeated, or students struggled to drag and drop blocks of code in block-based programming language Scratch using a laptop's miniscule touchpad, or small groups struggling to keep track of the execution of their algorithm by a robot that has worn its batteries out mid-exercise.

With students required to be able to accomplish so many steps before they even have the opportunity to exercise the skills and knowledges covered by the National Curriculum computing standards, teachers hampered by a lack of in-class support staff to guide students through these steps, and bare-bones technical support meaning that devices often malfunctioned or never worked in the first place, can teachers be expected to provide regular, rigorous computing lessons to their oftentimes large, mixed-ability classes?

For many teachers, the answer is "no." "Neglecting" the computing curriculum is not a matter of ignoring student needs; rather, for many teachers, it is a choice made in response to their needs. Participating teachers acknowledged that the underlying skills and knowledges needed by their students to engage with computing, as described in the

actual policy, are largely not present. Given their local context – ageing devices, limited technical and pedagogical support or training, and fewer teaching assistants than needed on the best of days – teachers are making logical, pedagogically-sound choices to largely neglect the narrow set of skills addressed by the National Curriculum computing standards.

5.5. Conclusion

It is clear that the teachers in this study are making logical, informed choices to largely minimise or reject outright the policy as written. This is because they see the skills and knowledges listed in the programme of study as interesting but not particularly relevant to students in primary school, as not nearly as important as other subjects (including content covered by the old ICT curriculum, such as word processing and Internet-based research), and as requiring more foundational knowledge than their students currently have and that they are capable of scaffolding with limited support staff available to them. In an overcrowded school day and with Sats testing and Ofsted inspections looming, there is no time for the extraneous, and so computing is set aside for much of the year.

Students, in turn, come to school with a positive but constrained understanding of technology and that this understanding is little broadened at school. Their disposition towards technology is largely positive because they use it in ways that adults have sanctioned (i.e. age-appropriately entertaining or educational) and which they mostly find fun or interesting. They are aware of its potential dangers because the adults in their lives warn them and because of this they self-constrain their use, as well as avoid exploration which might further broaden their understanding of its potential uses.

Use at school is similarly constrained and the addition of computing to the National Curriculum has not changed this in any significant way. Students' understanding of technology's potential uses has expanded slightly (e.g. coding in Scratch, basic robotics, computational thinking in one of the four participating classrooms) but their exposure to these uses is still limited, both in terms of the range of activities they have tried and the time given to practice these activities over the course of the school year. This is because: a) the curriculum programme itself is extremely limited, especially as compared to the old ICT curriculum and the early drafts of the new computing curriculum, and so even if taught to the letter would not greatly broaden students' understanding; b) teachers are overburdened with a large number of mandatory tasks (both pedagogical and administrative), meaning some subjects will inevitably receive less teaching time than others; c) schools received no additional funding with which to implement the computing programming of study and, already facing budget shortfalls, cannot afford to regularly service the technology they already own, let alone purchase new technology without significant financial support from parents; d) the computing curriculum includes content that requires more foundational knowledge than their students currently have or could be expected to develop quickly; and, e) teachers do not see the limited content covered by the computing curriculum to be a high priority compared to other subjects.

In conclusion, the computing education policy has slightly widened students' understanding of digital technology, but it has not greatly increased the depth of their understanding or experience, or dramatically changed their already largely positive disposition towards it. This programme of study also does not appear to have widened their understanding of the potential uses of advanced computing skills, nor have students

been inspired to incorporate computing curriculum topics and devices (e.g. free online computer programming website Scratch) into their home use, suggesting that either they do not perceive it to fit into the two categories for tech (i.e. fun or educational) or that there is little room for it in the narrow window of computing use allowed at home. This can be attributed to how little content the programme of study covers and the ways in which it clashes with the local dispositifs of the home and school.

The teachers in this study, in turn, have chosen to teach what they see as developmentally appropriate, and both pedagogically and logistically feasible, regardless of what the revised National Curriculum requires. With minimal surveillance or enforcement by external forces, they have used their professional judgement to largely reject a policy that does not align with their beliefs, experiences, abilities, or available resources.

6. Discussion

This chapter discusses how important factors such as the differing dispositifs of policymakers, teachers, and students influenced the way that the computing education policy was implemented in English primary schools.

6.1. Research Question #1: How are teachers translating the computing education policy into practice and why?

My first research question asked what the policy-in-practice state of the computing curriculum was for teachers in participating schools, as well as what their motivations were for how they enacted this policy. While I had initially hoped to see some interesting examples of computing instruction, I quickly found that very little was happening in the classroom regarding this new subject, as I first discussed in my methodology chapter (which resulted in the addition of Research Question #3). Absence of practice is a practice in itself and so, after the initial surprise and concern over what data I would have to collect, I quickly refocused on why teachers were translating the computing education policy into silence.

6.1.1. They are (largely) not

The teachers in this study were largely not adhering to the requirements of the computing curriculum in their teaching practice. When they did teach it, they focused on familiar computer science-based activities such as computer programming using Scratch or a programmable floor robot. While one teacher (School 2, Year 2) did lead a game design activity using Scratch, most of the potential pedagogical strategies recommended

by the extant research (Waite, 2017) mentioned in Chapter 2 were not used. Parts of the old ICT curriculum still persisted in most classrooms, though oftentimes these activities were labelled as “computing” lessons and taught in lieu of the new curriculum’s subject content.

Teachers in both of two participating schools had not received any significant quantity of CPD in the new subject before or after its addition to the National Curriculum. The closest thing to training that any of the teachers had received was three training sessions run by the local county council, attended by only School 2’s head of computing. However, this training was not of particularly high quality: “They put up Scratch and they said the best thing to do is just to play with it, and that was our training. And that was about four years ago“ (School 2, Year 2, teacher interview). It seems especially ironic that the Department for Education, whose sole purpose is to understand and support learning, so gravely underestimated the need for teachers to have time and support learning a new subject before they themselves could be expected to teach it to their students. Unfortunately, this reflects the larger trend found by the Royal Society’s (2017) survey, in which a third of teachers spent between one and nine hours a year in computing-related CPD, while another third attended no such CPD.

Given that “one of the main techniques of policy dissemination [by government] within schools is training and CPD,” providing support for such training may very well have improved the likelihood of their computing education policy being implemented (Perryman, Ball, Braun, & Maguire, 2017, p. 750), as the teachers would adopt government-approved best practices into their own professional beliefs and practices. It

also may have assisted teachers with understanding that the intended policy (still promoted by government and professional organisations, despite its absence from the wording of the actual policy) was that students would not only develop practical skills but also new ways of thinking, under the assumption that participating in the modern world requires new ways of thinking and acting:

> [In England,] learning to code is being positioned in part as a pedagogic relay for inculcating the capacities considered necessary for citizens to participate in the computational dynamics of an increasingly digitized social and political order (Williamson, 2016, p. 40).

However, these cognitive changes suggested as learning outcomes of studying computing are not explicit in the curriculum and would require a serious change in teaching practice in order to accomplish it. Without rectifying the current issue of a lack of equitable, funded access to high-quality, relevant CPD, "much beyond the conventional will be tough to attain" (Cuban, 1986, p. 100) and it is unsurprising that teachers have not yet found ways (or been motivated to find ways, or even realised they were supposed to find ways) to teach this hidden curriculum.

There is an ongoing, historical narrative of digital skills not being taught in as sufficiently a radical way as proponents of the subject had anticipated – a complaint made as recently as the English ICT curriculum – and it provides an easy scapegoat: "If only teachers would teach this subject correctly," the narrative goes, "then all of our problems would be solved."

> [The] problem that arises from treating the curriculum as an "instrument" is that it becomes possible for governments to claim that social or economic problems

> can be “solved” by changes in the curriculum (Young, Lambert, Roberts, & Roberts, 2014, p. 96).

Similar narratives blaming social and economic stagnation on teachers appeared in the Black Papers, a series of conservative articles on the state of education in England published in the *Critical Quarterly* between 1968-1977. The authors of these papers – similar to some of those voices supporting the addition of computing to the National Curriculum – laid the country’s readiness for international (economic, political, social, etc.) competition at the feet of educators, who were to use whatever resources they had to hand to keep England appropriately skilled and hardworking: “If the non-competitive ethos of progressive education is allowed to dominate our schools, we shall produce a generation unable to maintain our standards of living when opposed by fierce rivalry from overseas competitors” (Cox & Boysen, 1975, p. 1).

Teachers in England today have similarly been asked to aid in reskilling all young people for service in the digitalised knowledge society and this burden is heavy. Teachers are not magicians and their work requires far more than fairy dust. There are limits to what kind of education they can provide and, given the minimal support that they have received from the British government to teach computing – through funding, CPD opportunities, mentorship, and the clarity of the actual policy – the limit for many schools is currently set to “next to nothing.”

6.1.2. Overwhelmed as it is

In addition to serious institution-level issues of underfunding and overcrowding, teachers as individuals are also finding themselves terribly overwhelmed. A 2017 survey of a representative sample of 1,250 teachers in the UK found the following:

Table 7. Results of survey on British teachers' work-related health (YouGov, 2017).

Symptoms	**% of UK teachers**
Feel stressed most or all of the time due to work	29%
Feel stressed some of the time or occasionally due to work	64%
Faced physical or mental issues in last year due to work	75%
Have considered leaving the sector due to work-related health pressures	53%
Have experienced depression, anxiety, or panic attacks due to work	50%
Work-related mental health problems have caused personal relationships to suffer	47%
Major cause of stress: work-life balance	75%
Major cause of stress: changing education policy	42%
Major cause of stress: the inspection regime	42%

The cognitive load and emotional labour required to teach in today's political climate is high. To then require teachers to teach a subject that they are unfamiliar with, without providing adequate funding for training or resources but instead advising that they select appropriate free and commercial products online (Department for Education, 2014a) is a lot to ask. Previous studies demonstrate that teachers who are already feeling overwhelmed by their workload struggle to find, select, and use digital technologies, even when they are given a wide selection to choose from and are guaranteed to have their choices fully funded (Remold et al., 2014). To have so little technical support – an important predictor of the integration of technology into the classroom (Lao, 2000; Sime & Priestley, 2005) – and no additional funding added to this list of constraints, it is no surprise that many teachers [half of whom have low confidence in their ability to teach

computing (The Royal Society, 2017)] struggle to find the time and mental energy necessary to wade through the sea of materials available online.

The unexpected lack of surveillance of computing education in English classrooms – usually taking place through Ofsted inspections and Sats testing – has given teachers the space to choose if and how they wished to teach the computing curriculum. This "marvellous machine" (Foucault, 1979, p. 202) typically enrols "teachers as policy subjects" as teachers are professionally pressured into "committing themselves to the development of new competencies" (Perryman et al., 2017, p. 747). However, while they may have not been brought fully into the pro-computing fold, the surveillance regime still nudges them towards focusing on that content and behaviour which is subject to surveillance, regardless of their professional values regarding the prioritisation of certain subjects over others. This narrow focus on English and maths meant that there was little room for anything else, as seen in Chapter 5; not only computing, but also art, geography, and design and technology were seen to be given short shrift. While teachers do have a lot of control in the classroom, these powerful external forces do still play a significant role in their decision making. In this case, those external forces did not support the implementation of the computing curriculum.

6.1.3. Teachers are in charge... and are not

There is a history of conflict in education over the location of "the locus of the power to define" what education's purpose is (Ball, 1987, p. 251). While creation of the National Curriculum in 1988 did, in some ways, shift that locus further away from teachers and

closer to government, who has power during the implementation of the National Curriculum and other educational policies is much more nuanced than that:

> Our concluding point then, is that as policy the National Curriculum remains both the object and subject of struggles over meaning. It is not so much being "implemented" in schools as being "re-created," not so much "reproduced" as "produced." While schools are changing as a result, so too is the National Curriculum. This leaves us with a strong feeling that the state control model is analytically very limited. Our empirical data do not suggest that the State is *without* power. But, equally it indicates such power is strongly circumscribed by the contextual features of institutions, over which the State may find that control is both problematic and contradictory in terms of other political projects (Bowe et al., 1992, p. 120).

There is a back-and-forth, give-and-take quality to how teachers engage with policy: as they "bring their creativity to bear on its enactment, they are also captured by it. They change it, in some ways, and it changes them" (Ball et al., 2011, p. 630). Since teachers are the ones "doing" education, they have a great deal of power in the classroom (i.e. in their relationships with their students) and their "own understanding, desires, values and purposes" play an important role in the dispositif of the educational space (Rizvi & Kemmis, 1987, p. 21).

Teachers are also subject to surveillance from regimes of assessment and evaluation, which can in turn shape those desires, values, and purposes which influence their teaching practice. These devices and their attempts to "datafy" members of the teaching profession has impacted them (Lewis & Holloway, 2018), for example by leading them to teach subjects under the gaze of surveillance more than they would otherwise, and perhaps even to the detriment of subjects which they believe are more important to

students. In this way, teachers are both in control and out of control, both independent professionals and subjects of managerialism (Fitzgerald, 2008) within the school context.

6.2. Research Question #2: In what ways is England's computing policy-in-use influencing students' understanding of and disposition towards digital technology and why?

My second research question was focused on what impact England's computing curriculum would have on children subjected to it. While education policy has a significant impact on teachers, the ultimate focus of a mandatory curriculum is on producing outcomes for and within students, and so it was important to see what influence the policy-in-practice form of the computing curriculum would have on them given that that's the policy state they would be exposed to. Ultimately, the absence of computing teaching meant a lack of computing learning or enculturation, something which was also not supported by students' limited access to digital technologies at home.

6.2.1. Limited exposure, understanding, and disposition

The students who participated in this study were exposed to a limited range of digital technologies at home, as well as a limited range of uses for those technologies. This was because: a) their families owned an unsurprisingly low number of consumer electronics; b) these devices were often for the main or sole use of a parent or older sibling; c) parents were concerns about the content their children would access, the strangers they would meet online, and the physical, social, academic, or psychological toll extended technology use might have on their children; and d) parents prioritised other, offline

activities for their children to take part in. None of these reasons are particularly surprising given the negative messages around children and technology-use that are aimed at parents, both in the UK and internationally (American Academy of Pediatrics, 2016; Błanchnio, Przepiórka, & Pantic, 2015; World Health Organisation, 2018).

The range of devices available to students in the classroom is also not surprising, given the types of technologies typically marketed to and adopted by schools (e.g. desktop, laptop, and tablet computers; interactive whiteboards; educational floor robots). These devices were not used to their full capacity in any of the classrooms I observed – as discussed in Chapter 4 – with many of the pedagogical best practices explored in Chapter 2 not utilised. However, given the limited time that teachers have to devote to learning about computing (i.e. what it is, how do it, and how to teach others to do it) because of their overloaded schedules, it is also not surprising that teachers are only able to provide a limited range of activities for their students, many of which only align to the old ICT curriculum or are used in service of teaching a subject other than computing (i.e. TEL).

Lastly, the children interviewed and observed had a largely positive disposition towards digital technology because they used it to play games, consume media, and complete learning tasks similar to offline activities but with the addition of animation, sounds, and colourful characters and stories. Their positive feelings towards digital technology began to wane when they were asked to use it in repetitive ways (which resulted in boredom) or when they were given a limited range of activities to choose from (the same). Though some of the students (especially in School 2's Year 2 class) were beginning the grasp that computers could be used to build and operate other things that might interest them,

most students' who participated in this study appeared to be unaware that computers existed outside those desktops, laptops, tablets, and floor robots that they saw in school and at home. How gaining this knowledge might change their engagement with their (unfortunately limited and infrequent) computing lessons – or expand the range of reasons why they like or dislike digital technology – is unknown as it was not captured over the course of this study.

6.2.2. Children as subjects

Children – and especially young children – are allowed limited opportunities for agency, particularly within the regimented world of the school. Because of this, children have little say in their own enculturation, being reliant on the adults in their local social sphere to teach them the beliefs, values, and ways of thinking correct for the dispositif in which they are located. Within the classroom, the adults (i.e. teachers) make decisions based on a number of factors within their local dispositif, including: 1) their professional knowledge around teaching, learning, and child development, 2) their perception of the unique needs of their current class, 3) the "carrot and stick" consequences handed out by regulatory surveillance mechanisms, 4) the beliefs and values of parents, and 5) the unique culture of their school (e.g. religious affiliation, school mission, etc.). While educational technologies have, over time, been designed to encourage (or at least allow for) more active engagement and agency by young learners (Carliner et al., 2008), these devices continue to operate within hierarchical institutions (i.e. schools), in which they are controlled and given meaning by adults.

Within the dispositif of the home, power relationships remain largely top-down and technology is still seen by many as potentially dangerous, a message which is reinforced in media aimed at parents. Children are exposed to basic technological advances that are useful for their education or entertainment (e.g. word processing, television) but their use is limited to avoid dangers posed by others (e.g. grooming, bullying) and by the technology itself (e.g. negative impact of screen time on attention, eye strain), as well as to provide additional time for activities seen as more or equally valuable (e.g. outdoor play, offline homework, reading paper books).

The socio-cultural environment of both the home and the school do not call upon children to see themselves as coders or tech entrepreneurs; at most, they are asked to acquire the most basic level of digital skills. As a result, most children do not self-identify in this way and do not value or pursue activities that would lend themselves towards learning more computing or engaging with the technology sector (e.g. through online computer programming community websites like GitHub). Foucault (2000a) called these self-identities and the way they are reinforced the "technologies of the self" (p.177): "that is, the ways in which humans constitute themselves through a constant engagement in self-understanding and self-reinvention" (Perryman et al., 2017, p. 746). As said before, teachers would have to drastically change their pedagogical practice when teaching computing if they wished to create these cognitive changes and they would require the buy-in and support of parents to promote this tech-focused self-identity in young students. Until such a time as teachers are given the means by which to do this – and parents are convinced to support these ways of thinking and being at home –

children are unlikely to develop a self-reinforcing identity as someone who "does computing."

6.3. Research Question #3: What does the computing education policy – and teachers' and students' response to it – say about the incongruity between public policy around digital technology and people's real-world experiences with and understandings of it?

My third research question was written in response to the lack of computing instruction that I observed in school classrooms. If teachers are not teaching computing and students do not know much about the subject either, then what does that say about the curriculum and how its developers understood the context that their policy would be entering into? It would appear that they did not understand it very well at all, given how poorly the computing curriculum in its policy-in-practice state matched its intended policy and actual policy states within the classrooms that I studied.

6.3.1. Dissonant dispositifs

Dispositif is local (e.g. a school) and it interacts with the larger episteme and discourse of its surroundings (e.g. South of England, England, UK, European, Western world), accepting those elements that mesh with its episteme and rejecting those that do not (e.g. English rejection of European identity). Differing dispositifs will always clash when they come into contact as they play host to different understandings of the world (i.e. knowledges) and ways of communicating (i.e. discourse):

> I said that the apparatus [i.e. dispositif] is essentially of a *strategic* nature, which means assuming that it is a matter of a certain manipulation of relations of forces, either developing them in a particular direction, blocking them, stabilising them, utilising them, etc. The apparatus is thus always inscribed in a play of power, but it is also linked to certain coordinates of knowledge which issue from it but, to an equal degree, condition of it. This is what the apparatus consists in: strategies of relations of forces supporting, and supported by, types of knowledge (Foucault, 1980, p. 196).

The dispositif of the school did not result in the policy-in-practice (including a specific impact on students) anticipated in government and industry discourses. This is because both the discursive and non-discursive elements that politicians were responding to (and industry leaders were responding to and/or creating) clashed with what exists culturally, materially, and discursively in the classroom and in children's homes. In other words, the curriculum was created as a solution to a perceived problem, but teachers and parents do not fully agree that the problem exists or that the solution is appropriate. Furthermore, the policy is not representative of "the way things are" in all segments of English society, but instead is representative of a global discourse in certain sectors around the importance of computer science and Silicon Valley values, and the creation of *homo œconomicus*, "the man of enterprise and production" (p. 147) who is an "entrepreneur of himself, being for himself the source of [his] earnings" (Foucault, 2008, p. 226); in other words, computer science as empowerment of the responsible individual living in a neoliberal world.

Schools are being asked to indoctrinate children into an episteme and discourse that does not exist locally (e.g. within the school and home), is still being debated in larger British society, and which the text of the National Curriculum computing standards does not adequately address (e.g. too narrow a skill set, no tech-related social skills, not enough

clarity on how the terms used in the actual policy should be interpreted). Larger society is still figuring out its relationship with digital technology, and how and if pre-Internet values can be modified to apply to a digital world; in this way, the dispositif of larger English or British society has *not* shifted as I posited in Chapter 2. Parents and teachers have sensed that the status quo knowledge of digital technologies being accompanied by significant risks for children remains and so are erring on the side of caution when it comes to exposing their young wards to digital devices or training them in its use. The National Curriculum requirements as written and the government and industry messages the surround it (as examined in Chapter 4) are pro-technology, being neither critical of the subject nor of its potential impact on society. The actual policy also fails to address social aspects of modern technology use beyond illusions to "e-safety" – such as critical thinking, media literacy, or information literacy – and so, naturally, those who are sceptical of digital technology (due to their historical and still-current local knowledge) will be wary of this one-sided, narrow programme of study.

6.3.2. No venue for feedback

Issues around how the curriculum conflicts with the beliefs and values of teachers and young families could, in theory, have been addressed as soon as they were identified after the policy went into effect in 2014. However, there is no clear venue for teachers' voices to be heard or for them to feed back their concerns and suggestions to the DfE and other policymakers.

There are multiple reasons why it is difficult for teachers' concerns to be heard. For one, the lack of surveillance through inspections and testing means that no one from the

government is watching and therefore no one from government is seeing the reality on the ground. Secondly, the powerful role that CAS was given throughout the development and implementation stages of the computing education policy is significant, given its pro-computer science leanings and the strong influence of industry amongst its leadership. The official voice of computing in schools, CAS is largely supported by a band of computing-keen teachers, school administrators, and researchers who through CAS are feeding back to the government, industry, and public their largely positive experiences of the computing curriculum. While criticism of the actual policy has also been made by several CAS members, the altogether positive disposition of CAS towards the computing programme of study suggests – to the uninformed – that the curriculum is fit for purpose. However, these overtly positive experiences are clearly not the rule and may very well be the exception. As a result, the more negative experiences of many schools – facing the same nationwide, everyday struggles as those classrooms that participated in this study – are not properly acknowledged.

The danger of this homogeneous feedback is that it may lead to assumptions being made about schools not fully engaged in meeting the National Curriculum computing requirements: that they must not be making a good faith effort to do so or that the overall teaching quality at the school is lacking. Teachers grappling with the computing requirements in perfectly logical ways may be labelled non-compliant, Luddites, or "bad" teachers. But even CAS appears to be losing the ear of government, with the end of funding for their Master Teacher programme in April 2018. Who will come out as the voice for computing in schools going forward?

Lastly, the wider societal discourse around the curriculum – promoted by industry and supported by the government – does not have space for criticism. If computing skills are critically important and a computing skills curriculum has been written by people who are experts, what more could anyone want? Of course, this over-valuing of technological skill over social (science) skill neglects to acknowledge the fact that teaching and education research are fields in their own right, with their own experts who have expertise unique to their work. The privileging of computer scientists' voices over that of educators (and particularly primary school-based educators) during the writing of the computing curriculum was a weakness in its development, not a strength. However, the dominant discourse does not currently allow for this narrative, nor for subsequent criticism that the curriculum is ill-suited for use in the classroom, as "experts" have created the curriculum and teachers – the narrative goes – are obliged to teach the National Curriculum as written.

6.3.3. Disruption or reproduction?

The dispositifs of Western society are shifting but not dramatically changing: "According to this description, it would seem that it is not a matter of radical breaks, or shifts of paradigm... as much as the ongoing historical displacement of one set of mobile power relations by another" (Bussolini, 2010). Ultimately, society has not become more equal, democratic, or meritocratic as a result of technological innovation: instead, the usual structures of inequality and power relationships have simply shifted to new institutions (e.g. to tech companies like Palantir, Facebook, Google, and, until early-2018, Cambridge Analytica) and new formats. Students may very well need digital, media, and information literacy skills and knowledges in order to become aware of the strategic, manipulative

digital behaviour of foreign states, political organisations, hate groups, advertising agencies, and companies that deal in personal data and propaganda online.

The National Curriculum computing standards are too narrow to meet students' and society's needs for a public able to engage educationally, civically, and economically with digital tools and systems, and to defend against bad actors online. Additionally, this curriculum has been framed in a techno-positive light that conflicts with other government, media, and public narratives around the potential dangers of technology. It reveals a DfE that has fully bought into the narrative being sold by American tech companies: that digital technology has changed society forever (and for the better) and if only the public could keep up with the necessary technological skills, they would benefit from it as the Silicon Valley and its employees have.

Digital technology has not disrupted societal structures but it has changed the discourse, and the public's knowledge is obfuscated while they try to sort out who is wielding power and in what ways. Discourse is part of dispositif and young people should be prepared to engage with society's shifted discourse, which is often used to manipulate or exploit those who do not understand the ways in which discourse, power, and knowledge function in the digitalised world.

6.3.4. The power to define

The power to define (i.e. by shaping knowledge) lies with different people or groups of people within different dispositifs. Within government, policymakers have the power to define; in the current Conservative government, they define as valuable concepts such as

business, capitalism, and patriotism through economic competitiveness on global markets. Since the modern tech industry embodies many of these values, policymakers from the current (and other recent Conservative) government(s) have invited representatives of the tech industry into the policy-making fold (i.e. “We, as policymakers, don’t know enough about technology to write a technological skills curriculum on our own. However, your business aligns with our values *and* you know a lot about technology, so we want you to write the curriculum for us.”)

In schools, teachers have a great deal of relational power over their students, which allows them to define values within their classrooms. This power is supported by their ability to enforce disciplinary measures (e.g. rewards and punishments; i.e. governmentality), the support of (most) parents as allies, and their training and prior experience. Since policymakers are not physically present in schools, they have to send officials into the classroom who represent their values (i.e. knowledge) and power over teachers, in order to create a relationship with schools through which they can exert that power. These forms of governmentality – that is, the regulation of behaviour in order to make subjects governable (Foucault, 2009) – are embodied in the school inspectors sent from Ofsted and the paper Sats tests shipped to schools, neither of which are present as relates to computing.

Policymakers also, traditionally, exert indirect power over teachers through government-provided CPD or by providing sufficiently explicit guidance so that private CPD providers can align their training to policymakers’ values. CPD is a form of governmentality that teachers who engage with it internalise, so that (for many) they begin to identify good

teaching practice as that which aligns with the CPD they have received, which in turn aligns with policymakers' values as defined within the National Curriculum and other official documents.

However, without these three forms of governmentality, the government is "out of the room" so to speak when it comes to the computing curriculum and the power to define how teachers should or should not teach it. For this reason, teachers have had more space to act according to their local episteme when engaging with their students, as they are now the ones with the power to enact their will within the school rather than being coerced into enacting the will of policymakers in this one subject area.

7. Conclusion

This chapter concludes the thesis by reviewing its purpose, synthesising my research findings, and considering how understanding the function of dispositif can aid in creating change in schools.

7.1. Purpose of this thesis

The purpose of this research was to examine how policy changes as it passes through different hands, unveiling the power relationships that define the purpose of education, the function of policy, and the values of particular groupings of people. I believe that there are a variety of skills and knowledges that people need in order to engage safely, productively, agentically, and in an informed way with the world, and that some of these skills and knowledges are unique (or require unique applications) compared to those needed in the pre-Internet age. I also believe that it is important that children begin to acquire these abilities at a young age so that they can interact in a healthy manner with digital technologies from the start. Schools are institutions of education and enculturation and so, in that sense, are well suited for this. However, there is also a long history in Western societies of trying out new educational strategies with insufficient evidence and uneven success. How we can change schools so that they better prepare young students with these digital-related skills and knowledges requires a better understanding of how knowledge, power, and discourse function than was had by those who created England's computing education policy.

This thesis has investigated exactly how this particular policy was developed and how that process compares to what research shows is necessary for educational policy to be implemented with high fidelity. It also explored what subject content was included in the final policy and how that compares to the content of the policy that it replaced. In my fieldwork I studied how implementation of the computing curriculum took place naturally in the field with real teachers and real students in order to identify how conflicting dispositifs and real-world obstacles made a high-quality computing education not happen in these classrooms.

7.2. Synthesis of the findings

The advocacy, creation, and implementation of England's computing education policy was a messy affair, consisting of numerous actors and their various, sometimes conflicting beliefs and priorities:

> Computing in the curriculum... 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 (Williamson et al., 2018, p. 17).

Whilst I initially set out to identify what impact the computing curriculum was having on young people, it quickly became clear that something entirely different from what I had anticipated was taking place in primary school classrooms. Though not every primary school in England will share the same knowledges or practical challenges – or host the same limited practice – as were present in the classrooms that participated in this study, the factors that influenced what was taking place there are occurring in schools nationwide.

7.2.1. Nostalgia, fervour, and belief

It was a nostalgia-fuelled desire to remain economically and socially competitive in a global economy that led to the replacement of the National Curriculum ICT programme of study with a curriculum considered better able to meet those goals. There has been an ongoing fervour developing around the influence of digital technologies and the supposed agency and influence gained by knowing how to design, build, and (presumably also) sell that technology. There is also an underlying assumption present that society has been fundamentally changed by technology and that we need particular technological skills in order to keep up both as individuals and as a nation, as demonstrated through my "archaeological" exploration of artefacts in Chapter 4.

Teachers' beliefs – based on their training, experience, and philosophical leanings – are so powerful within the context of the classroom that they have managed to largely block a nostalgia- and fervour-backed education policy, something which they are doing for reasons that are clearly logical within their own episteme. Cuban (1986) said the following about the use of computers in the classroom, which could equally be said to apply to the study of computing:

> The new technology, like its predecessors, will be tailored to fit the teacher's perspective and the tight contours of school and classroom settings... [T]he common complaints about educator conservatism, stubborn teachers, stifling bureaucracies, and so forth will surface again. The blinders that nonteachers wear once again will shut out any awareness of the teacher's universe and the substantial impact that existing organizational arrangements in schools and classrooms have upon how teachers teach. Teachers, again, will receive rebukes for closing the classroom door to the magic of another technology. Debates over whether computers should be used in classrooms, under what conditions, and to what degree – if at all – will be buried in the scorn heaped upon intransigent teachers (pp. 99-100).

Despite these potential criticisms, confident teachers continue to teach content that meets their professional standards (which may include abiding by regulatory mechanisms, e.g. through the prioritisation of subjects covered by national testing). The teachers in this study viewed the content of the computing curriculum as developmentally inappropriate, too narrow, too difficult to teach without additional staff or technological resources, requiring more prerequisite knowledge than their students had or could be expected to acquire during the school year, and as a lower priority subject compared to other (mostly non-digital) subjects.

7.2.2. Practical mistakes made

Several missteps were made over the course of this policy's creation, from the unfairly over-hyped criticism of the ICT curriculum to the funnelling of funding from the DfE to private organisations to create resources rather than directly to schools to purchase those resources. Though many justifications were given for updating the digital skills curriculum, it is still not clear that there was any significant, conclusive evidence supporting the focus on computer science in the creation of this programme of study. Why something as significant and influential as a national curriculum was not directly and clearly informed by research-gathered evidence is highly problematic. The process that the computing education policy went through during its development was overall a mess, as can be seen in the "draft-y" nature of the final product (e.g. mentioning "computational thinking" in computing's *Purpose of study* but then only referring to "logical reasoning" under the list of subject content). It would appear, instead, that this choice was made based on the knowledge local to the tech industry, which was then given additional credence by pro-business policymakers.

Teachers should have been asked to lead the way while being advised by members of industry, rather than the other way around. There was always going to be a place at the table for members of industry since economic and industrial concerns were an important motivator for introducing this curriculum. The DfE's hands-off approach should have begun only after teachers (including primary school teachers) were elected to the drafting committee(s). Teachers' perspectives should always be given due consideration during the development of any new curriculum as they are (in many ways) its most significant stakeholder (Viennet & Pont, 2017). This would result in a better informed curriculum design – as it would align with the dispositif of the school – and improve the likelihood of it being implemented due to it aligning with educators' episteme.

The introduction of any new digital technology-centric curricula is bound to require additional investment in teacher training, staffing, and the maintenance of digital devices in order to be successful (Ginsburg & Elmore, 2000). The absence of such important funding has proved to be a significant practical obstacle for the teachers in this study and it likely would not have been overlooked in the policy's design had teachers been allowed to be more closely involved in its development, as they would be intimately aware of the funding pressures faced by most state-maintained schools at this time.

7.2.3. "Power produces, it produces reality"

As Foucault (1979) said, "Power produces; it produces reality." In the classroom, adults exert power over children in the teacher-student relationship, defining children's educational reality. In the home, adults exert power over children in the parent-child relationship, defining the reality of their home life and life outside of school. Children's

realities are heavily shaped by these adults, who then have their knowledge shaped by their local dispositif and the discourses which they interact with there. Parents adopt knowledge from their childhood experiences with their own parents, their belief systems (e.g. religion, politics, philosophy), their social circles, and the messages they are exposed to (and, in many cases, have targeted at them) through various forms of media. Teachers – though they encounter representatives of policymakers through Ofsted and Sats testing for other subjects – bring their own experiences with technology, professional training and experience, professional ecologies, belief systems, and local school culture with them to the subject, without direct influence (beyond infrequent documents and speeches) from the government regarding computing.

The knowledges and discourses that teachers and parents are exposed to include government-sponsored messages, but these messages must compete with other knowledges within their episteme, where they oftentimes conflict as they were developed in a dispositif different from the ones these groups (i.e. teachers, parents) exist within. Because of this dissonance – and because primary school teachers and parents were not included in any meaningful way in the development of the computing curriculum – these two groups have not adopted the knowledge that computer science is the "fourth science" (Runciman, 2016) or that it should be the "fourth pillar of a child's education" "alongside reading, writing and mathematics" (House of Lords Select Committee on Communications, 2017); in return, the curriculum does not accurately reflects the knowledges of those adults with the direct power to enculturate young students.

This thesis has unveiled the power relationships and knowledge present in the education policymaking sphere and how they conflict with those of the school-based policy-in-practice sphere. The computing curriculum is a relatively unique case of the British government not utilising the usual tools of governmentality in schools by neither evaluating computing teaching nor assessing students' computing learning, resulting in teachers being able to more fully enact their own will over students. One begins to wonder how teachers in England would teach other subject matter, were it also not under these forms of government surveillance.

7.2.4. Implications

It is difficult to offer specific recommendations as "the primary task of the analyst is not to proceed directly toward intervention and repair of the situation's discordancy but rather to understand and to put forth a diagnosis of 'what makes these responses simultaneously possible'" (Foucault, quoted in Rabinow, 2003, p. 18). However, it is clear from studying the three stages of this computing education policy that, during the policy's development, there was a lack of understanding of how it would be understood and interpreted by teacher. This was accompanied by a dismissive approach taken to teachers' agency and power, with the assumption made that teachers would simply obey whatever new regulatory requirements were placed upon them.

This study has clear implications at the policy level, where there is an obvious need for the DfE and other government agencies to work more closely with important policy-in-practice stakeholders – such as teachers, parents, and students – when developing school-based policy reforms. This will increase the likelihood that they will create

education policy that aligns with those stakeholders' episteme and is translated into the language of their discourse. Stakeholder involvement in the policy-making process would also help guide a more appropriate distribution of government assistance and resources during the policy implementation stage, ensuring that stakeholders have what they need to enact the policy rigorously. All of these steps – as outlined in Chapter 2 and further informed by Foucault's concept of dispositif – are critical to developing education policy that is a) going to be enacted in practice, and b) considered worthwhile by those who will be expected to engage with it.

At the level of practice, the implications are clear but the catalyst for their implementation less so. The skills and knowledges offered by the National Curriculum computing programme of study are too narrow and so a far wider range of digital skills and knowledges should be taught. Additionally, there is a need for social and behavioural training to be integrated into computing[36]. This is critical as we develop a growing awareness of how power relationships are being reorganised in the digital world: "Opaque social media algorithms get to decide, to an ever-increasing extent, which articles we read, who we keep in touch with, whose opinions we read, whose feedback we get" (Chollet, 2018).

Both the public and the world's governments appear to be two steps behind and as a result are being taken advantage of by bad actors due to governments' failure to provide more regulatory protections and industry's failure to provide technical solutions. Until

[36] Or ICT, or whatever else the amended curriculum would or should be called.

regulatory and technical solutions are in place, people (and the young in particular, given their particular vulnerability to manipulation and abuse) will need to be taught how to protect themselves and to make the most of new digitalised tools, systems, and processes. Schools – despite the desperate state of their finances and significant issues of overcrowding, over-regulation, and poor regulation – are best suited to provide a consistent training to all young people in these skills, and to enculturate them in these ways of thinking about and understanding the world.

Teachers who participated in this study understood their role as including the preparation of children for economic, civic, and social engagement in a changing world. However, the specifics of what exactly was needed for that successful engagement was less clear, resulting in mixed and muddied computing-ICT hybrid lessons and an overall focus on more obviously useful and rigorous subjects such as reading, writing, and maths. Who will provide teachers across the country with the guidance they need when the government has failed to do so? Are national academies, learned societies, professional organisations, and subject associations well suited to carry out this task given the role that several played in the creation of England's problematic computing curriculum? What can be done to make sure that every child has an adequate level of digital, media, and information literacy by the time they leave school? Do we even want *this* curriculum to work? Is it worth fixing? Because if not, then "there is no solution because there is no problem" (Marcel Duchamp, quoted in Webb, 2014, p. 365); perhaps instead we should start again from scratch, this time with all of the relevant stakeholders at the table wielding real power to make change. The answers to these questions are not yet clear

but the results of this study suggest that nothing will change in practice until new actors step up to make a new start at England's computing education policy.

The academic implications of this study include an improved understanding of how power relationships function to define a policy's purpose and value across different settings. The example of England's computing curriculum demonstrates how the power to define (e.g. values, morals, "truth") equates to the power to shape reality. This research contributes a unique perspective to the field of a single education policy as it passes through different stages in its development and implementation, encountering and being shaped by the beliefs and values of several groups along the way. Understanding how knowledge and discourse function to shape our reality is critical to understanding social processes in which multiple groups of individuals wield relational power, as they can modify the process of policy creation and enactment in unexpected ways, and therefore create unexpected outcomes. While the subjective, Foucauldian perspective on truth and reality may suggest that there is nothing universally worth doing, we may still wish (as individuals and groups existing within our own local dispositif) to make changes to the world and therefore act in ways which create desired outcomes.

An adequate digital skills education for children, for example, I find to be laudable and I would like to see it enacted. In order for me to make this change (or to advise allies from similar episteme on how to accomplish it) then I must understand which actors ultimately will be involved in the policy's development, creation, and enactment, and the discourse and episteme of the dispositifs which it will pass through on the way. By developing better understandings of these processes – and the role of dispositifs as processes

interact with different people groups – we, as academics, can better advise policymakers, practitioners, and others on how to make for true change in the world.

7.3. Future research

There is a critical gap in the field's understanding of a) what modern digital skills and knowledges people need, and b) how best to teach those skills and knowledges to children on a nationwide scale. We know that there is a serious need for further research into this type of education at the school level as opposed to in higher education, where most prior research has taken place (The Royal Society, 2017). From my thesis research it is clear further research is required on how digital skills curricula can be better designed to meet teachers' beliefs, needs, and abilities. We also need a more concrete understanding in the first place of which skills and knowledges are important for young people to learn. Overall, research has an important role to play in improving education in this area, which will benefit young people in a much-needed way:

> Young people need the best possible education if they are to thrive in a rapidly changing world. A good education should equip people to lead flourishing lives and give them the tools to help others flourish as well. Yet as the world changes, so too does the nature of education itself. For instance, technology has revolutionised people's access to information, reshaping the routes to public knowledge. Meanwhile, governments across the world spend billions on education, making countless crucial decisions about how to deploy those resources. Getting it right matters. That is why educational policy and practice should be informed by the best available research evidence (The Royal Society & The British Academy, 2018, p. 6).

Additionally, the field needs a better understanding of how power relationships work and how they develop knowledge. If the power to define knowledge is *the* most important form of power in any one culture, then it is all the more important to understand how it

develops, whether we can become aware of it in the moment and change it (or take on that power to define ourselves), and if there are ways to stabilise where the power to define rests. Given that the power to define is the power to shape a shared *episteme* of a society's beliefs and values (including how policy should be created and enacted, what education is or should be, and more) – and given our growing awareness of how networked, digital devices are being used to spread propaganda, mislead, and shape societies' understanding of "the truth" – the study of the power to define should be a high priority for social philosophers and others in similar lines of work.

It would also be useful to study how episteme and discourse overlap, for example between neighbouring "groups" or between slightly different groups located within the same broader culture. While the Internet has, in some ways, democratised communication, social groups and their differing dispositifs still exist, and the fact that they interact even more due to the Internet (and other technological innovations) means that there are more opportunities for these episteme and discourses to clash. Dispositifs clearly played a large role in why England's computing curriculum did not function as expected (as explored in Chapter 6) – even though there are significant overlaps between the knowledge of British policymakers, British teachers, and British parents – and it will play a role in the enactment of any policy. Further study of the similarities and differences between culturally neighbouring groups may give us some insight into how they can come to a common understanding about policy and practice, improving the functionality and harmony of a diverse country.

Lastly, seeing as one of the most problematic factors in the computing curriculum's development was the lack of teacher input, future research should be conducted on how teachers might be included in creating education policy and what impact that would have on the quality of its policy-in-practice state. A particularly interesting case at the time of this thesis's writing is Wales and the development of their Digital Competence Framework. The Welsh answer to England's computing curriculum, this framework was written by groups of teachers and trialled in thirteen Digital Pioneer Schools, nine of which are primary schools. All state primary schools across the country will be expected to fully implement the Digital Competence Framework by the end of 2022, making this an ideal time to study what impact teachers actively shaping education policy has had on its development (e.g. teachers' dispositif being accounted for) and adoption.

7.4. Failure to disrupt

While what technical skills individuals need in order to fully participate in society may change as new technological advancements (or particular companies' proprietary designs) come to the fore, many of the underlying social structures remain the same, as do the skills and knowledges necessary to engage with them. Leading on from this, there appears to be a fundamental misunderstanding around schools' fitness for purpose in the modern world and, as a result, what needs changing there. State-funded schools are overloaded with constantly shifting demands from government and industry, and the computing curriculum is no different. While implementation of the old ICT curriculum may have been flawed, the obstacles to providing a comprehensive and rigorous education in digital technology remain. Narrowing the list of content to be covered while also shifting to a subject that many teachers are unfamiliar with has not removed those

obstacles and, in fact, has left subject generalists with very little guidance on how to teach a very limited set of specialist skills. Additionally, the heavy burden of meeting the requirements of the government's various regulatory mechanisms takes time, energy, and other resources away from the teaching of more traditional subjects which are just as important today as they were before the invention of the Internet; some subjects are even more valuable now that we are located in a knowledge society and the need to read, write, and critically engage with information and media has become all the more important.

Educational policy, though it attempts (or gives lip-service) to listen to teachers' voices, ultimately is shaped by the episteme of policymakers and those discourses that they value, such as those of successful businesspeople in the modern tech industry. This is a fundamental issue in the British government as Cabinet ministers are frequently shuffled about to different roles and the Secretary of State for Education is not required to have any prior experience or training in education in order to qualify for the position. These ministers have a short period of time to implement their own policy ideas and make an impression on the electorate before they are moved again, either due to another Cabinet reshuffle or an overall change in government [i.e. the political party(/ies) in control of government], resulting in limited institutional memory in the DfE due to a high rate of staff turnover.

Schools have been largely left by design to interpret and implement the computing curriculum themselves, unsupported (Department for Education & Gove, 2012). If teachers did have an official forum in which they could be heard by policymakers, or an

official organisation that was dedicated to engaging with them about computing without an agenda, then the government, industry, and public would know by now that the implementation of the computing curriculum is not going as planned. This is important to acknowledge as each of these groups had hopes for what the curriculum would accomplish and it is not accomplishing those things in many schools for many students.

In the end, with weak policy and minimal ongoing training and support comes heterogeneous and contextualised practice, which is a point of both concern and hope. Further research is needed to decipher how the computing curriculum – or the National Curriculum more widely, or even England's entire educational apparatus – should be changed to better prepare young people for life in a world that has been affected in unknown ways by digital technology. The skills and knowledges offered in the current version of the National Curriculum are too narrow and ignore an obvious need for an education in the social and behavioural sciences to be integrated there. Additionally, the curriculum was not designed with the dispositifs of teachers and families in mind, and so could never hope to be fully adopted in the school and in the home. Addressing these deficiencies in design is critical as recent scandals have contributed to our growing awareness of how power is being reworked in the digital world. My future research will focus on how schools should be preparing young people for economic, civic, and social engagement through the development of students' information, media, and digital literacies in schools. In the meantime, teachers will do the best they can by their students, as they always have.

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Appendix A: Letter of ethical approval

SOCIAL SCIENCES & HUMANITIES INTER-DIVISIONAL RESEARCH ETHICS COMMITTEE
Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD
Tel: +44(0)1865 616576 Fax: +44(0)1865 280467
ethics@socsci.ox.ac.uk



6 April 2016

Ms Laura Pinkerton
Department for Education

Dear Ms Pinkerton,

Research Ethics Approval (CUREC 2)
Ref No: R45046/RE001
Title: Computing inequality: an ethnographic study of computing education, class culture, and access to power in English primary schools

The above application has been considered on behalf of the Social Sciences and Humanities Inter-divisional Research Ethics Committee (IDREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to the IDREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly approval has been granted.

Should there be any subsequent changes to the project, which raise ethical issues not covered in the original application, you should submit details to the IDREC for consideration.

Yours sincerely,

Claudia Kozeny-Pelling

Claudia Kozeny-Pelling
Research Ethics Manager and Secretary SSH IDREC

cc: Sara Loosemore, Education Office

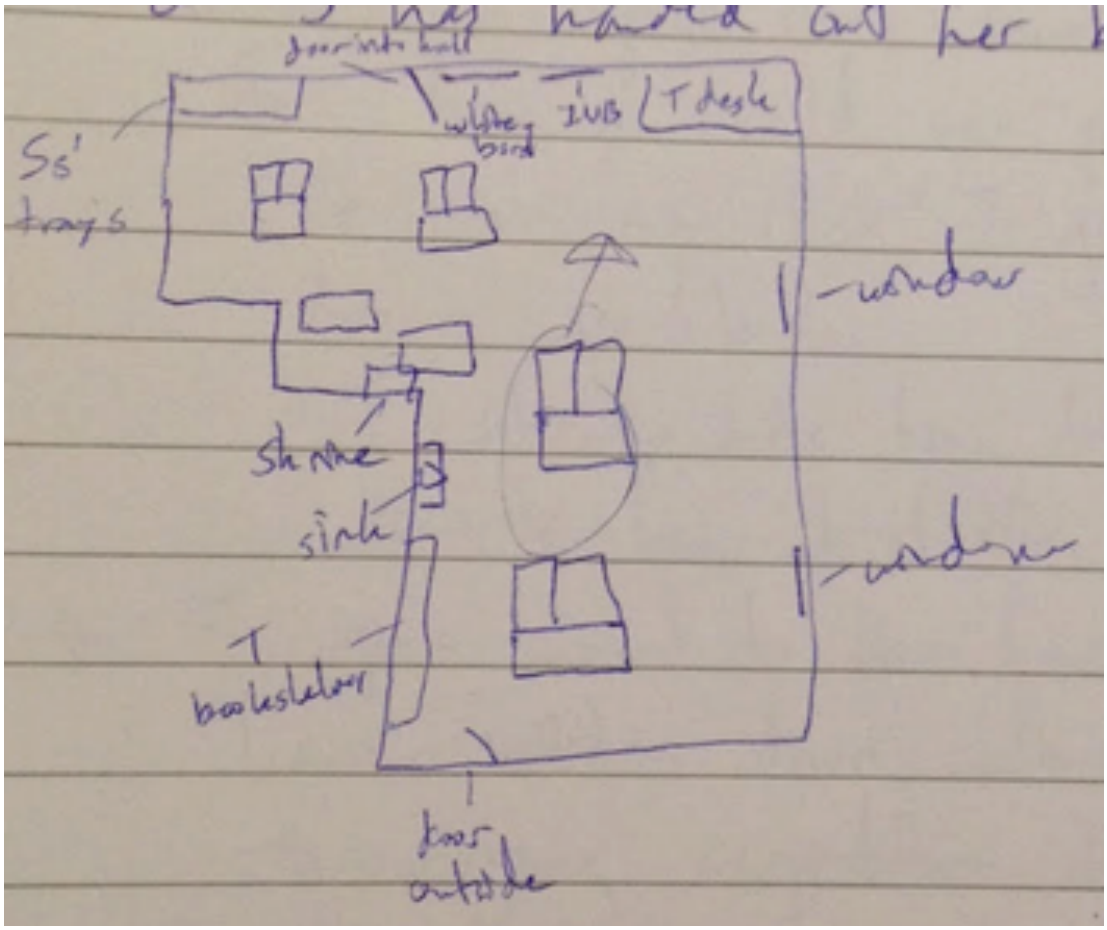
Appendix B: Excerpt from field notes – classroom setup

School 2, Year 3 classroom
6th June 2017

Key:
S/S1/S2, etc.: student
ST: student teacher
T: classroom teacher
Y2, etc.: Year 2

8:35am

- Classroom wall board: Africa (with maps and big cat info); English, Science, and shrine with cross and picture of Pope (class saint: ***[redacted]***).
- Day's schedule is on whiteboard, including 2min. silence at 11am; S1: "Why is there two minutes silence?" ST: "Because of the attacks in London." S2: "London Bridge!" S3: "Ohhh." S4: "Again?!"
- 29 Ss: 11 boys, 8 girls
- T(Y2) comes in to ask ST about chairs in the hallway. S: "What's in the hall?" ST: "It's none of your business, S. Stop being nosy."
- A S is handing out her birthday invitations.



Appendix C: Excerpts from field notes – reward/punishment systems

School 1, Year 2/3 classroom
5th September 2016
Staff meeting:

- Last week was "growth mindset" teacher CPD
    - "A bit 'airy-fairy'" says HT.
- HT [headteacher] introducing school "houses"
    - House points replacing stickers; will be displayed on ClassDojo
    - Related to British values somehow? Maybe each house exemplifies a certain value? But assignment to houses seems largely random.
    - Keeping Golden Moments for exceptional behaviour
    - Mix of House assignments within each classroom

School 1, Year 2/3 classroom
6th September 2016
9:00 – Carpet time:

- Points are uploaded to ClassDojo on the IWB and avatars are displayed
    - Some Ss have changed their avatars at home
- Ss' HPs [house points] are displayed
    - T: "Who has the most HPs?" Anthony does.
- Some HPs added last night by T based on submitted work.
- T teaching Ss why they should cross legs (to avoid tripping or kicking others) and how to show they're listening (e.g. eyes forward)
    - Also goes over behaviour that can earn Ss more HPs (e.g. keeping desks clean without being asked, reading at home, helping others and being kind, etc.)
- The house with the most points across the school will get a prize from the HT

School 1, Year 2/3 classroom
16th September 2016
10:00 – Carpet time:

- James is in the lead on ClassDojo house points
    - The student at the end of the week with the most house points receives a certificate
- House #3 is missing Ron and has the least house points; T points out that this is a reason why it's important not to be absent
- Netbooks will be on offer during Golden Time today
    - Some students say, "Yeah!"

Appendix D: Excerpts from field notes – capturing non-verbal behaviour

School 1, Year 2/3 classroom
10th October 2016
10:30am – Literacy lesson

- T insisting the Ss pick partners who they can work with "sensibly."
    - Anthony picks Ron who is unhappy with the arrangement and refuses to go with him until Anthony tells on him to T. He sits at his desk with his face on his folded up knees.
    - T insists he work with Anthony on this task. After T leaves, Ron starts crying, says something heatedly to Anthony (can't hear from this distance), then drags his chair to face the corner of the room.
    - Marty calls out to T: "Anthony made Ron upset." T calls them both over, looking stern.

11:15 – Assembly (Autumn Festival practice):

- At the end, T is telling off Keith for talking during assembly.
    - T: "I don't know why you're smiling. It makes me sad."
    - Keith stops smiling. As they are excused from the assembly he strays to the end of the line, furthest from the T and a little ways from the other students, who he doesn't talk to.

School 1, Year 2/3 classroom
19th October 2016
12:00 – Maths lesson

- Allan to Jane: "It's so easy! It's so easy, isn't it?"
- Jane pouts when Allan rushes through counting on their shared pattern sheet, making her lose her place. He asks her one of the questions, she answers doubtfully, he says she's correct and says what the pattern is for the rest of the answers on the sheet. She fills them in using the pattern. Later, when TA points out that she figured out the pattern, Jane tells the TA that Allan told her the pattern. TA looks displeased [adult perspective is this is cheating? but children see it as giving credit where credit is due?].

Appendix E: Excerpt from teacher interview transcript

School 2, Year 4 teacher

Interviewer: Can you speak about the constraints on you as a teacher? Like the National Curriculum and Ofsted, how that affects how you would like to teach.

Respondent: I think the biggest thing is funding. Especially things like, obviously we've mentioned extra support, but I'm talking from as a sort of new teacher, so I've come into it kind of used to this is how it is, this is the norm. But when you hear teachers who have been here for a while and they are saying we used to have this sort of support and this sort of support and then gradually it's just been cut and cut and cut. I personally like the National Curriculum, if I'm honest.

I think there are certain areas which it's just they've, I can't think of the word, say for example in the grammar and the stuff that kids have to know grammatically well, I think grammar is great that they are actually learning it but there are certain areas in there that you don't necessarily need and it's not a fundamental thing to have, like learning what a determiner is and I just think kids use it in everyday language so I don't think they need to know specifically what that is.

But then there are lots of things that I think is really beneficial and that I didn't have when I was a child at school which I would have liked to have learnt myself because I've had to reteach myself everything because it's not so much in maths, because it was new systems and you just deal with it. But I think in English you just write because you can write; you don't remember actually how you have managed to get there so when a child goes well how do you know where to place a comma? Oh, okay, I actually need to learn everything again; obviously during training and things.

Ofsted obviously is a huge huge constraint, we've had our Ofsted inspection this year, academic year and the two inspector's that came in were really calming so it wasn't such a stressful time, it is just because if you are a teacher, you just want to be the best that you possibly can but when I started here in the September we were expecting Ofsted and they didn't come until about a year and a half later, so that whole time that I was there you are constantly on edge thinking they are going to come in so that doesn't help much. Because you feel like you can't sort of go off on some massive project because you can't have Ofsted coming in half way through a massive project and you just teach like that.

When they do come in you just do a one off lesson so I don't know, I think that's frustrating but definitely resources is the major factor.

Interviewer: So, you must have come in the year they made those changes to the National Curriculum like adding computing.

Respondent: Yes, during my PGCE they obviously started with the computing course although I think they were just in the dark about it than anyone else. It was a little bit I don't think I gained enough from the PGCE with the computing course.

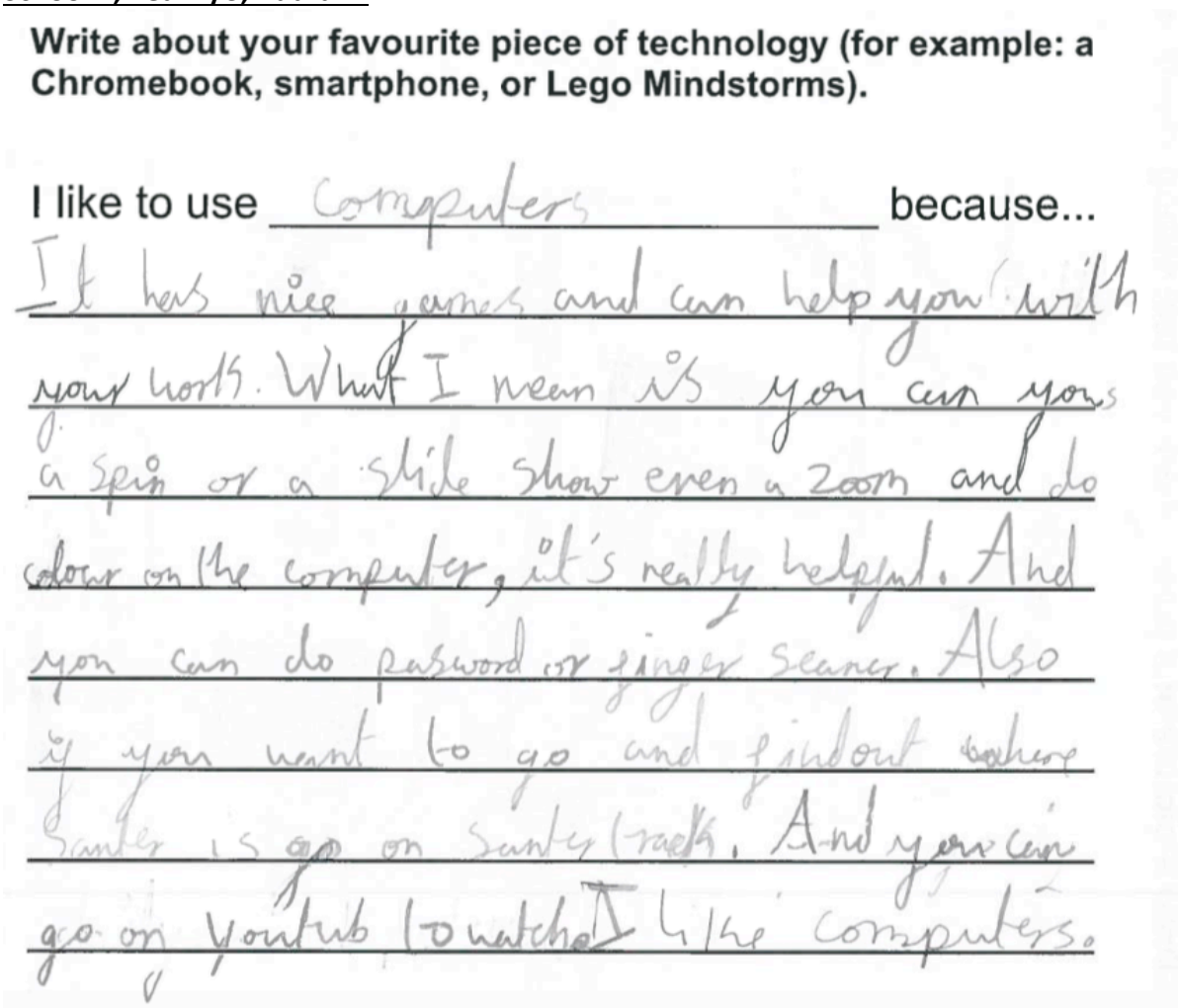
Interviewer: What did they teach you?

Respondent: It was more like programming and debugging rather than anything, because that's something, well not everybody just knows but you know that's one thing where I don't think they delved into enough equally. I was only on a PGCE course, so you are only in there for however many weeks overall so it makes it a little bit harder.

Appendix F: Example student writing activity sheets

School 1, Year 2/3, Rudrani:

Write about your favourite piece of technology (for example: a Chromebook, smartphone, or Lego Mindstorms).

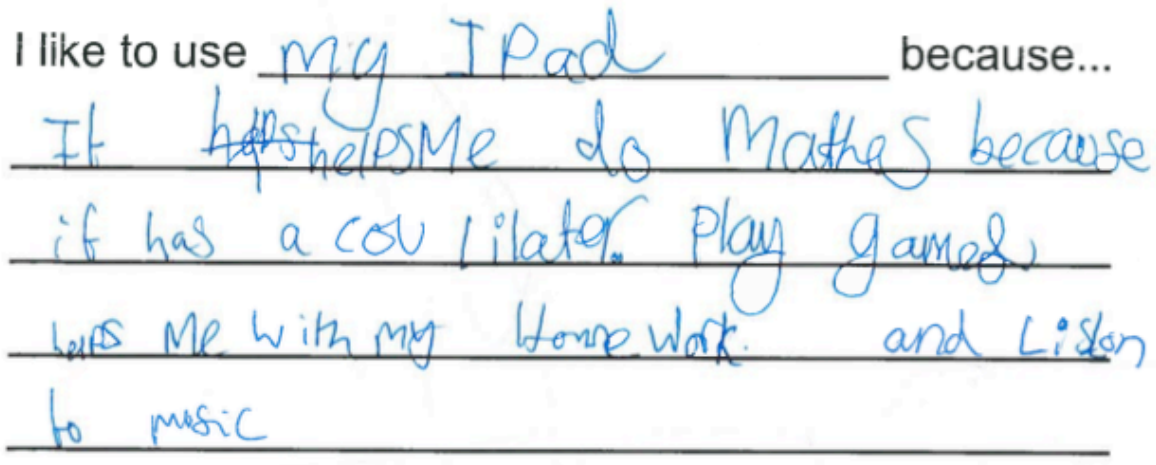


I like to use Computers because...

It has nice games and can help you with your work. What I mean is you can you a spin or a slide show even a Zoom and do colour on the computer, it's really helpful. And you can do password or finger scanner. Also if you want to go and find out where Santa is go on Santa tracks. And you can go on Youtub to watch I like Computers.

School 1, Year 2/3, Flora:

Write about your favourite piece of technology (for example: a Chromebook, smartphone, or Lego Mindstorms).



I like to use my IPad because...

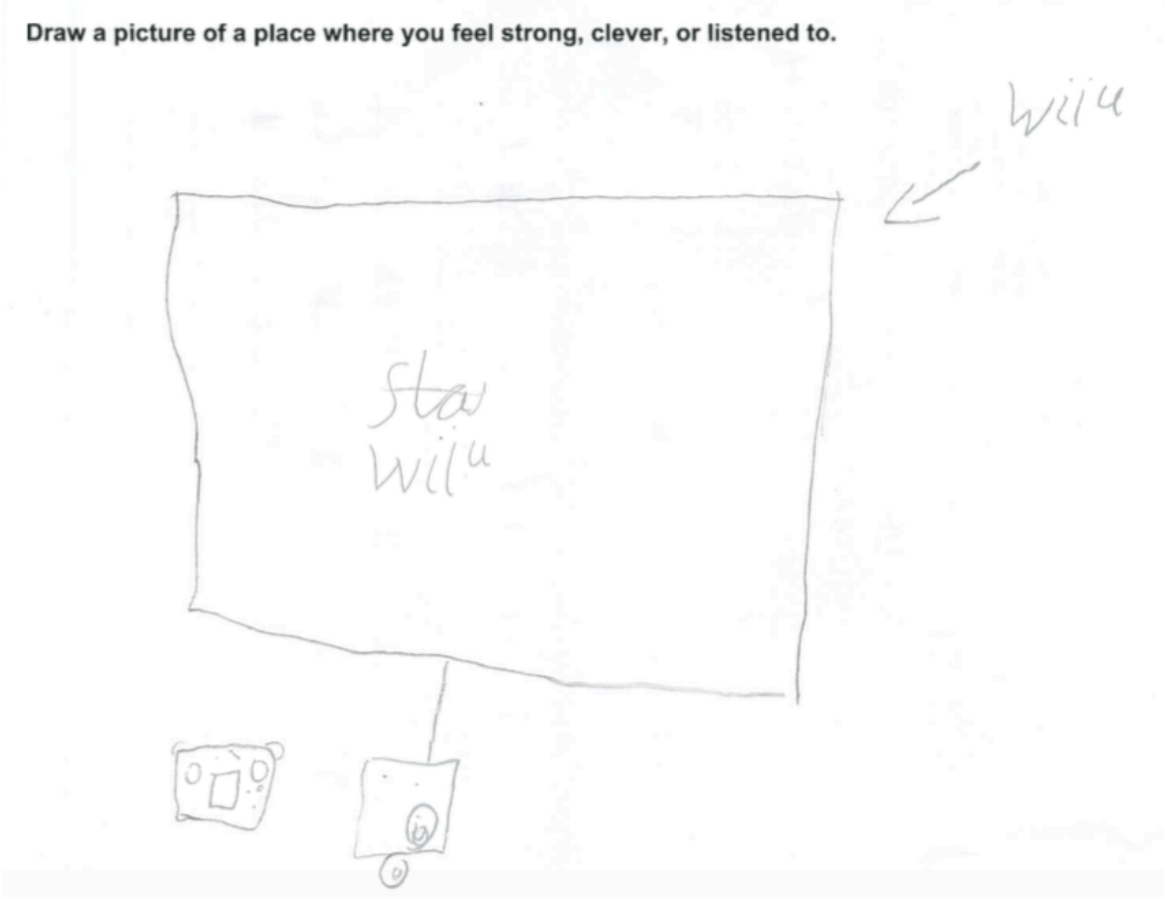
It ~~has~~ helpsMe do Mathes because if has a cou / ilator. Play games. helps Me with my Home Work. and Lisen to music

Appendix G: Example student drawing activity sheets

School 2, Year 2, Camilla:



School 2, Year 4, Sean:



Appendix H: Excerpt from student interview transcript

School 2, Year 3, Alistair

Respondent: I like to use the iPad because you can see what the weather is like; you get to play games and you get to learn new things.

Interviewer: Okay. So, do you have an iPad at home?

Respondent: Yes, my dad normally lets me play on it. My dad has two, one that he bought and one for work.

Interviewer: And how often does he let you use it? Does he have rules?

Respondent: Well, when he says it is time to get off, I have to get off quickly otherwise he gets a bit cross because he may want to use it for a reason.

Interviewer: And, so, you like to look up the weather?

Respondent: Yes.

Interviewer: Do you know what app you use for that?

Respondent: Well, sometimes we use a Met Office one and sometimes we use weather kind of thing one.

Interviewer: And is the weather something you are really interested in?

Respondent: Yes, because my mom and dad work about it. My mom makes machines and my dad does all the "why wind changes this way, then this way up here, and just all squiggly down here."

Interviewer: So, is that something you look at together, the weather app?

Respondent: Yes, and sometimes I have to do it quickly so, sometimes my mom and dad or even my grandpa or grandma [want to] know what weather it is so that they know if we put it in the tumble-dryer or outside.

Interviewer: Yes, okay. And you also said that you can learn things on the iPad. What kinds of things do you learn?

Respondent: Well, you can learn things on Google. Stuff. As well, if you have a question you have like a million answers to it.

Interviewer: So, if there are a million answers, how do you know which one is the right answer?

Respondent: Well, you could have a look at all of them and make a prediction about which one is right, because the one that has more and the one that has least, they may say it in different ways. You have to work that out.

Interviewer: And is there anything in particular you would like to learn about on Google?

Respondent: Well, I am interested in the periodic table, atoms and stuff.

Interviewer: So what is something you might type into Google about the periodic table?

Respondent: Well, I type in to see what some look like and as well, what the atoms look like. What the atoms combine to make like, water, two hydrogens and an oxygen and diamonds and sugar. I am just trying to remember how you make sugar, oh yes, sugar, so we have, sugar is a carbon, oxygen and hydrogen and I have no idea how many.

Interviewer: Cool. Yes, I don't think I know either but that is something you can look up.

Respondent: Yes, and a diamond molecule is all carbons.

Interviewer: Okay. So, you find this all out on the Internet?

Respondent: Yes, and sometimes my dad gives me information and I have a chart of it so I learn some things off of it as well.

Interviewer: Okay. Is the chart things he wants you to look up or is the chart things that you have found and you write on?

Respondent: Well to help me remember, because there is an awful lot to remember.

Interviewer: It is, you are right. And if you had to choose, would you rather learn about the periodic table, for example, from the Internet using your iPad or from a book?

Respondent: Well, I think a book is more better because, a) it is cheaper, b) it is like, it is kind of, your eyes do not go a bit funny by just watching it all the time.

Interviewer: Does the screen hurt your eyes sometimes?

Respondent: Yes.

Appendix I: National Curriculum Computing Programme of Study

Purpose of study

A high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world. Computing has deep links with mathematics, science and design and technology, and provides insights into both natural and artificial systems. The core of computing is computer science, in which pupils are taught the principles of information and computation, how digital systems work and how to put this knowledge to use through programming. Building on this knowledge and understanding, pupils are equipped to use information technology to create programs, systems and a range of content. Computing also ensures that pupils become digitally literate – able to use, and express themselves and develop their ideas through, information and communication technology – at a level suitable for the future workplace and as active participants in a digital world.

Aims

The national curriculum for computing aims to ensure that all pupils:

- can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation
- can analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems
- can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems
- are responsible, competent, confident and creative users of information and communication technology

Attainment targets

By the end of each key stage, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study.

Subject content

Key stage 1

Pupils should be taught to:

- understand what algorithms are, how they are implemented as programs on digital devices, and that programs execute by following precise and unambiguous instructions
- create and debug simple programs
- use logical reasoning to predict the behaviour of simple programs
- use technology purposefully to create, organise, store, manipulate and retrieve digital content
- recognise common uses of information technology beyond school
- use technology safely and respectfully, keeping personal information private; identify where to go for help and support when they have concerns about content or contact on the internet or other online technologies

Key stage 2

Pupils should be taught to:

- design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts
- use sequence, selection, and repetition in programs; work with variables and various forms of input and output
- use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs
- understand computer networks, including the internet; how they can provide multiple services, such as the World Wide Web, and the opportunities they offer for communication and collaboration
- use search technologies effectively, appreciate how results are selected and ranked, and be discerning in evaluating digital content
- select, use and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating and presenting data and information
- use technology safely, respectfully and responsibly; recognise acceptable/unacceptable behaviour; identify a range of ways to report concerns about content and contact

Appendix J: National Curriculum ICT Programme of Study

***Note*:** Retrieved 28 March 2012; curriculum last updated 25 November 2011.

ICT: Key Stage 1

During Key Stage 1 pupils explore ICT and learn to use it confidently and with purpose to achieve specific outcomes. They start to use ICT to develop their ideas and record their creative work. They become familiar with hardware and software.

Knowledge, skills and understanding

Finding things out

1. Pupils should be taught how to:

a. gather information from a variety of sources [for example, people, books, databases, CD-ROMs, videos and TV]

b. enter and store information in a variety of forms [for example, storing information in a prepared database, saving work]

c. retrieve information that has been stored [for example, using a CD-ROM, loading saved work].

Developing ideas and making things happen

2. Pupils should be taught:

a. to use text, tables, images and sound to develop their ideas

b. how to select from and add to information they have retrieved for particular purposes

c. how to plan and give instructions to make things happen [for example, programming a floor turtle, placing instructions in the right order]

d. to try things out and explore what happens in real and imaginary situations [for example, trying out different colours on an image, using an adventure game or simulation].

Exchanging and sharing information

3. Pupils should be taught:

a. how to share their ideas by presenting information in a variety of forms [for example, text, images, tables, sounds]

b. to present their completed work effectively [for example, for public display].

Reviewing, modifying and evaluating work as it progresses

4. Pupils should be taught to:

a. review what they have done to help them develop their ideas

b. describe the effects of their actions

c. talk about what they might change in future work.

Breadth of study

5. During the key stage, pupils should be taught the knowledge, skills and understanding through:

a. working with a range of information to investigate the different ways it can be presented [for example, information about the Sun presented as a poem, picture or sound pattern]

b. exploring a variety of ICT tools [for example, floor turtle, word processing software, adventure game]
c. talking about the uses of ICT inside and outside school.

Explanatory notes and cross-curriculum references
Note for 1a - Cross reference to English
En2 Reading: Reading for information
2. Pupils should be taught to:
a. use the organisational features of non-fiction texts, including captions, illustrations, contents, index and chapters, to find information
b. understand that texts about the same topic may contain different information or present similar information in different ways
c. use reference materials for different purposes

Note for 2a - Cross reference to mathematics
Ma2 Number: Processing, representing and interpreting data
5. Pupils should be taught to:
a. solve a relevant problem by using simple lists, tables and charts to sort, classify and organise information

Health and safety note
The general teaching requirement for health and safety applies in this subject.

ICT: Key Stage 2
During Key Stage 2 pupils use a wider range of ICT tools and information sources to support their work in other subjects. They develop their research skills and decide what information is appropriate for their work. They begin to question the plausibility and quality of information. They learn how to amend their work and present it in a way that suits its audience.

Knowledge, skills and understanding
Finding things out
1. Pupils should be taught:
a. to talk about what information they need and how they can find and use it [for example, searching the internet or a CD-ROM, using printed material, asking people]
b. how to prepare information for development using ICT, including selecting suitable sources, finding information, classifying it and checking it for accuracy [for example, finding information from books or newspapers, creating a class database, classifying by characteristics and purposes, checking the spelling of names is consistent]
c. to interpret information, to check it is relevant and reasonable and to think about what might happen if there were any errors or omissions.

Developing ideas and making things happen
2. Pupils should be taught:
a. how to develop and refine ideas by bringing together, organising and reorganising text, tables, images and sound as appropriate [for example, desktop publishing, multimedia

presentations]
b. how to create, test, improve and refine sequences of instructions to make things happen and to monitor events and respond to them [for example, monitoring changes in temperature, detecting light levels and turning on a light]
c. to use simulations and explore models in order to answer 'What if ... ?' questions, to investigate and evaluate the effect of changing values and to identify patterns and relationships [for example, simulation software, spreadsheet models].

Exchanging and sharing information
3. Pupils should be taught:
a. how to share and exchange information in a variety of forms, including e-mail [for example, displays, posters, animations, musical compositions]
b. to be sensitive to the needs of the audience and think carefully about the content and quality when communicating information [for example, work for presentation to other pupils, writing for parents, publishing on the internet].

Reviewing, modifying and evaluating work as it progresses
4. Pupils should be taught to:
a. review what they and others have done to help them develop their ideas
b. describe and talk about the effectiveness of their work with ICT, comparing it with other methods and considering the effect it has on others [for example, the impact made by a desktop-published newsletter or poster]
c. talk about how they could improve future work.

Breadth of study
5. During the key stage, pupils should be taught the knowledge, skills and understanding through:
a. working with a range of information to consider its characteristics and purposes [for example, collecting factual data from the internet and a class survey to compare the findings]
b. working with others to explore a variety of information sources and ICT tools [for example, searching the internet for information about a different part of the world, designing textile patterns using graphics software, using ICT tools to capture and change sounds]
c. investigating and comparing the uses of ICT inside and outside school.

Explanatory notes and cross-curriculum references
Note for 1a - Cross reference to English
En2 Reading: Reading for information
3. Pupils should be taught to:
a. scan texts to find information
b. skim for gist and overall impression
c. obtain specific information through detailed reading
d. draw on different features of texts, including print, sound and image, to obtain meaning
e. use organisational features and systems to find texts and information
f. distinguish between fact and opinion [for example, by looking at the purpose of the

text, the reliability of information]
g. consider an argument critically

Note for 2a - Cross reference to English
En3 Writing: Planning and drafting
2. To develop their writing on paper and on screen, pupils should be taught to:
a. plan - note and develop initial ideas
b. draft - develop ideas from the plan into structured written text
c. revise - change and improve the draft
d. proofread - check the draft for spelling and punctuation errors, omissions and repetitions
e. present - prepare a neat, correct and clear final copy
f. discuss and evaluate their own and others' writing

Note for 2c - Cross reference to mathematics
Ma2 Number: Solving numerical problems
4. Pupils should be taught to:
d. recognise, represent and interpret simple number relationships, constructing and using formulae in words then symbols [for example, c = 15n is the cost, in pence, of n articles at 15p each]

Health and safety note
The general teaching requirement for health and safety applies in this subject.

ICT: Attainment target level descriptions
Level 1
Pupils explore information from various sources, showing they know that information exists in different forms. They use ICT to work with text, images and sound to help them share their ideas. They recognise that many everyday devices respond to signals and instructions. They make choices when using such devices to produce different outcomes. They talk about their use of ICT.

Level 2
Pupils use ICT to organise and classify information and to present their findings. They enter, save and retrieve work. They use ICT to help them generate, amend and record their work and share their ideas in different forms, including text, tables, images and sound. They plan and give instructions to make things happen and describe the effects. They use ICT to explore what happens in real and imaginary situations. They talk about their experiences of ICT both inside and outside school.

Level 3
Pupils use ICT to save information and to find and use appropriate stored information, following straightforward lines of enquiry. They use ICT to generate, develop, organise and present their work. They share and exchange their ideas with others. They use sequences of instructions to control devices and achieve specific outcomes. They make appropriate choices when using ICT-based models or simulations to help them find things out and solve problems. They describe their use of ICT and its use outside school.

Level 4
Pupils understand the need for care in framing questions when collecting, finding and interrogating information. They interpret their findings, question plausibility and recognise that poor-quality information leads to unreliable results. They add to, amend and combine different forms of information from a variety of sources. They use ICT to present information in different forms and show they are aware of the intended audience and the need for quality in their presentations. They exchange information and ideas with others in a variety of ways, including using email. They use ICT systems to control events in a predetermined manner and to sense physical data. They use ICT-based models and simulations to explore patterns and relationships, and make predictions about the consequences of their decisions. They compare their use of ICT with other methods and with its use outside school.

Level 5
Pupils select the information they need for different purposes, check its accuracy and organise it in a form suitable for processing. They use ICT to structure, refine and present information in different forms and styles for specific purposes and audiences. They exchange information and ideas with others in a variety of ways, including using email. They create sequences of instructions to control events, and understand the need to be precise when framing and sequencing instructions. They understand how ICT devices with sensors can be used to monitor and measure external events. They explore the effects of changing the variables in an ICT-based model. They discuss their knowledge and experience of using ICT and their observations of its use outside school. They assess the use of ICT in their work and are able to reflect critically in order to make improvements in subsequent work.

Level 6
Pupils develop and refine their work to enhance its quality, using information from a range of sources. Where necessary, they use complex lines of enquiry to test hypotheses. They present their ideas in a variety of ways and show a clear sense of audience. They develop, try out and refine sequences of instructions to monitor, measure and control events, and show efficiency in framing these instructions. They use ICT-based models to make predictions and vary the rules within the models. They assess the validity of these models by comparing their behaviour with information from other sources. They discuss the impact of ICT on society.

Level 7
Pupils combine information from a variety of ICT-based and other sources for presentation to different audiences. They identify the advantages and limitations of different information-handling applications. They select and use information systems suited to their work in a variety of contexts, translating enquiries expressed in ordinary language into the form required by the system. They use ICT to measure, record and analyse physical variables and control events. They design ICT-based models and procedures with variables to meet particular needs. They consider the benefits and limitations of ICT tools and information sources and of the results they produce, and they use these results to inform future judgements about the quality of their work. They take part in informed discussions about the use of ICT and its impact on society.

Level 8
Pupils independently select appropriate information sources and ICT tools for specific tasks, taking into account ease of use and suitability. They design successful ways to collect and prepare information for processing. They design and implement systems for others to use. When developing systems that respond to events, they make appropriate use of feedback. They take part in informed discussions about the social, economic, ethical and moral issues raised by ICT.

Exceptional performance
Pupils evaluate software packages and ICT-based models, analysing the situations for which they were developed and assessing their efficiency, ease of use and appropriateness. They suggest refinements to existing systems and design, implement and document systems for others to use, predicting some of the consequences that could arise from the use of such systems. When discussing their own and others' use of ICT, they use their knowledge and experience of information systems to inform their views on the social, economic, political, legal, ethical and moral issues raised by ICT."