The impact of the Computing National Curriculum in English secondary education. A comparative case study.

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Abstract

The National Curriculum for Computing was introduced in 2014 to move away from the predecessor subject information communication technology (ICT). The new curriculum was intended to change pupils from being users of computers, to building an in-depth understanding of how they work (Royal Society, 2012; DfE, 2013). This change was to address a lack of fundamental computing knowledge and remedy a skills gap identified in employment patterns. Despite the intentions, data and research demonstrated a decline in the numbers of pupils studying computing at the ages of 14-16 years in the years following the curriculum change. There were also indications of gaps in both gender and socioeconomic background of the pupils selecting to study computing at higher levels (Royal Society, 2017). The data for this thesis was collected in the academic year 2018 to 2019. This was following the outcomes in 2017 when just 11.9% of eligible pupils were selecting to study the general certificate of education (GCSE) in computer science (qualification at age 14-16 years). This was far fewer than those studying the predecessor qualification in ICT at its peak in 2014 (Kemp, Berry and Wong, 2018).

This thesis takes a case study approach to explore how the updated curriculum was being received and delivered in schools within the first five years of its introduction. The study also explores what the perceived impact was for learners in the schools. The two case studies are dissected through a Bernsteinian lens to explore the strength of classification of computing as a subject, including the influence of the official field of reproduction, the pedagogic discourse, as presented through a range of pedagogic

devices, and the experience of learners from different backgrounds (Bernstein, 1975; 1990; 2000). During the academic year 2018 to 2019, data were collected in two contrasting schools. Data consisted of interviews with each of the Heads of Department, two teachers, 6 pupils in key stage 3 (age 11 to 14 years), 14 pupils in key stage 4 (age 14 to 16 years) and 2 pupils in key stage 5 (age 16 to 18 years). Included as part of the data is a selection of photographs of the learning environments, a range of curriculum documentation and department level documentation including a department vision and web pages.

Analysis of the data explores the strength of classification of computing as a subject and how the curriculum was being designed and structured. The data also explore the pedagogic discourse, how teachers were delivering the curriculum and the experiences of learners in the classroom. This is followed through to attainment and whether the learners intended to continue their studies or seek employment relating to computing. The findings indicate an interconnectedness between the curriculum intentions, the strength of the classification of the subject and the experience of learners. For example, when the classification of the subject was weak, this resulted in a lack of prioritisation of computing in management decisions. This could then reduce the efficacy of pedagogic devices, for example, through a lack of curriculum time given to the subject. These consequences are revealed through the regulative discourse, which is the actual pedagogy taking place in the classroom (Bernstein, 2000). Schools also faced external barriers, including a shortage of specialist staff, that weakened the pedagogic discourse in the subject. The study concludes with recommendations for further research to explore relationships between the strength of classification of the subject in individual schools and the outcomes for pupils, including for those in demographic groups that remain underrepresented in computing education.

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Chapter 1: The impact of the Computing National Curriculum in English secondary education. A comparative case study.

1.1 Introduction

In 2012, the Department for Education introduced the computing curriculum in England (Gove, 2012). The new National Curriculum programmes of study in computing were published in 2013 and became statutory for maintained schools in England in 2014 (DfE, 2013). The computing National Curriculum was a shift away from the discontinued National Curriculum in information communications technology (ICT) (Royal Society, 2012). The implementation and progress against the new curriculum since its launch is the basis for this study. The extract following is taken from the National Curriculum outlining the purpose for pupils to study computing in English schools.

> *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

(Taken from National Curriculum in England: Computing Programmes of Study, DfE 2013)

This thesis explores the implications of the Computing National Curriculum for both teachers and learners. The data were collected during the academic year 2018-2019, over four years after their introduction.

1.2 Professional influence and choice of study

I have been a teacher of Information Communications Technology (ICT) since qualifying as a teacher in 1999. I have progressed through the ranks, leading departments, faculties and being part of the senior leadership team in schools. This career has been based in the secondary education sector. The 2000s were a 'boom time' in ICT in schools and this particularly impacted my rapid career development. At that time, ICT was innovative, both as a subject and as a tool for use across the curriculum (Cox, 2003, Somekh, 2007). Learners completed a range of qualifications in ICT at GCSE level or equivalent (General Certificate of Education, qualifications taken at age 16 years in English secondary schools). These contributed considerably to the overall number of qualifications a learner would take, sometimes providing 2 or even 4 of their final 9 or 10 grades. At the time, the top 5 grades were used as headline figures for the performance of each pupil and also used to compare schools. ICT as a growing subject and the development of subject based qualifications is explored in detail in chapter 2. As a head of department in school producing strong ICT results, I was valued. From a school leadership perspective, I was able to contribute massively to the overall performance of a school and support colleagues in developing their practice. In 2006, I was recruited by a local authority as an ICT adviser, to provide the support and guidance for schools across the area to improve their own ICT results.

But pupils' examination results was not the sole motivation for my work. Of course, all teachers take great delight in their learners doing well and achieving top grades, but pupils grades are not the main driver for my love of teaching ICT. I have always been passionate about the subject.

During my own education, computers were not always available to me to use constructively at school; we had access occasionally as a one-off experience to try disconnected activities. My love of computing came from wider experiences outside of school and during my undergraduate course. During that time, the applications and computational thinking opened up so many doors for me, including speed of communication, collection and analysis of data and learning about the world. Post-university I went into a computational role, carrying out programming and software engineering for a large utilities company. Ultimately, this was not as fulfilling as I wanted; I wanted learners in schools to benefit from the same opportunities I had had, to develop their computer-based skills and see what an impact ICT could have on their wider lives. I made the decision to retrain as a teacher. At the time, there was much talk of the 'digital divide'. Learners who had access to computers and those who did not. There was a fear that learners without access and experience of computers would be left behind (Eynon, 2009). As a passionate, young teacher I had lots of lunchtime clubs, after school clubs and supported pupils to take part in all sorts of computer education-based competitions. In the schools I worked in, all pupils were required to take ICT subjects as part of their core studies. There were no gender differences in this. The differences in outcomes for pupils from disadvantaged backgrounds, who tended not to perform as well as those from more affluent households, were similar in ICT as they were in other subjects. Whilst the digital divide was much talked about, the actual impact on securing ICT qualifications was similar to that of other subjects (Coe, 2008; Playford and Gayle, 2014). Chapter two of this thesis explores this time of ICT education and the shift towards computing education.

Despite the prominence of ICT in the 2000s and the high numbers of qualifications earned by learners, a concern was rising in the information technology (IT) industry in the UK. They felt that the young people emerging into the labour market did not have the skills and computer-based knowledge required to join the industry, even at the most junior of levels (Schmidt, 2012). The Department for Education listened and commissioned a report into ICT. The report identified a number of issues with ICT and essentially determined that the ICT curriculum was not fit for purpose (Royal Society, 2012; Wells, 2012).

A significant shift between 2012 and 2014 brought about a considerable rethink and subsequent policy change In England. Ultimately, the National Curriculum was rewritten to move from ICT to computing education. GCSEs in ICT were phased out, being replaced with GCSE in Computer Science. Similar was happening for older learners at A (Advanced) Level (Kemp et al, 2016). My own previous experience in programming and software engineering meant I had the technical skills and knowledge to be able to adapt from ICT teaching to the new demands of the computing curriculum. At that time, I changed roles, moving from schools into university-based initial teacher education, tasked with implementing a new postgraduate certificate in education (PGCE) for computing. Part of this role was to provide subject specialist continuing professional development (CPD) for prospective mentors. These mentors were existing heads of department and experienced ICT teachers. The conversations we had during the CPD sessions were highly reflective of the changes, of how these teachers had been made to feel by the changes and whether they felt they had the knowledge and experience to make it work. The ultimate topic of discussion on several occasions was whether it was the right thing for the learners. Teachers at this time were also presented with a range of challenges including addressing subject knowledge and ensuring computing was inclusive for all learners (Brown et al, 2013; Sentence and Csizmadia, 2017).

During part 1 of my EdD course I explored many of these tensions in the shift from computing to ICT education. I interviewed mentors and student teachers and explored the rhetoric in the media at the time. Particularly memorable pieces of data I explored were Jeremy Paxman on Newsnight looking at programming being introduced to primary schools and a prevalent classroom poster featuring Barack Obama (President of the United States of America at the time) (see Figure 1.1). Paxman looked at some of the tasks pupils were being asked to do and asked the interviewee ‘what was all this ‘gobbledygook’?, implying the code he could see on the screen was entirely incomprehensible (BBC, 2014). Simultaneously, in the prevalent poster, Obama instructed ‘Don’t just play on your phone, program it’ (Hour of Code, 2014).

Figure 1.1: Barack Obama featuring in promotional material for 'The Hour of Code' http://hourofcode.com/us [accessed 15/04/15]

There was certainly a shift in how the subject was perceived, no longer a simple software usage subject, cashing in on qualifications. It was then seen as something much more complex. Chapter 2 explores some of the initial concerns raised in my conversations with teachers at the time. Subsequently, there was a decline in learner numbers. There were also differences in the data that were not evident in ICT, including differences in percentages of learners from different backgrounds, ethnic groups and the formation of a significant gender divide (Kemp et al, 2016; Royal Society, 2017; Crick, 2017).

My explorations of both theory and data in part 1 of my doctoral studies gave me the freedom to explore some quite complex relationships between teachers, student teachers and the new computing curriculum. In one paper (Appendix 1), I used images of computing and ICT-based activities and resources to explore how student teachers themselves identified with the subject. What became clear from that study was that, for the forty student teachers involved, their consideration of the ‘how’ of generic learning was far more dominant than the actual subject matter itself. Peer learning and group work were more of a priority for them than the disciplinary knowledge they were teaching (Overland, 2016). The most dominant topic of the subject knowledge being taught emerged as that of ‘e-safety’, a topic prevalent in the previous ICT curriculum. This study indicated that even for new teachers joining the profession, computing as a subject lacked a clear subject specific identity. What I did not have scope to explore at the time was why that was potentially the case. It could have been influenced from the mentors in school, the tutors on their teaching course (I of course include myself in that) or a continuation from their own experiences in education.

A report published in 2017 raised even more questions for me about the impact and consequences of the change from ICT to computing had made (Royal Society, 2017). My own professional experiences mirrored the findings of this report. Not all schools were offering computer science at GCSE. Many learners were still following ICT style qualifications under different titles and formats, such as certificates in iMedia (Oxford, Cambridge and RSA, 2019). Many schools still had ICT lessons on their timetables as their software would not update to the new name. There was a general mixed economy in schools. The most stark observation from both the data and my experiences was the lack of girls selecting to study the subject as one of their formal qualification selections (Lewin and Overland, 2024).

My observations, the reports I have read, and the experiences of my student teachers and their mentors, has resulted in a real dichotomy of potential research questions. In much research in the field, each of the challenges in computing education is addressed independently, sometimes with an associated intervention. For example, much is being done in an attempt to increase the number of girls opting for computer science (Gorriz et al, 2000; Wilson, 2002; Craig et al, 2008). In these cases, events may engage girls and spark their interest in the subject, but if the curriculum is not clearly defined within their school, or their teachers lack subject knowledge, then these interventions may ultimately not have the intended impact. Whilst the 'After the reboot' report draws together a range of issues in the form of 12 separate recommendations, the relationships between these are potentially complex and the interplay between them could provide a different way of exploring the impact of the computing curriculum (Ball et al, 2012; Royal Society, 2017).

As part of developing my research questions, I had conversations with many colleagues and carried out a pilot study in a local school, interviewing both teachers and pupils. Whilst the focus of my study is on policy implementation, what was clear from my initial discussions was the complexity of the issue. The national curriculum is a formal requirement, although the extent to which it is fully being implemented is complex. For example, one colleague reported changing the title of the subject in name alone, but had not had time to make any substantive changes to the content they were delivering. The differences in implementation were mainly subtle, potentially a hidden curriculum taking place as part of a regulative discourse (Giroux and Penna, 1979; Bernstein, 2000).

1.3 Research questions

With such broad questions, I returned to the subject matter I know, programming and systems design. In each of my projects, at the simplest level, I would apply a simple logic model, to analyse the input, process and output of the system (McConnel et al, 2011). In the overall case of the computing curriculum, in its simplest form, the input is the curriculum design, the process is the teaching and learning taking place in school and the output is the achievement of learners as they complete their computing education. Whilst simplistic, this does provide a model for the journey of the computing curriculum.

In a more educational focussed approach, the Education Endowment Fund have adopted a similar structure to their research projects (Humphrey et al, 2016). The implementation and process evaluation model (IPE) builds on implementation models, a multi-disciplinary and inter-disciplinary model (Forman, 2015). Whilst this three-part model relates directly to education, this does not fully align with the scope of my research as the focus of the IPE is on interventions and carrying out randomised trials. Within computing, whilst the intent is that all schools are implementing the computing curriculum, research has already explained that this is not uniform (Crick, 2017). Alternatively, the Office for Standards in Education (Ofsted) devised an inspection framework to identify the quality of education in individual settings based on curriculum delivery, through an investigation of curriculum intent, implementation and impact (Spielman, 2017). Again, although a three-part model, this does not quite align with my research due to the implementation of the curriculum design being at a local level of an individual school. I want to explore the implementation of the curriculum from the central, standardised documentation. The scope of this research extends into the external influences determining the subsequent design of the curriculum, the official recontextualising field (Bernstein, 2000). Whilst the three, three-part models are not a perfect fit, the structure provides a sequence for the research questions and categorisation of data. In my adaptation of the model, the first part is entitled 'computing as a subject', the second is pedagogic discourse and the third is experience of learners. The full structure of this aligned with the data collection and Bernsteinian concepts that can be seen in the methodology chapter (see Figure 4.1). The three research questions based on this model are:

1. How is the National Curriculum in Computing viewed by school leaders and teachers?
2. How are teachers delivering the National Curriculum in Computing in their schools?
3. What is the perceived impact for learners as a result of the National Curriculum in Computing?

1.4 Interdisciplinary approach

This study builds a thematic analysis of exploring the implementation of the curriculum. Curriculum theory is the interdisciplinary study of educational experience (Pinar, 2004). As the use of the IPE structure identifies, there are several stages to the implementation of a new curriculum. This requires a broad approach to research, both in terms of the power and influence of those designing and directing the new curriculum through to the learned experience of those in the classroom. Curriculum is a tangible subject that is tied to decision making within institutions (Null, 2011). Current debates in curriculum studies include the reduction of autonomy for educators to design their own curriculum, based on their views of what they want learners to study (Young, 2013). In the case of computing, this has been imposed, alongside a magnitude of formal qualifications with specific subject matter to be taught in preparation for formal assessment.

The growing dictatorial nature of the curriculum, through a top-down approach, has led to tensions and conflict for some educators. The hidden curriculum identifies covert teaching that takes place in the classroom (Apple, 2004). To get underneath this is a research challenge, as exposing if and when teachers may not be fully compliant with policy requires understanding, trust and an awareness of subtleties in data collection and analysis. It cannot be a simple evaluation of an implementation model (Ball, 2012).

1.5 Discovering Bernstein

The structure of input, process and output of the curriculum, whilst it provides an organisational structure for my studies, does not provide a framework for my thinking. Earlier work in my doctoral studies had explored the language and power in computing (Foucault, 1982; Ball, 2012). I have also explored the building of cultural capital in computing through the work of Bourdieu (2000). Whilst my part A has really been an exploration in my thinking, this study needs to bring a tapestry of themes together, including control and the power of government and business to influence the practice in the classroom and the agency teachers have in designing their own curriculum; whether there is a hidden curriculum in which the intended curriculum is not being fully delivered and overall, what the implications are of this for learners, especially those in different demographic groups. Initially, the interconnectedness of each of these aspects of my study, and my inability to think through a single lens, brought about somewhat of a jumble and no clear frame on which to focus my thinking and discussions.

As part of our Doctor of Education (EdD) studies, we were invited to a programme of events entitled ‘an introduction to…..’. It was during one of these sessions, an introduction to Bernstein, led by Gabrielle Ivinson, whose work is referenced in this thesis, that I managed to make a clear connection to my work. A particular aspect of Bernstein’s work resonated and drew me to subject specific aspect of my research, the use of classification and framing of a subject (Bernstein, 2000). The priority for my study is to really focus on the subject: does a change in title (from ICT to computing), and a change in the programmes of study, result in a change in the knowledge that is being taught or learned. The work of Bernstein is frequently revisited by those exploring curriculum studies and some of his early work on knowledge structures was only fully recognised sometime later (Muller, 2000; Moore, 2004; Young, 2008; Young, 2013,).

Chapter three explores how each stage maps to the three-part model of computing as a subject, pedagogic discourse and experience of learners, in terms of looking at the implementation, process and evaluation of curriculum implementation, in relation to the work of Bernstein. This is considered alongside other educational sociologists and researchers in curriculum studies.

1.6 Organisation of the thesis

Chapter two is a literature review, developing the ontology of computing education based on research in the field. Initially, it is clear that in some cases learner numbers in computing are smaller than they were for ICT. Also, fewer girls are studying the subject and that fewer learners from disadvantaged backgrounds are studying computing (Crick, 2017). It is also evident that not all schools are offering computing as a subject to study at key stage 4 (age 14 to 16 years). This is not the case in all countries and the chapter explores some international comparisons.

Chapter three takes an epistemological approach to exploring theoretical frameworks in curriculum studies and most specifically on the work of Bernstein, alongside a discussion of work of other theoretical readings in the sociology of education (Sadovnik, 2007).

In chapter four, I identify the methodology on researching with two case study computing departments in contrasting schools. The data collection is mapped to the three-part model and discussed alongside the theoretical framework (Stake, 2006; Thomas, 2011).

Chapter five is the findings from each of the cases. The data are presented in a relatively natural form with commentary as to how the data have been extracted to inform each stage of the three-part model. Each case is presented separately and present some very different findings.

The analysis in chapter six brings the cases together under the themes of the three-part model. Direct comparisons have not been made between the cases as, intentionally, they are very different settings. However, there is a discussion on each of the themes and, of particular focus, is the relationships between the themes and recommendations for these to be explored in more depth. The connections between the themes are considered in detail although I have been careful not to make false causations between different stages (Ball, 2012).

The evaluation of the thesis identifies the limitations of the study alongside recommendations and identification of future research. I also reflect on my own journey as a researcher through the process. The thesis concludes with a final comment on the impact of the Covid-19 pandemic, both on the process of this study, but also on the potential impact on computing education.

Chapter 2: A review of the literature

Chapter 2 outlines tangible changes in the subject including curriculum changes, the names attached to the subject, developments in technology, the types of qualifications and the numbers of students studying it.

Since 2011, there have been a number of significant policy decisions that have impacted the teaching of computing and ICT in England. The first section of this chapter outlines this recent history, mainly through the use of policy documents and pivotal research-based reports that have influenced these changes.

2.1 Computing as a 'new' subject; the current position in England

In 2014, the National Curriculum in England was updated. It was at this point that 'computing' was formally introduced as a subject in England. Later sections of this chapter recognise the subject as an earlier presence in in a variety of guises, using a range of terminology, different curriculum content and a number of international variations. Whilst the historic and geographic variations are essential in understanding computing as a subject, this section explores how the National Curriculum in England currently identifies computing as a subject, an outline of perceived provision across English schools and current research around its implementation.

The current National Curriculum in England outlines 'computing' as a subject with three key strands, IT (Information Technology), Digital Literacy and Computer Science. The terminology used across computing education is varied and significant. There is further discussion on this in section 2.3, but 'computing' will be the term used to describe the current curriculum in England as outlined in the National Curriculum documentation

(DfE, 2013). The subject is introduced at Key Stage 1 (KS1) with pupils from the age of 5 to 7 years. It continues throughout formal education to the end of Key Stage 4 (KS4) at age 16 years. The National Curriculum document, although brief, outlines a clear set of aims and subject content with a view to it bringing pupils to a level suitable for the future workplace and be active participants in the digital world (DfE, 2013). The document outlines computer science as the core, whilst pupils are to *use* information technology and *become* digitally literate. These aims are the same across all keys stages although at KS4 (14-16-year-old education) schools tend to follow requirements for qualifications following specifications outlined by awarding bodies rather than the National Curriculum itself, although the document does stipulate that 'all pupils must have opportunity to study aspects of information technology and computer science at sufficient depth to allow them to progress to higher levels of study or to a professional career' (DfE, 2013). The computing content of the National Curriculum was seen as a replacement for the Information Communications Technology (ICT) programmes of study, which were removed from the National Curriculum as computing was introduced (Sentence and Humphreys, 2018). It is also pertinent to note that not all schools are legally bound by the National Curriculum. Independent schools, free schools and academies (state funded schools outside the control of the local authority) are exempt from the formalities of the National Curriculum providing they can provide evidence of a broad and balanced curriculum for their learners (Parliament of the United Kingdom, 2002).

At KS4, the main qualification pupils follow is the General Certificate of Secondary Education (GCSE). GCSE Computer Science is currently the only formal GCSE qualification linked to the National Curriculum programmes of study in computing, so the strands in

IT and Digital Literacy are not studied at this level unless outside the construct of a formal qualification framework or as part of a vocational course. A range of vocational qualifications are available at this level, and these come in many different forms. Computing offers some of the widest range of qualifications in school curriculum subjects as it encompasses a number of work-based programmes which fall under this level 2 category (GCSE equivalent) and so can be embraced by schools (DfE, 2017). The main determinant of qualifications selected by schools in England are progress measures, the means by which schools are judged (Leckie and Goldstein, 2017). Since September 2014, the progress measures for schools have shifted significantly to reduce the value and prevalence of vocational qualifications for school attainment measures as recommended by the Wolf report on vocational qualifications (Wolf, 2011). GCSEs in ICT have also been withdrawn within this period.

The English Baccalaureate (EBacc) was introduced as an accountability measure for schools from 2011 (DfE, 2014). The EBacc is designed to encourage schools to ensure pupils' GCSE qualifications include five main subjects; English, mathematics, the sciences, history or geography and a language (DfE, 2019). In addition to the EBacc, the DfE has also introduced 'Attainment 8' and 'Progress 8' as school performance measures. These were introduced in 2013 to include EBacc subjects and 3 additional subjects including a small range of 'high value' vocational qualifications (Parameshwaran, 2015). The same subject area cannot be recognised twice within this measure even as different qualifications. With the introduction of Computer Science GCSE, this is the reason GCSE ICT was withdrawn as a qualification (Royal Society, 2017). GCSE Computer Science is recognised as an EBacc qualification within the 'sciences' category and there are a small number of vocational qualifications covering ICT-style content. A list is updated annually, which lists the approved vocational qualifications which can be included in the subsequent ‘Progress 8’ data measures (DfE, 2017). The current list contains 4 such qualifications with one of the most popular being ‘Creative iMedia’ (Ofqual, 2018; OCR, 2019).

The previous Head of Ofsted (The Office for Standards in Education, Children's Services and Skills), Amanda Spielman, has requested and evaluated a range of research on current curriculum provision in schools linked to the performative measures placed on schools (Spielman, 2017). Whilst the function of this section is to outline the current picture, it is important to note that, in response to the perceived ‘narrowing of the curriculum’, a consultation has been carried out into the Ofsted framework, the guidance by which schools are inspected. A new framework was implemented in September 2019 and, whilst progress measures are still significant, Ofsted has placed more importance on the provision of a broad curriculum (Ofsted, 2019). The impact of policy, such as Ofsted frameworks, will be explored later in the chapter.

In post-16 education, a range of vocational qualifications and apprenticeships are available in computing and digital disciplines, but post-16 education is outside the jurisdiction of the National Curriculum. Traditionally, A Level qualifications are viewed as the most academic qualifications and those most likely to be taken by students progressing onto university courses. A Level Computing has been available as a qualification since 2003. Whilst small in number of entries compared to most other A Level subjects, there was a decline in A level entries for computing from 2005 onwards. In 2003, 8,000 students were entered for A Level Computing but by 2012 this had decreased to 4,000. During the same time, mathematics A Level entries increased from

56,000 to 85,000. The numbers of students taking A Level Computer Science are so small that it is not a requirement for university entry to computer science or other computing-related degrees (Brown et al, 2013). A view that had started to develop in response to this was that if children were encouraged to engage with computing at an earlier age, then more would select the subject at post-16 and the quality of entrants to undergraduate computing-related courses would be increased (Schmidt, 2011). Currently, the majority of computing faculties at university level rely on mathematics as an entry requirement and assume no prior education specifically in computing (Williams and Overland, 2018).

2.1.1 Support for the computing curriculum

Computing at School (CAS) is a key organisation in the development of computing education in England and is a member of the council for subject associations. CAS initially formed as a grassroots working group in 2009 in association with the British Computer Society (BCS) (Computing at School, 2009). It has been instrumental in lobbying for computing education across the United Kingdom (UK) and has secured DfE funding to develop an online platform, a network of regional centres and CPD for computing teachers. CAS presents a lively picture of a community of teachers working together to develop resources, effective classroom practice, CPD for colleagues (through a ‘network of excellence’), additional qualifications and a strong voice for computing teachers. Key figures from CAS have been invited to talk at international events and have celebrated the success of the new computing curriculum in England (Brown et al, 2013; Sentence and Csizmadia, 2017; Crick, 2017).

2.1.2 Uptake and outcomes of computing qualifications

Despite the groundwork and funding secured by CAS, there is considerable concern as to how effective the curriculum development has been and whether it is actually fully embedded, as a formal requirement in the National Curriculum would imply (ETAG, 2015; The Royal Society, 2017; Sentence and Humphreys, 2018). Consideration of the numbers of pupils being entered for computing-based qualifications paints a different picture as to the implementation of the curriculum. It is data from the entries into Key Stage 4 qualifications (GCSE level) that have been most used to provide indicators of pupil numbers and the current level of implementation of computing in English schools. Kemp et al (2015) first reported on the uptake of computer science qualifications using the annual data published by the Joint Council of Qualifications (JCQ) and explored a number of themes. The data analysis has been repeated for a second year and has formed part of the basis for the Royal Society review of the curriculum changes (Royal Society, 2017). The main findings of the latest review are that computing education is 'patchy and fragile' (Royal Society, 2017, p 6). Based on national school census data, in the examination series completing in summer 2016, 70% of students attended a school that offers computer science as an examination subject at KS4, although only 11% of all eligible students took GCSE computer science. Of these, only 20% were female (Kemp, 2017). Concerns around the numbers of pupils accessing computing education and the variances in demographic representations including female pupils and those from low socio-economic groups have been identified.

Further research into provision within schools identifies wider issues than those particular to pupil numbers. During the academic year 2015-16, only 68% of the target number of trainee teachers were recruited into initial teacher training (ITT) in computing (House of Commons Education Committee, 2017); this was the lowest for all targeted shortage subject areas. Confidence amongst practicing teachers was varied, with 48% indicating low confidence levels in delivering the computing curriculum. The number of teachers lacking confidence is even greater at GCSE level than other levels of the curriculum, with teachers explaining that, although they may be competent users of technology, this does not equate with an understanding of the computer science behind it (Royal Society, 2017).

As a result of the research commissioned by the Royal Society (2017), a number of key recommendations have been made to currently address the varied and fragile provision of computing education in England. These include:

- Ofsted to monitor whether and how schools are teaching computing to all pupils.
- Ofqual and key stakeholders to work urgently on qualification pathways to ensure they are suitable for all pupils, with an immediate focus on information technology.
- Research projects on pedagogy and curriculum development to investigate how to improve female participation.
- Government and industry-funded interventions must prioritise and evaluate their impact on improving the gender balance of computing.
- Introduce quality assured conversion courses for existing teachers.
- Develop accredited subject content courses to enable more people from a wider variety of backgrounds to become computing teachers.

- HE providers to promote careers in computing education to a wide range of students.
- Industry and academia to support 'braided' careers for staff who want to teach as well as work in another setting.

(Royal Society, 2017, pp 8-9)

Despite these recommendations and the sense of urgency for action, following the publication, further developments in the GCSE qualifications have exacerbated some of the challenges of delivering computing within English schools. Examination boards have developed a GCSE Computer Science qualification incorporating a practical element of computer programming. This has taken the form of 20 hours for pupils to complete a programming assessment in 'examination conditions' during their lesson times. A number of incidents of malpractice within this aspect of the qualification have been detected, including solutions to the tasks being shared and discussed online (Ofqual, 2019). Following a consultation, Ofqual have identified that the non-examined assessment element of the qualifications will no longer contribute towards the final grades, even though many pupils have already completed it, to maintain the integrity of the course (Ofqual, 2019). This will result in the computer science GCSE now being assessed through 2 written papers rather than any practical application. Practical tasks are still included as part of the qualification specification; however, they will not contribute towards the final grade (OCR, 2018). Although decisions on future years are still being explored, this decision may make it more difficult to attract pupils to engage with the subject at Key Stage 4.

Despite the ongoing challenges, the UK Government are keen to keep momentum going for the development of computing within schools. In January 2018, the then recently appointed Education Secretary, Damian Hinds, announced several new measures to support the ongoing developments. These included the announcement of £84 million over five years to improve the teaching of computer science including additional training for 8,000 existing teachers (Hinds MP, 2018).

A National Centre for Computing Education was newly formed in January 2019 (NCCE, 2019). The organisation was granted DfE funding to provide support for teachers to improve the support, training and delivery of computing education for school pupils across England. They generated a number of online and face-to-face courses to improve subject knowledge and confidence amongst practicing teachers to 'achieve a world-leading computing education for every child in England' (NCCE, 2019).

However, the current picture is quite mixed. The English National Curriculum in computing was the first in the world to allow school pupils to fully embrace the more scientific aspects of the computing curriculum, to prepare pupils for a future where they may well have jobs in technology not yet developed, where examination boards have developed appropriate qualifications and CAS had been funded to provide appropriate support for existing teachers to embrace the new demands (Sentence et al, 2012). The newly formed NCCE was then optimistic in taking this agenda further, but there were a number of concerns. The change in curriculum may have ultimately reduced the number of pupils involved in technology-based education. The policy change may have potentially had unintended, less than helpful consequences (ETAG, 2015; Royal Society, 2017). Gender and socio-economic representation have become a division within the subject (Kemp, 2017), in particular relating to pupils having equal access to the subject and in those selecting to engage with the subject past KS3.

When exploring the current picture of computing education in England, it is clear there are a number of challenges for those prioritising its implementation and accessibility for all pupils. Funding has been allocated to strengthen the current provision, which is significant, given the current budget constraints in the English education system. There are also a number of other countries who are following the English computing curriculum developments with interest as they develop their own policies and similar strategies. It is therefore essential the complexities of the development are fully explored and considered whilst the developments are still relatively recent.

Having outlined the current picture of computing education in England, it is now important to add a historic, economic and geographic context for the subject in order to explore the tensions, challenges and success that it may have brought for pupils and teachers.

2.2 The development of computing as a subject; historical perspectives

The most recent developments within computing education in England have, in many ways, proved to be the most controversial and the subject is not without a history of heated debates.

Whilst considerable work was carried out outside the school system on developing mathematical thinking and computing using electronic machines, personal computers did not appear in mainstream consciousness until the 1970s and did not start to appear in schools until the early 1980s (Somekh, 2007). As a school ‘subject’ compared to such realms as mathematics and geography, this makes it a relative newcomer to the curriculum subjects delivered in schools. Many early policies and shifts towards using technology in the classroom were funding and technology driven rather than curriculum and qualification driven, particularly with the introduction of the BBC Micros and with funds given to schools for the purchase of hardware and software annually by the Department of Trade and Industry (Somekh, 2007). Initially, there were very few teachers with any formal training in using the microcomputer in school. Many teachers were self-taught and school leaders relied on the enthusiasm of individual teachers to develop their usage in school. Due to the required mathematical understanding of making use of the microcomputers, it was often a mathematics or physics teacher within schools who felt an affinity with computing development. Computer studies at CSE and O Level (qualifications at school leaver age of 16 years, a precursor to current GCSEs) were a formal study of the programming and computational thinking required to make use of the first personal computers (PCs). Many of the theoretical and programming-based questions would not look amiss in the newly developed Computer Science GCSEs designed to assess the latest computing curriculum (Simmons and Hawkins, 2015).

The Technical and Vocational Education Initiative (TVEI) qualifications in the early 1980s was the first group of qualifications to recognise Information Technology (IT) skills. These were designed to be a vocational route for those pupils less likely to gain more formal, academic qualifications but to ensure this group of learners were prepared for working life with up-to-date skills (Williams and Yeomans, 1983). These qualifications developed skills that may be necessary within the workplace such as word processing and data entry. At a similar time, many schools also offered the opportunity to develop touch-typing skills through qualifications such as the Royal Society of Arts (RSA) typing award (Hillier, 2005). With these qualifications being closely aligned to work-based learning, they drew on the skills of a range of teachers including those specialising in business studies or technology. In the early times of computer use within schools, the notion of a specialist teacher was not so much someone with relevant training or qualifications in the area, but someone willing to 'give it a go' and 'learn on the job'. Much concern has been raised in more recent reviews and studies regarding the lack of non-specialist teachers within the discipline (Royal Society, 2012), but it is seldom acknowledged that the whole subject was developed by 'non-specialist', enthusiastic frontrunners who now may well be the most experienced educators in the field.

The developing subject in the late 1980s acquired an umbrella term Information Technology (IT). The growing prevalence of the internet in the 1990s added the 'Communication' aspect to ICT. Vocational qualifications continued to develop, with General National Vocational Qualifications (GNVQs) in ICT superseding the TVEIs. Qualifications developed for use in the workplace were also adopted by some schools such as Business and Technology Education Council (BTEC) qualifications, Computing Literacy and Information Technology (CLaIT) qualifications and the European Computer Driving Licence (ECDL). Many of these level 2 qualifications carried the same value as GCSE passes at Grade C or above so became popular with school leaders as school performance measures became critical (Coe et al, 2014). A full level 2 GNVQ in ICT carried the same equivalence of 4 GCSEs in school performance measures, despite being based on competence measures rather than examinations and being delivered in a much-reduced amount of curriculum time. New teachers were starting to appear who had experience in industry or their own university studies in using ICT and the new Labour Government in 1997 launched the National Grid for Learning with over £700 million pledged to schools to purchase hardware, software and internet connections. Along with this, a £230 million ‘New Opportunities Fund’ (NOF) was announced to pay for training all teachers and many school support staff in ICT (Somekh, 2007). In 1999, ICT was given status as a National Curriculum subject in its own right, with programmes of study for pupils to follow from infant education through to age 16 years. Comparing the £230 million NOF funding to the £84 million announced in January 2018, even without allowing for inflation, it is clear that the late 1990s were a boom time for investment and growth in ICT education in schools.

During the growth time of ICT education, new GCSEs in the subject were developed; Computer Studies was removed with the withdrawal of CSEs and O Levels, with very little of the content making it to the new GCSE ICT qualifications. Initially, many schools preferred to make use of the fruitful vocational qualifications on offer but, with the addition of English and mathematics as a measure of the 5 A-C success in schools (Parameshwaran and Thomson, 2015; Leckie and Goldstein, 2017), in many cases the subject was given a reduced curriculum time and also carried less status with school leaders, parents and pupils. Initially there was considerable uptake for GCSE ICT, as ICT became a core subject at KS3 and so a natural progression for pupils was to take the KS4 qualification (National Strategies, 2004). In 2007, Statutory Assessment Tests (SATs) tests in ICT were piloted for the first time for 13-year-olds, although these were scrapped shortly afterwards due to the complexities of running such a large scale, online practical examination.

The government-commissioned Wolf Review (Wolf, 2012) reviewed the provision of vocational education and the reliance on schools for performance measures. Whilst Wolf identified that some qualifications might be appropriate for young people and adults in occupations, the learning programme should be different for those in full-time education and those in occupational training. This required programmes to be redesigned to meet different needs and those for work-based training should be linked entering or progressing in the workplace rather than 'gaming' the system of qualification performance league tables (Keep, 2012). One such qualification used to 'boost' school performance measures was the European Computer Driving Licence (ECDL), which focuses on software for use in the workplace, particularly on Microsoft Office skills. The qualification awarding body is the British Computer Society (BCS), the same organisation overseeing the initial working group to develop computing education in schools (CAS). The removal of the qualification from school progress 8 measures contributed to the 45% decline in ICT qualifications awarded to pupils aged 16 years between 2017 and 2018 (Kemp and Berry, 2019).

In the mid-to-late 2000s, the number of pupils being entered for GCSE ICT fell into decline, falling by almost a half between 2007 to 2010 (The Royal Society, 2012). The rhetoric that launched the GCSE ICT qualifications and promoted ICT as essential for any school leaver, seemed to have less impact as computers were being used widely by pupils in other aspects of their lives. Parents and pupils seemed less concerned with a formal education in the subject. Over this time, the required content for the ICT qualifications changed very little, apart from being updated for later versions of software, and curriculum time for the subject was being ever more squeezed to make way for other subject areas (Ofsted, 2008). During this period, A Levels in both computing and ICT were also in decline, actual numbers of entries were much lower than for GCSE and for other, comparable A Level subjects. At the same time, it was also recognised that vocational qualifications in ICT increased in popularity, although many felt this was due to the performance measures rather than a drive to develop pupil learning and understanding in ICT, as previously reflected in the Wolf Review (Wolf, 2012). Research at the time found that the qualifications carried little value with many stakeholders, particularly those seeking to employ school leavers with computing know-how (Royal Society, 2012).

As previously mentioned, and at a similar time, a grass roots organisation, with the support of the British Computing Society (BCS), was formed, calling itself ‘Computing at School’ (CAS) (see section 2.1.2). They started with an initially small membership to introduce computing-focussed rather than ICT-focussed education into schools and a pilot GCSE in Computing was first developed in 2011 (Peyton-Jones, 2011). It was the slow decline of ICT and a concern for the skills and understanding of the future workforce that also prompted the call for a review, carried out by the Royal Society, led by Professor Stephen Furber.

The House of Commons Science and Technology Committee (2016) discussed a range of issues around digital education, adult engagement in society, barriers through a lack of digital skills, and a concern for the future economy as a result of a lack of a digitally-skilled workforce. Aside from the formalities of computing curriculum and qualifications in schools, there is now a wider national agenda for digital development in the form of the UK Digital Strategy (DDMCS, 2017). Within this strategy, there is a particular focus on adults who lack basic digital skills, also ensuring businesses have a suitable ‘pipeline’ of talent to fill digital vacancies. In response, the DfE has produced an ‘Essential Digital Skills Framework’ for adults, to identify the minimum digital skills required to function in their home life and at work (DfE, 2019). When considering some of the current shortfalls in curriculum time and entries for qualifications, there is a concern that pupils may emerge from the current education system without meeting the expected standards of minimum digital skills for all.

2.3 Research in computing education in England

The ‘Shutdown or Restart’ report commissioned by the Royal Society (Furber, in the Royal Society, 2012) was pivotal in presenting a view of delivery of the then ICT curriculum, now computing education within UK schools and this has since been used to guide and influence curriculum policy. The original report took a three-pronged approach to methodology. The first was a call for evidence. The authors received 120 contributions from a range of stakeholders including industry, teachers, pupils and parents. Those who contributed clearly had strong views and had been motivated to write. It is not clear whether an attempt was made to acquire the voices of those who did not hear the ‘call for evidence’ through their networks, those who may have lacked confidence in voicing their opinions or felt too busy or apathetic to contribute. From the literature, it was clear that ‘non-specialist’ teachers and those under immense pressure have been impacted by the computing curriculum changes. These teachers may be within the categories of people not ‘heard’ in the research.

The second data collection method within the report involved workshops with groups of invited stakeholders including the newly-formed CAS. Invitations were sent out via organisations and networks where members already had an interest in computing education or they had contributed via the initial call, again perhaps missing key voices. The third aspect of the review commissioned research based on a range of data. The data included international comparisons, workforce data, surveys on CPD given to teaching staff, surveys on computing enrichment opportunities, Higher Education Statistics Agency (HESA) data and University and College Admissions Service (UCAS) data to explore continuity in computing education. Several other key pieces of work have focussed on the story as told though data based on examination entries and CPD provision (Sentence et al, 2013; Kemp, 2015).

In 2012, the then education secretary, Michael Gove, made a crucial speech at the British Educational Technology Exhibition (BETT) following the Royal Society report. During the speech, he outlined a number of criticisms of the then still compulsory National Curriculum in ICT, stating concerns about its lack of stretch, opportunity for creativity and it being generally ‘dull and off-putting’. During the speech, the ICT National Curriculum was disapplied with immediate effect, announcing a freedom for all teachers in the field to cover innovative, specialist and challenging topics (Gove, 2012). He made it clear that the Government must not wade in and prescribe to schools exactly what they should be doing or how they should be doing it. Less than a year later, the National Curriculum programmes of study in computing were published (DfE, 2013).

GCSEs in Computing were developed and rolled out by all major examination boards across England and Wales from 2012 onwards. In September 2016, under the GCSE reforms, the qualifications were changed to 'computer science' to provide additional academic rigour and to meet the new GCSE 9-1 criteria (Ofqual, 2018). CAS developed the 'Network of Excellence' supported by funding form the DfE. The network created local coverage of 'hubs' to support computing teachers at a local level, an online platform for forums and sharing of resources and a range of CPD provided by 'Master Teachers', specialists who are funded to come out of schools for short periods to run CPD for developing teachers. GCSE ICT examinations were sat for the last time in the summer of 2017, and data show a small but steady increase in the numbers of pupils being entered for GCSE Computer Science (see Figure 2.1, Kemp et al, 2017).

Computing cohort size - longitudinal study

For the following tables and graphs 'Computing'[1] is defined by any subject under the names: Applications, Applied ICT, Computer Appreciation / Introduction, Computer Architecture / Systems, Computer Games, Computer help, Computing, D&T Sys & Control, desk Operations, Electronic / Electrical Engineering, Handling & Interpreting Data, ICT, Keyboarding, Music Technology (Electronic), Office Technology, Systems / Network Management, WebSite Development

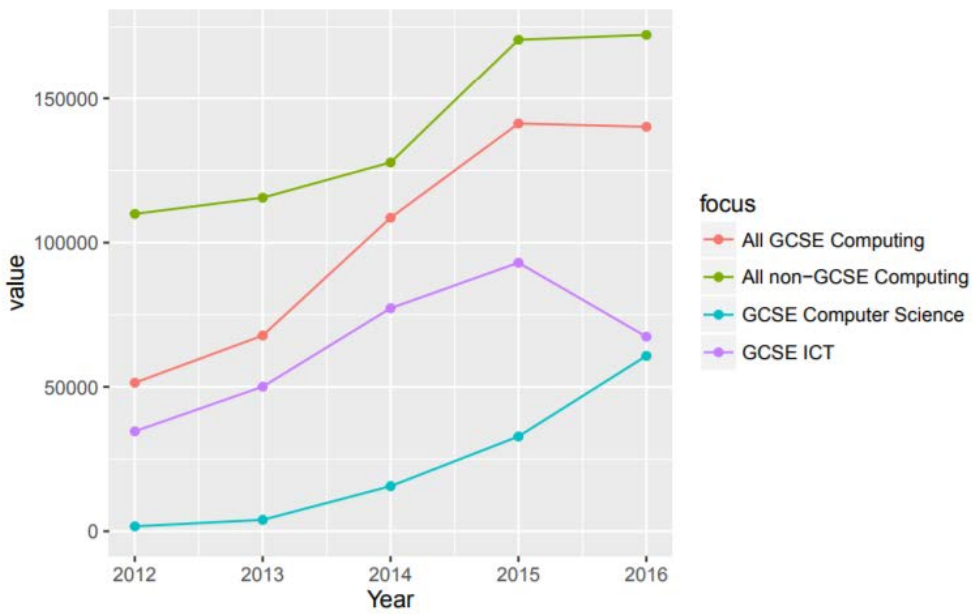


Figure 12: 2012-2016 KS4 computing qualification trends - total participants

Figure 2.1: GCSE Equivalent entries (taken from Kemp et al, 2017)

On the surface, this would seem like a success story for GCSE computer science but, presented in an alternative form, the data on examination entries can be interpreted quite differently.

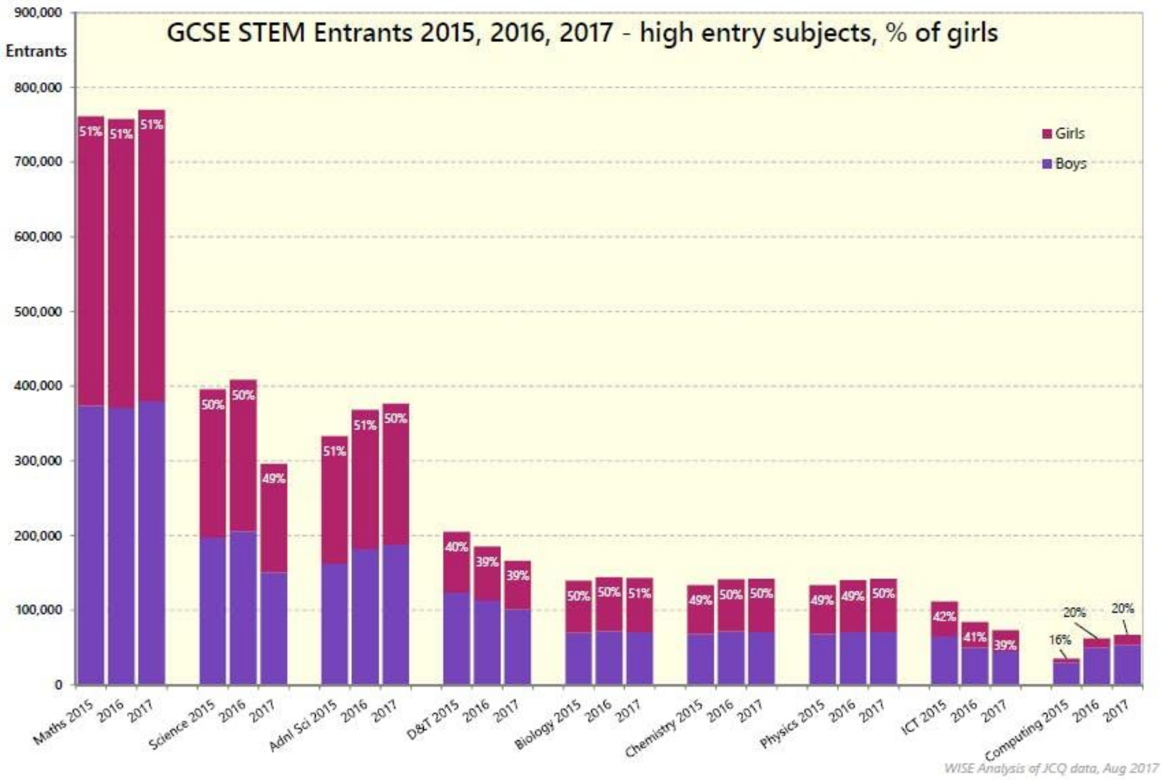


Figure 2.2: GCSE entries for STEM subject compared by gender (WISE Campaign, 2017)

A second data presentation (see Figure 2.2) shows that entries for GCSE Computer Science are relatively small in comparison to other subject areas so, despite the growth, there are still a very small number of pupils opting for the subject. When these data are broken down by gender, only 20% of entries were female. This opens wider questions, not just about the coverage of computer science at GCSE but also the inclusivity of the subject. In contrast, ICT GCSE entries were more equal between the sexes; however, this is now unavailable as a qualification. The removal of GCSE ICT has not had any impact on the percentage of females opting for computer science as an alternative (Kemp, 2018).

In addition to inequality between gender, analysis of data has also identified differences between ethnicity and socio-economic backgrounds of pupils and their engagement with computing education. Whilst the differences are not as stark as with gender, there are still notable differences between ethnic groups, with black children less likely than white and Asian children to take GCSE computer science (Royal Society, 2018). Socio-economic data are measured in different ways, so the data are less conclusive; however, pupils eligible for pupil premium funding (a measure of low family income in England) shows that pupils make a smaller percentage of the GCSE cohort than they do in other subjects (Kemp, 2015).

Further exploration of data raises concerns about access, with not all schools offering GCSE computer science as an option choice for their pupils. There were suggestions that the lack of opportunity for pupils was linked to a lack of teachers with the required subject knowledge to be able to deliver computing to GCSE level and beyond. It was these data that highlighted the fragility of the subject and geographic differences in the access to computing as a subject.

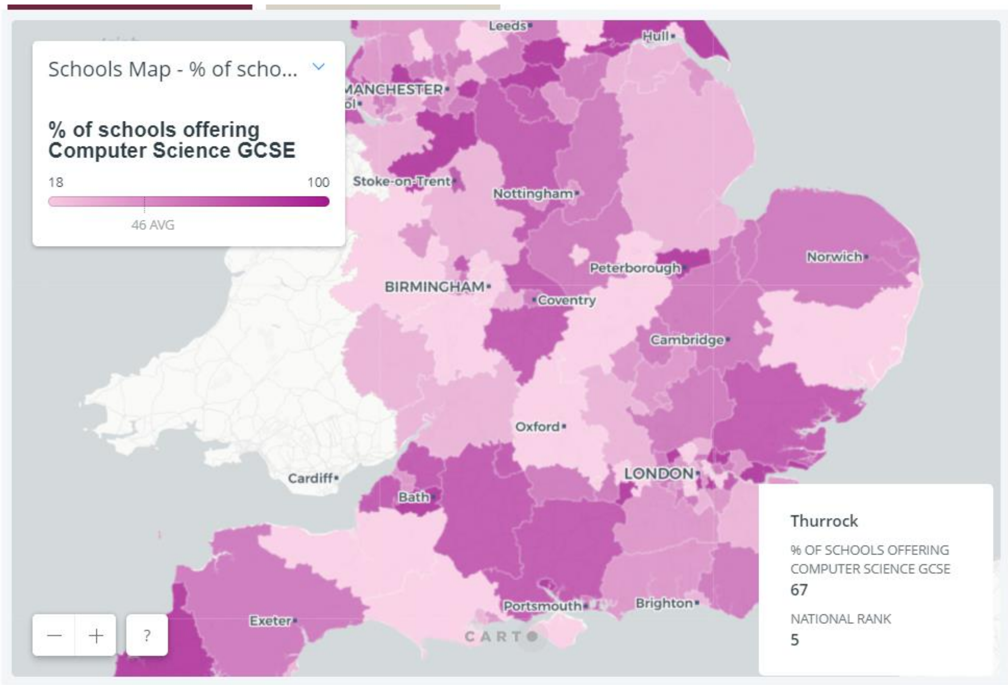


Figure 2.3: A map to show geographic access to computer science GCSE

Figure 2.3 is a 'live' map, allowing the user to click specific regions to see exact percentages of schools and national rank. It is available on the 'After the Reboot' website (https://royalsociety.org/topics-policy/projects/computing-education/ [accessed 17/5/19]).

Following the data capture used to inform the 'After the Reboot' review (Crick, 2017, Royal Society, 2017) the numbers of entries of learners to GCSE Computer Science did increase, particularly as the GCSE in ICT qualification was phased out. Later data show an improved picture; however, the number of learners studying GCSE Computer Science is well below most other subjects except for modern and ancient foreign languages (see Figures 2.4 and 2.5) (DfE, 2023).

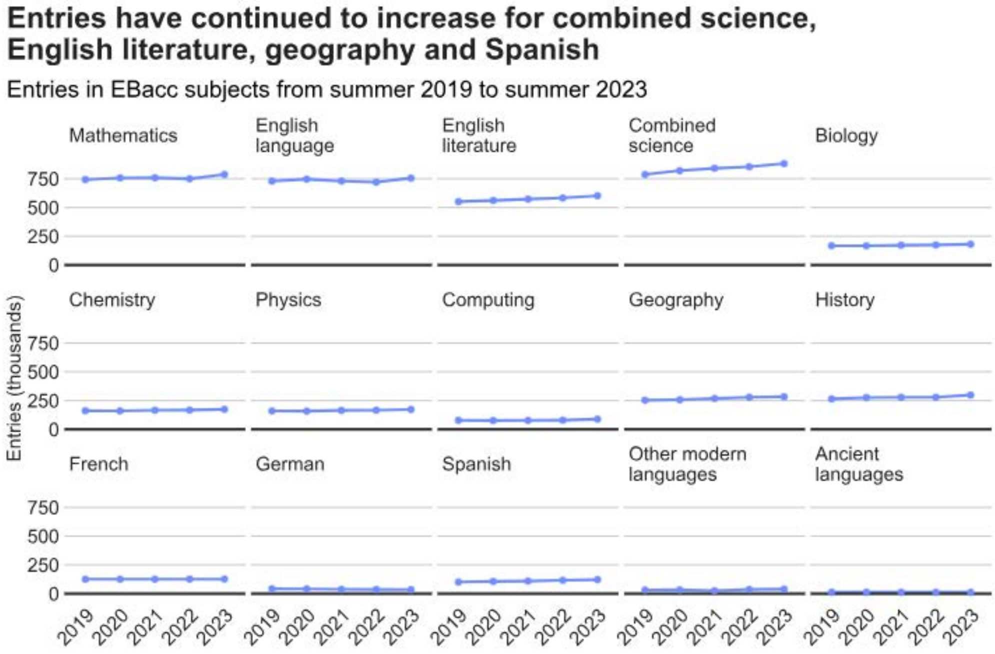


Figure 2.4: GCSE entries for Ebacc subjects between 2019 and 2023 (DfE, 2023)

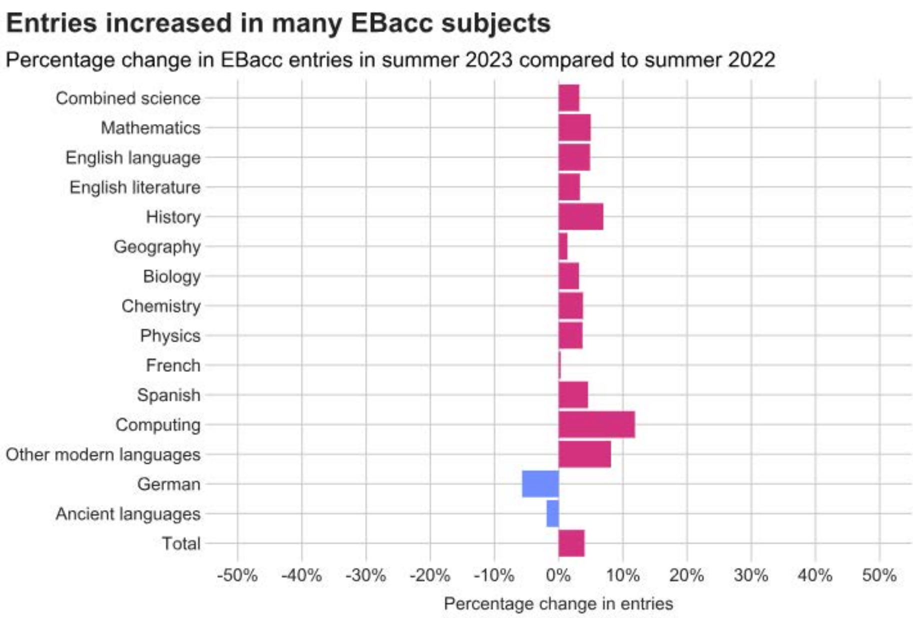


Figure 2.5: Percentage change in Ebacc entries in summer 2023 compared to summer 2022 (DfE, 2023)

Initially, computer science seems promising as subject with most growth, at 11%. Numbers have steadily increased, but so has the population of 16-year-olds, as GCSE entries overall have increased by 3.6%. The share remains consistent and relatively small compared to other optional subjects such as history and geography. The British Computer Society review of the landscape in 2021 identified a continued lack of learners studying computing compared to the demand for new recruits in the industry. They also identified a continued under-representation of females embarking on computing qualifications (BCS, 2022). This was mirrored by analysis by the Wise Campaign, who identified 21.4% of GCSE Computing learners to be female in the 2023 examination cohort (Wise Campaign, 2023).

These data present a series of questions as to how learners are experiencing computing education in their settings and how teachers are delivering the curriculum for the learners. This research will explore the pedagogic devices that are used in a wider context, to create a climate for recontextualisation (Bernstein, 2000), although this creates a research challenge as such processes are difficult to capture, define or categorise.

2.4 The nature of research into the computing curriculum in England

The previous section (2.3) outlines a range of measurable data that explores the implementation of the computing curriculum including school engagement and completion of qualifications. However, there are many other ways to explore the impact of the curriculum change beyond such measures. This is particularly the case for the primary phase of education, where formal testing in computing subjects is not carried out (Kemp et al, 2016).

In a study carried out in primary education, Larke (2019) explored the implementation of the computing curriculum through detailed case studies in two schools. The research found computing specific instruction to be rare with teachers finding barriers to delivering the computing curriculum including a lack of resources and a lack of professional guidance. Despite the barriers to delivering the updated Computing National Curriculum, the previous ICT National Curriculum was also not being delivered. The subject was weakened through the practice of the teachers. The teachers were described as being the 'gatekeepers' being able to control the level of priority given to the subject within the schools. In these schools, the intended curriculum, that which curriculum documentation outlines what is to be taught, does not correlate with the enacted curriculum, what teachers actually deliver in the classroom (Apple, 2012; Larke, 2019).

In order for teachers to fully embrace the delivery of the computing curriculum, they need to value the subject and see the benefits to the computing being taught. The 'After the reboot' report (Royal Society, 2017) identifies that a number of barriers are preventing effective delivery of the computing curriculum across many schools. Passey (2017) identifies five key arguments for the presence of computer science and related subjects in compulsory education. These include an economic argument relating to the need for a future workforce, an organisational argument, providing opportunities for building collaboration and a community argument as computing will be used by social groups and those with similar interests. In addition, there is an educational argument so that learners have opportunity to understand the capabilities of computing, whilst the learner argument identifies that learners will be interested in studying the subject

(Passey, 2017). To achieve successful 'buy-in' of the computing curriculum, it is useful to consider these aspects from both a teacher perspective, but also from the viewpoint of the learners. If learners in school held the subject in high esteem, then this may lead to increased motivation from teachers in overcoming barriers, such as a lack of training and resources, to improve the delivery of the computing curriculum (Apple, 2012).

Wohl et al (2017) explore the narrative for the computing curriculum and how this can be perceived by learners themselves. They view the priority for researching the computing curriculum in England is focussed on content, delivery and pedagogy, with particular focus on computer science. As an alternative, different narratives, such as the opportunity to enjoy learning for the sake of self-development and identifying potential for building collective prosperity could be a focus for learners (Wohl et al, 2017). It may be that learners are building a commitment to the subject beyond the confines of formal qualifications; however, research that explores such views is rare.

As recent data from the BCS identifies, this is still a time of change in computing, with additional learners still required to meet the recruitment needs of the industry (British Computing Society, 2022). However, this review takes little account of the views of learners towards the subject. My research questions move beyond the measurable outcomes such as numbers of pupils, and explore the messages and perceptions of learners, leaders and teachers through qualitative data collection. I need a clear lens to consider the data collected in schools in relation to the context of computing education. The next chapter will explore these challenges through a theoretical framework.

Chapter 3: Theoretical framework - how to understand computing as a subject and how it currently manifests in classrooms

3.1 Introduction

In this chapter, I take my three research questions and align them, as closely as possible, to the work of Basil Bernstein to create a theoretical framework on which to base the data collection and analysis. Section 3.2 approaches question 1: How was the National Curriculum in Computing presented to school leaders and teachers? Section 3.3 explores question 2: How were teachers delivering the National Curriculum in Computing in their schools? Section 3.4 grapples with question 3: What was the perceived impact for learners as a result of the National Curriculum in Computing?

Chapter 2 outlined the historic development of computing as a subject and the position of computing in schools at the time of the data collection, during the academic year of 2018 to 2019. It introduced tangible changes in the subject including a rewritten curriculum, the names attached to the subject, the types of qualifications offered and the numbers of students studying it. Within this study, I explore how these changes were received in schools, delivered in classrooms and the impact they had on teachers and learners through a clear lens that provides a structured approach (Thomas, 2017).

3.1.1 An introduction to Bernstein

My introduction discusses my discovery of Basil Bernstein's theory of curriculum, and the way I activate it to understand the journey of computing as a subject (see Chapter 1, section 1.4). As already noted, this journey starts with the inputs into the curriculum, including the influence of policy and business in creating a curriculum. This informs how the subject of computing is taught and received within classrooms. But finally, the computing curriculum has an impact on pupils, especially those in different social classes and gender groups (see Chapter 2, section 2.3). Bernstein describes this process as cyclical, a 'cultural relay' with the metaphoric baton being the knowledge passed from one generation to the next (Bernstein, 1990; Sadovnik, 1995). However, computing as a subject was only added to the National Curriculum in 2014 (DfE, 2013). Compared to many other subjects, computing can only be near the start of Bernstein's cyclical model. As a result, the knowledge being taught in schools is not one that was learned by current teachers of computing whilst they were at school themselves. Maton (2013) identifies a potential weakness in the work of Bernstein, that, whilst he explores new processes of pedagogy, he makes little reference to building new bodies of knowledge. However, Bernstein does address the collection and integration of bodies of knowledge, which includes incorporating new knowledge (Bernstein, 1975). The identification of a body of knowledge in computing is explored in detail in this chapter, in section 3.2.5. This example of the cultural relay model not fitting exactly with the new computing curriculum demonstrates how Bernstein's curriculum theory needs to be carefully considered within this context. This subject specific discussion is a feature throughout this chapter.

Bernstein focuses on the sociology of knowledge and draws on sociologists including Emile Durkheim (Aubrey and Riley, 2017; Young and Muller, 2010) and philosophers like Foucault (Bernstein, 1990; Singh, 2017). Bernstein makes use of the functionalist theory of Durkheim with particular attention to the influence of schooling for social order (Bernstein, 1975; Atkinson, 1995; Sadovnik, 2007). Influences can also be found in conflict theory from neo-Marxist approaches and the theories of Weber (2013). Whilst Bernstein and Weber both concentrate on power and control, Bernstein specifically focuses on the transmission of knowledge and the authority in the educational system.

Bernstein's earliest scholarship in the late 1950s and 1960s built on his own experiences teaching in schools and explored language, particularly examining the relationship between public language, authority and shared meanings (Sadovnik, 2007, p 10). This developed into the theory on code, particularly restricted and elaborated code, which formed the basis for his four volumes 'Class, Codes and Control' (Bernstein, 1973; 1975; 1996; 1999) and is synthesised in his final book, 'Pedagogy, Symbolic Control and Identity' (Bernstein, 2000).

Bernstein's theories develop different ways to explore curriculum structure, the influence and power of knowledge and issues of inclusivity. Other theorists do not approach subject-based thinking with such a broad scope, from the macro- to the micro-level of practice. His models, discussions, and frameworks have been scrutinised and discussed by other researchers (Solomon, 1989; Atkinson, 1995; Dickinson and Erben, 1995). More contemporary contributions building on the work of Bernstein have also been used to inform this chapter (Morais, 2002; Clark, 2005; Williams and Wilson, 2010; Loughland and Sripikash, 2016; Barrett, 2017).

Accessing Bernstein's work is not straightforward, as complex ideas and discussions are interwoven between volumes of work and revisited, sometimes several decades later, with renewed ideas and perspectives (Erben and Dickenson, 2004). My reading of Bernstein's work started with one of his earliest papers, published in a collection edited by Young in 1971, entitled 'On the classification and framing of educational knowledge' (Bernstein, 1971, in Young (ed.), 1971). Building on my understanding of subject, knowledge classification and framing, I moved to part 2 of volume 3 of 'Class, Codes and Control' (Bernstein, 1975, pp 78 - 162). This was his first substantive writing on curriculum and classification of knowledge (Singh, 2002). Following this, my focus shifted more towards the second of my research questions, addressing the actual enactment of teaching itself, which Bernstein refers to as pedagogic discourse (Bernstein, 1990; 2000). I also draw on the work of Young and Muller with a focus on powerful knowledge and the three futures curriculum (Young and Muller, 2010). Although Young and Bernstein take different approaches, their work addresses some of the same challenges and ideas and they themselves valued the exchanges and comparisons made between their work (Young, 1995). The inclusion of the work of Young adds a rich layer to the social aspects of subject classification and framing.

3.2 Subject identity

This section selects the work of Basil Bernstein, which I argue will help me to address my first research question: How was the National Curriculum in Computing presented to school leaders and teachers?

3.2.1 Classification of the subject

A key thread running through Chapter 2 was how the subject is named. Over time, the naming has included computer studies, ICT, computing and computer science. Each name is more than a fashion of the time, particularly reflecting changes in the emphasis of what the subject entails, technological developments, or the qualifications on offer (Somekh, 2007).

Having explored historical developments and the current position of computing in English education in Chapter 2, it is still not clear 'what' the subject is. The curriculum is detailed in the National Curriculum (DfE, 2013), and it is named 'computing'. Despite this, there are schools and organisations who use different terminology such as coding, iMedia, computer science and the predecessor subject name, ICT (Simon et al, 2015; Fluck et al, 2016).

For the purposes of exploring the pedagogic processes later in this chapter, it is important to consider the identity of the subject. To describe this, Bernstein adopts the term classification (Bernstein, 1971; 1975; 2000). To explore how a subject is classified one needs to know what skills and knowledge fall within its boundaries and how the subject is viewed and realised within the curriculum. In his models, Bernstein denotes subjects with a strong frame with a + symbol and those with a weak frame with a – symbol (Bernstein, 1990). A subject with a strong classification is one with a clear identity, body of knowledge and insulation (+C), whereas subjects without that clear identity have a weak classification (-C) (Bernstein, 1975; 2000). The insulation is the protection the subject has from outside sources. Where it is weak, the subject boundaries are blurred and other subjects may encroach on the territory (Bernstein, 1970; Walford, 1995).

The classification of subjects is fundamental to Bernstein's work and underpins much of his analytical focus. Bernstein (2000) outlines an example of classification, returning to medieval education, exploring the relationship between the trivium and the quadrivium. The trivium is concerned with logic, grammar and rhetoric. The quadrivium is concerned with astronomy, music, geometry and arithmetic (Bernstein, 2000). Trivium is based on a religious understanding of the world where as quadrivium is focussed on abstract formulations of the physical world using the language of mathematics. The trivium is an example of a strong classification, the knowledge is bounded, based on the teachings of the church and must be studied before moving on to different subjects. Other subjects, such as astronomy, did not fit with the teachings of the church and so the classification was weaker and subject to judgement and influence from others outside of the subject; the boundaries were not well insulated (Bernstein, 2000). The widely discussed scientific discoveries of Galileo and the clash with the Church demonstrates both the strength of classification of trivium, but also that classification is not fixed and evolves with the discovery of new knowledge. This discussion, situated in the medieval and early modern periods, helps us to understand how the classification of the subject computing has been subject to change (Levinson, 2001). Bernstein (2000) argues that the subjects with the strongest classification form the regulative discourse, the knowledge that controls what is learned by the population. The regulative discourse is explored in more detail in the recontextualisation section of this chapter (section 3.3).

Bernstein's second example of classification is between different subjects, referred to as singular subjects (Illera, 1995; Bernstein, 2000). A singular subject has a unique name and a discourse which only relates to the specific subject itself, such as physics, chemistry and psychology. These subjects have clear boundaries and broadly accepted bodies of knowledge, giving them a strong classification (Bernstein, 2000; Moore, 2006). Subjects that move beyond the singular subjects are referred to by Bernstein (2000) as the 'regionalisation of knowledge'. Examples include medicine, engineering and information science. Bernstein argues that regions are the interface between the field of the production of knowledge and the field of practice. In the example of medicine, singular bodies of knowledge including biology, chemistry and anatomy are brought together to form the region of medicine. In the National Curriculum for computing, three disciplines are brought together: digital literacy, IT and computer science. It could be argued that computing is a region rather than a singular classification. However, other National Curriculum subjects are also divided in such a way, for example mathematics includes disciplines including geometry and algebra (DfE, 2013). In relation to the first research question, how computing is presented to school leaders and teachers, the exploration as to whether the subject is viewed as singular or a region provides insights into the strength of classification of the subject.

The UK government commissioned reports into computing were completed by the Royal Society (The Royal Society, 2012; 2017; Crick, 2017). These reports have been fundamental in reviewing and driving the developments of computing education in England over the last decade. They indicate very clearly that computing is a science subject with its own distinct identity. As discussed in the previous chapter (Chapter 2, section 2.1), the GCSE qualification in the subject is currently called computer science. The three disciplines under the umbrella of computing suggest it has a weaker classification than that of specific computer science. In the 2012 report, The Royal Society identified this issue within the predecessor subject, ICT, and suggested computer science is the subject with the strongest, singular classification:

> Computer Science is a rigorous academic discipline, distinct from, but on an equal footing with, other disciplines such as mathematics, physics, chemistry, geography or history. Like mathematics, Computer Science underpins a huge range of subjects, and has concepts and ways of working that do not change quickly over time, including programming, algorithms and data structures. (The Royal Society, 2012, p10)

The term ICT had at least five separate meanings in the school context. According to the Royal Society (2012), this had led to confusion for pupils and poor policy-making. The report recommendations were designed to raise the status of the subject through strengthening the classification and suggesting that the term 'ICT' should no longer be used.

The structure of the computing curriculum suggests a specialising of knowledge as learners progress, narrowing from three broader areas to one specific area at GCSE and beyond. This contradicts Bernstein's discussions around regions as a field of practice, where several disciplines are brought together such as biology, chemistry and anatomy in medicine. The National Curriculum implies the three strands under the umbrella of computing carry the same weight: digital (DfE, 2013). The GCSE qualification in computer science is more specific and does not bring a balance of the three strands through to learning for ages 14 to 16 years (OCR, 2018). This raises a question of the purpose and design of the National Curriculum strands. Taking these three sources together, The Royal Society Report, the National Curriculum and specifications from examination boards, it is arguably not clear to teachers or pupils exactly how the subject is structured or weighted between the strands of IT, digital literacy and computer science (The Royal Society, 2012; DfE, 2013; OCR, 2018). This may be an indication that the classification of the subject provided for schools is not strong. Any space for ambiguity weakens the insulation of the subject and can result in a lack of prioritisation in schools. Indicators of weak classification within the school can be reduced curriculum time or cross-curricular approaches to subjects (Bernstein, 2000).

3.2.2 From classification to framing

Classification is related to the organisation of knowledge, whereas framing is related to the transmission of knowledge (Bernstein, 1975; Sadovnik, 1995). A frame refers to the degree of control the teachers and learners possess over the selection, timing and pacing of knowledge transmission (Bernstein, 1971; Edwards, 1995). In addition, evaluation relates to assessment as a process of evaluating learning (Bernstein, 1977). If classification regulates the voice of a category, then framing regulates the form of its legitimate message (Bernstein, 1990).

Where teachers are provided with prescriptive frameworks in which they are required to work, the frame is determined to be strong (+F) whereas more freedoms result in a weak frame (-F) (Bernstein, 2000). For example, a curriculum with very precise knowledge to be taught within a specific timeframe would be classed as having a strong frame. In contrast, one where the teacher or learners can select knowledge from the curriculum and determine the timeframe for learning this knowledge is classed as having a weak frame (Singh, 2002; Morais and Neves, 2011; Brosseuk, 2021). The strength of frame is also used to explore the relationship and balance of power between teachers, as transmitters of knowledge, and learners, as receivers of knowledge (Bernstein, 1971; 1975; Morais and Neves, 2011).

The strength of classification and framing of a subject form the basis for the pedagogic discourse (Bernstein, 1971; 1975; 2000; Singh 2002). Many Bernsteinian scholars have developed categories of strength of frame in their research; however, such classifications are often subjective and open to interpretation. Where categories have been clearly defined, they provide useful insights into pedagogic discourse that can be difficult to identify or compare (Maton, 2006; Morais and Neves, 2011; Brosseuk, 2021).

Bernstein also incorporates the strength of external and internal values into the model for both frame and classification (Fe Fi Ce Ci) (Bernstein, 1990). Where Fe is strong, the teacher is influenced by external values such as curriculum time and content. Where Ci is strong, the classification of the subject within the institution is strong. It is possible for both internal and external influences to be simultaneously strong or weak (Bernstein, 1990). Some critics of Bernstein identify that his models do not take into account teachers' political views of education policy (Archer, 1995; Erben and Dickenson, 2004). However, it seems there is scope in this model to include political influences as external influences when exploring the strength of classification of the subject.

3.2.3 A strong classification and powerful knowledge

Each time there is a shift in the classification of knowledge, there is space for ideology to 'play'. Power relations shift between regions and singulars as they compete for resources and influence (Bernstein, 2000). To explain this, Martin, Maton and Matruglio use the metaphor of cosmology, where each classification of knowledge being formed is the creation of constellations, whereby ideas, practices and beliefs are grouped together and contrasted to other groups (Martin, Maton and Metruglio, 2010; Firth, 2011). As new classifications are formed, constellations will restructure, potentially incorporating other constellations or singular nodes of a constellation within the new formation. Bernstein outlines this through knowledge codes, a collection code where boundaries of the subject are strong, or integrated code, where boundaries are weaker and require constant renegotiation (Bernstein, 1975; 1977; Maton, 2012).

In thinking about the National Curriculum in computing incorporating the three strands, computer science, digital literacy and IT, it could be that three separate bodies of knowledge have been restructured and amalgamated, demonstrating an integrated code, or that the body of knowledge itself is new and strongly bounded presenting a collection code. Exploration of curriculum documentation and teacher perspectives provides an insight into the structure and building of knowledge in computing (see Chapter 6).

A body of knowledge being taught can be described as hierarchical; for example, in mathematics, basics in number need to be taught before algebra for this to make sense to the learner. In other subjects, the body of knowledge is cumulative, for example in history (Harris and Burn, 2016). Here, teachers may have more autonomy over what is taught and when; the subject may have a weaker frame. History teachers may decide to build knowledge chronologically, or by similar themes taken from different historic periods. Although the frame is weak, the classification is still strong; history has a distinct boundary and accepted body of knowledge.

Treating knowledge as simply hierarchical or cumulative is a simplistic take on a complex process. In the National Curriculum for Computing, learners need to understand the basics of representation of numbers in binary form before being able to carry out simple operations using them; the body of knowledge is hierarchical. In contrast, learners develop creative projects across different software and devices in no particular order (DfE, 2013); the body of knowledge is cumulative. This oversimplification does not apply when exploring the less distinct curriculum strand of digital literacy which is less specific about what pupils are to do or learn.

As explained in the introduction to this chapter, the work of Young has developed in parallel to that of Bernstein. In approaching a similar challenge around frame and classification, Young identifies a less diagnostic model but one which clearly aligns with the model of a collection code and integrated code. These are social realist theories of knowledge that can be summarised in two approaches: ‘under-socialised’ and ‘over-socialised' (Young and Muller, 2010). An under-socialised epistemology defines knowledge as sets of verifiable propositions along with the methods for testing them (Young and Muller, 2010). This would result in a traditional model of knowledge being taught followed by an examination. In these disciplines, the danger is that the boundaries of knowledge are seen as implicit or can be taken for granted. Alternatively, over-socialised disciplines leave the knowledge to the 'knowers' (teachers in a school setting) and their practice (Bernstein 1975; 1990; 2000). Such models build on the exploration of cross-curricular approaches to learning and allow teachers to select the knowledge they deem most appropriate. This model, therefore, has a weak classification and a weak frame, with teachers having total autonomy (Bernstein, 1990). The concept of teachers as 'knowers' and having authority and autonomy in learning builds on the work of Bernstein, focused on recontextualisation and is explored further in section 3.3. Building on the models of under- and over-socialised curricula, Young and Muller present three potential specific educational models (Young and Muller, 2010; Young, 2011) known as three futures. The models explore different bounds of knowledge and social differentiation and have been used widely to explore subject level curriculum development in education (Priestly et al, 2023; Karseth and Wahlstrom, 2023; Hudson et al, 2023). 'Future 1' builds a scenario where the boundaries are given and fixed. This is a more traditional or 'under-socialised' concept of knowledge. In contrast, 'Future 2' is without boundaries, as in an over-socialised concept of knowledge, a weak classification. Young and Muller provide examples of the curricular format of Future 1 being based on subject content and of Future 2 being based on skills.

'Future 3' is presented as an alternative curricular format, where boundaries are maintained before some crossing of the boundaries takes place. This is the condition that best facilitates the creation and acquisition of new knowledge (Young and Muller, 2010; Young, 2011). The application of the Bernsteinian ideal of subjects having a strong frame in Future 3 is not straightforward. Future 3 requires a more longitudinal view with subjects initially building a strong frame followed by some penetration between boundaries taking place.

The narrative of computing as a subject, especially that presented by the Royal Society, suggests that computing does not yet have a strong frame. According to the Royal Society's first report, the previous subject, ICT, was more skills and application based and so indicates quite a weak classification, most akin to Future 2 (The Royal Society, 2012; Young and Muller, 2010; Young, 2011). The move to computing aims to establish a stronger frame developing a greater subject specific status (The Royal Society, 2012). The work of Young and Muller suggests that only once that process is embedded would a Future 3 scenario be possible.

Applying the three futures scenarios to explore a subject curriculum creates a risk of oversimplification. The identification of subject knowledge, the pedagogical approaches and the subject discourse require a more detailed view of the construct of the subject in question. The next sections of this chapter explore these aspects in more detail. Delving more deeply into the subject not only provides a more complete picture, but it also explores how the curriculum is realised in practice.

3.2.4 Identification of disciplinary knowledge

The organisation of knowledge is central to the work of Bernstein and many other contemporaries in the field. Hirst argues that a critical step in the formation of subject knowledge is the process of making disciplinary knowledge accessible (Hirst, 1971; White, 2018). In its simplest terms, disciplinary knowledge is a collection of true propositions about the field. Beyond this, a disciplinary 'knower' (an expert in the field) must understand how the propositions are interconnected and must be capable of the appropriate kinds of inference from one proposition to another (Winch, 2023). Specialised knowledge such as this needs to be transmitted through specialist institutions such as universities, colleges or schools (Young and Muller, 2013; Thomas, 2018). Young and Muller identify that such knowledge cannot be acquired or produced informally as part of everyday life. They define this specialist knowledge as 'powerful knowledge'. In many ways this term aligns with Bernstein's description of subjects with a strong frame.

Bernstein describes teachers or subject specialists in a field as 'knowers' (Bernstein, 1975). Beyond learning a body of disciplinary knowledge, knowers will find ways to transmit the knowledge to leaners. Many subject disciplines also have distinct manipulative or inferential activities to support understanding within the discipline. For example, learners carry out calculations in mathematics or perform experiments in chemistry (Winch, 2023). Discipline specialists engage in these activities as part of their own acquisition in the field. In Chapter 2, the shortage of specialist computing teachers is identified as a barrier to computing education. In this description of a knower, someone who has experienced the activities and acquired the disciplinary body of knowledge, this shortage may be exacerbated by the relative newness of the subject and teachers therefore not having engaged in these activities as part of their own schooling.

Bernstein refers to disciplinary knowledge as having a grammar. The grammar is the structure and the rules that the subject follows. For example, in mathematics there is a common accepted definition of what a circle is (Bernstein, 1975; 1999). Subjects with a strong frame will have a strong grammar (Bernstein, 1996). Young and Muller illustrate this through looking at the knowledge category of heat. The knowledge structure is the theory of heat, and the grammar is the accepted measurement of heat, measured by the instrument of the thermometer (Young and Muller, 2013). The subjects with the strongest grammars are hierarchical in nature. Bernstein identifies the process of this knowledge transmission as the instructional discourse.

As in the heat example, equipment and tools can contribute to the strength of grammar (Young and Muller, 2013). An obvious item in computing might be a computer itself, although some key theories within computer science may not require a computer at all. Using software, such as a word processor, may not be disciplinary at all if used as a tool for carrying out a task. However, having an understanding of how the software is created and the functionality may fall into disciplinary knowledge. Those developing the curriculum ultimately have the power to determine what falls into the realm of instructional discourse.

Bernstein identifies that the instructional discourse is embedded within the subject and is specific in nature. If teaching moves beyond the disciplinary, it follows a regulative discourse. The regulative discourse is broader in scope than disciplinary knowledge. It includes the transmission of values (Bernstein, 2000). As the knowledge is transmitted from one source to another, a space appears. Within that space, a transmitter, in this case a teacher, has space to add context and values such as time given to certain topics, emphasis and importance given to aspects of the subject, examples or cases studies used to illustrate the knowledge (Bernstein, 2000). For example, in the National Curriculum, the creation of digital artefacts provides the teacher with more freedom to select the activities, tools and context for the learning than a topic with a stronger grammar such as understanding Boolean logic (DfE, 2013). The weaker the frame of the subject, the more space is available for the regulative discourse. Bernstein names this process of transmission recontextualisation.

3.3 Recontextualisation

This section relates to my second research question: How were teachers delivering the National Curriculum in Computing in their schools? Recontextualisation is a concept which will help me unpick how teachers responded to the new computing curriculum.

3.3.1 What is recontextualisation

This section primarily focuses on how a subject discipline is 'recontextualised'. Bernstein borrows this term from the field of linguistics to explain how a text or other source may have a change in meaning or a redefinition based on the context (Singh, 2002). Through recontextualisation, a discourse is moved from its original site of production to another site, where it is altered in form (Bernstein, 1996). Bernstein makes use of the term to explore pedagogic processes and relationships between organisations and individuals and how these manifest in pedagogic discourse. Pedagogic discourse is the way a subject is communicated and taught. This is explained in more detail in section 3.4.

Disciplinary knowledge is created within the field of production. Bernstein (1975) identifies this as an 'official' institution, the source for knowers to build their disciplinary knowledge. The body of knowledge created within the field of production is that which is then decontextualised, e.g., takes on new forms as it is reproduced. The recontextualised knowledge is delivered within the field of reproduction. The field of reproduction is a learning institution such as a school, where knowers transmit the knowledge to learners (Bernstein, 1990). The categorisation of a learning institution is now broader than when Bernstein first defined the field of reproduction. The online environment has opened more channels of reproduction and sources for learning which may not come direct from a teacher (Czerniewicz, 2010). This is potentially of more relevance in computing where learners spend the majority of their time in lessons on a computer rather than more traditional subjects where learners have less access to devices in their lessons (Ofsted, 2022).

In the process of recontextualisation, Bernstein identifies two influencing fields. The official recontextualising field (ORF) is the official voice, often the state. In the case of computing in England, this would include the National Curriculum produced by the Department for Education. I also include the Royal Society reports and examination specifications produced by examination boards as these outline exactly what should be learned and the processes teachers should follow (The Royal Society, 2012; 2017; DfE, 2013; OCR, 2018). Bernstein also identifies a parallel field at work, the pedagogic recontextualising field (PRF). This field includes teachers, authors of teaching materials and curricular guides. In some situations, the PRF is clearly visible, for example, curriculum summaries on classroom walls (Ball, 2011) but 'invisible pedagogies', such as approaches towards behaviour management or teacher dialogue, are also key insights into the PRF and may be less obvious (Bernstein, 1975; Ball, 2011). Additional sources could now be included in this field including online videos and materials. The PRF will include those who create the online content, although in some cases the platforms and web hosts that house the content may fall into the realms of the ORF. A recent example is Oak National Academy, where online content produced by teachers in schools is now hosted on a platform owned and funded by the Department for Education (Peruzzo et al, 2022).

In the process of recontextualisation, knowledge is thought about, not as the body of knowledge itself, but how it relates to the experiences and interactions of those that construct and communicate the knowledge (Bernstein, 1975). For example, computing teachers teaching the use of Boolean logic will draw on their own learning of the topic, and they will choose teaching materials or create their own. They will also use examples built from experiences they consider relevant and explain this in a way they believe is best for their learners. Where a subject has a weak frame, the teachers have more autonomy in this process, whereas a strong frame provides less freedom, and so reduces variation between teachers (Pluim, Nazir and Wallace, 2021; Brossuek, 2021). In the process of recontextualisation, teachers (or transmitters, using Bernsteinian terminology) draw on their esoteric and mundane knowledge. Esoteric knowledge is disciplinary knowledge, that which is created by those recognised to have authority in the field, such as a scientific research community. In contrast, mundane knowledge is built on everyday experiences and interactions (Bernstein, 2000; Singh, 2002).

Ungar explores the development of a body of knowledge within the context of understanding climate change (Ungar, 2000). Ungar recognises the sheer growth in knowledge resulting in a knowledge-ignorance paradox. As populations learn more about one discipline, they learn less in others. Whilst the body of knowledge is developing all the time, an individual’s capacity to learn and remember more has not expanded in the same way (Ungar, 2000). Computing, by its very nature as a subject, is growing and evolving as a body of knowledge, both generated by the research community and within everyday experiences. As new knowledge is created, part of the recontextualisation process involves selecting the knowledge to be taught. Different balances of power within the recontextualisation process determine where the decisions are made about what is taught and when. Models with authoritative and influential ORFs will reduce the influence and flexibility of teachers to select what to teach and when, resulting in a strong frame. Where the ORF carries less authority, the frame is weak, giving teachers more autonomy (Bernstein, 1975; 1990; 2000; Pluim, Nazir and Wallace, 2021; Brossuek, 2021). This process can also be communicated from a bottom-up model. ORFs can appropriate knowledge and pedagogies from the PRF where those delivering the subject are seen as authoritative or further forward in their development (Apple, 2004).

By the 1990s, Bernstein had reworked these ideas based on the work of Foucault. This expanded the thinking from regulative principles within the discipline to explore more broadly the regulative principles within schools and classrooms (Bernstein, 1990; Singh, 2017; Singh and Kwok, 2023). Whilst this answers some critics, Illera (1995) argues that Bernstein never fully addresses attitudes to learning and whether learners actually want to be taught the subject.

As an example, Marsh has explored the relationship between the ORF and PRF within the subject discipline of English (Marsh, 2007). Marsh identifies that, in the 1970s, the ORF had little influence over pedagogy and curriculum with little centralised practice. This changed significantly with the introduction of the English National Curriculum in 1988. The power of the ORF increased again with the introduction of the National Literacy Strategy in 1997. In this model, the ORF determined how each lesson would be structured within blocks of 10 minutes. Marsh indicates that this was a shift to a focus on a performance model with a focus on explicit transmission of uncontested and dominant knowledge. This resulted in a strong frame, with the teacher having little or no control over their transmission of knowledge. Marsh identifies that, in this case, the ORF was selective in appropriating aspects of the PRF, including how pupils learn with technology. This indicates a selective approach to using Bernstein's research and scholarship on children's communicative practices (Marsh, 2007). This may be a result of the freedoms available to the researcher in applying the C/F model in the relationships between the ORF/PRF and between transmitters and subjects (Sadovnik, 2007).

In contrast to the English subject example, ICT, now computing, has a less defined classification as a subject discipline. It therefore may have a stronger frame and so potentially has more flexibility in terms of freedom in the classroom and the power and influence of the PRF. To explore this in more detail, I draw on Bernstein's outlines of the influence of different pedagogic discourses and the use of pedagogic devices (Bernstein, 1975; 1990; 2000). These are explored in the next sections.

3.3.2 Vertical and horizontal discourse

Bernstein distinguishes two distinct, oppositional types of pedagogic discourse. Horizontal discourse, which he describes at the most basic level as common-sense knowledge, and vertical discourse, a specific and explicit structure, hierarchically organised, such as in the sciences or texts within the humanities (Bernstein, 2000). Horizontal discourse can be most closely aligned to previously described mundane knowledge, grounded in everyday knowledge. Vertical discourse is mostly closely connected to esoteric knowledge, bounded as disciplinary knowledge determined by knowers in the field, although Bernstein recognises these can change position over time (Bernstein, 1975; 1990). It is not explicit how Bernstein views the knowledge changes over time, but this can be linked back to the model of classification. Where subjects are weakly classified, they are more penetrable to outside influences and changes in the boundaries of knowledge and are therefore more likely to change over time (Atkinson, 1995; Goodson, 1995). In horizontal discourse, the recontextualisation is community based and so the learner develops their understanding from others.

Bernstein describes the horizontal discourse as a cultural relay, where the knowledge within the community is redistributed to those within it (Bernstein, 2000). It is widely acknowledged that learners from more middle-class backgrounds have more opportunities for learning outside school (Bourdieu, 2010; Muller and Young, 2019; Ofsted, 2019). However, Bernstein identifies further inequalities when horizontal discourse is used as an alternative to vertical discourse, where learners are relying on learning outside of school rather than as an addition to their formal learning. This is most often the case where a subject is weakly classified (Bernstein, 2000). Where pupils do not have access to computing within school, the horizontal discourse may be their only source of learning.

In vertical discourse, transmission is more formal through explicit use of time, space and actors. In the teaching of mathematics, the time is specified by the timetable of the school which provides specific time allocations for the subject; the space will usually be the classroom and the actors are the roles of teachers and students. Vertical discourse usually takes place within a formal learning institution, such as a school. But the model may also now be applied to formal online learning courses (Czerniewicz, 2010). Where online learning is applied to the model, learners have more control of the space and timing of the formal learning taking place.

	Vertical Discourse	Horizontal Discourse
Practice	Official/Institutional	Local
Distributive Principle	Recontextualisation	Segmentation
Social Relation	Individual	Communalised
Acquisition	Graded Performance	Competence

Figure 3.1: A summary of vertical and horizontal discourse (taken from Bernstein, p 160, 2000)

In addition to those differences listed in Figure 3.1 formulated by Bernstein, is cost (Ivinson and Duveen, 2006). A vertical discourse requires financed input including knowledgeable teachers and time for the curriculum to be delivered. The same costs are not always associated with a horizontal discourse, although this can be complex. In some cases, expertise is prevalent in more affluent communities, so a specific cost is difficult to ascertain.

In Figure 3.1, the distributive principle of segmental pedagogy is carried out in face-to-face relations such as in the family, a peer group or the local community. Unlike in the vertical discourse, these interactions may be one-off events and may be no longer than the segment in which it is enacted (Bernstein, 2000). For example, if a learner wanted to do something with a specific piece of software such as underline some text, and a parent was able to show them, that would be a segmented distribution of knowledge. The knowledge is shared and then the discourse ends. Alternatively, a teacher may put together a series of formal lessons to build knowledge on the tools and software. This may involve underlining text but also a full range of other tools, usually developing in complexity. This is a recontextualising distributive principle where the knower has identified and redistributed a body of knowledge (Bernstein, 1995; 2000). Such an approach to teaching software use was commonplace in the ICT National Curriculum prior to 2014 (National Strategies, 2004; The Royal Society, 2012).

It is possible to explore two different, current topics from the National Curriculum in Computing and frame how they are taught/learnt in relation to the vertical and horizontal discourse. One section of subject content from the National Curriculum explains that students should recognise inappropriate online content, contact and conduct, and know how to report concerns (DfE, 2013). This learning is of paramount importance in terms of safeguarding children and supporting them to operate safely in the digital world (Ofsted, 2022). Whilst signposting and information can be shared in formal education, it is the personal experience and the support of others that leads to greatest understanding in this area (Moreno et al, 2013). Most 'inappropriate content' is filtered and blocked by school internet providers and so examples of how to identify or block such content can be difficult for institutions to demonstrate and address. Many children's experiences of inappropriate content occur in their personal lives requiring education and support at a local level and from family and friends. It is this community who contribute to education in this area. Bernstein refers to such a horizontal discourse as being characterised by functional relations of segments or contexts to the everyday life (Bernstein, 2000). Where learning such as this does not have a strong classification, has a weak frame, and learners might not even be guaranteed access to it, how are school leaders ensuring that learners have the knowledge they need?

Alternatively, the National Curriculum also identifies learners should understand how numbers can be represented in binary and be able to carry out simple operations on binary numbers, for example, binary addition, and conversion between binary and decimal (DfE, 2013). It is quite unlikely that children would come across this in their lives outside school or in any other curriculum areas. Such a topic requires specialist knowledge to gain understanding and then apply it to binary calculations. The topic also requires no use of computers and can be formally tested by paper-based examinations, with conversions and calculations at varying levels of difficulty. Using Bernstein's model, this exemplifies a vertical discourse, referring to specialised symbolic structures of explicit knowledge (Bernstein, 2000; Ferreira, Morais and Neves, 2011; Barette, 2017). Maton (2009) determines such a discourse as less dependent on relevance to its context, and instead is related to other meanings hierarchically.

This model suggests that current discussions in the subject identify the general use of computers and wider technologies as a horizontal discourse developed through use of computers outside schools or informally in other subject areas (Ofsted, 2022). In contrast, curriculumised computing education is a more formal, vertical discourse. However, within the subject of computing, both horizontal and vertical discourses are evident. Learning how to use social media on a mobile device could be considered to be horizontal, whereas a formal programming class could be viewed as vertical. That said, learning does not fit neatly into such categories. Many programmers are self-taught or use collegiate online sources to develop their knowledge. Despite programming knowledge being mainly hierarchical in nature, needing to know basic operations before building to more complex sequences, the learning of this may not be formal and classroom based (Hayes and Overland, 2024).

The Royal Society report (2012) outlines that computer science is a rigorous discipline, in the same way that mathematics or physics are. It states that computer science has a strong classification with a bounded body of knowledge, implying a vertical discourse is required (Barrette, 2017). However, the report also focuses on digital literacy and information technology (IT). These subjects are more problematic, as their classification is not as strong. The messages for teachers and leaders in education are therefore quite difficult to interpret. The need for a vertical, more traditional subject discourse is clear from the National Curriculum documentation and the messages from the Department for Education (Gove, 2012), but the content is not strongly classified. This leads to a weaker frame, so teachers have more autonomy and so can change in the discourse. The use of terminology and the key messages are mixed and leave themselves open to interpretation or even ignored altogether. For example, where schools have embraced the key message of a vertical discourse for computer science, this may be to the detriment of digital literacy or IT which may be left out of the curriculum delivery (The Royal Society, 2017). These aspects of the curriculum may therefore follow a horizontal discourse with learners building their knowledge and skills through segments and through their community interactions (Thomas, 2018).

A particular challenge with Bernstein's model and relating it to computing is the construct of knowledge itself and how this develops over time (Bernstein, 1975; 1990; 2000). Bernstein does recognise growing bodies of new knowledge; he outlines that hierarchical knowledge structures develop through new knowledge integrating and subsuming previous knowledge. For example, as quantum computing research continues at university and industry level, there may well be a point where this is taught as part of the school curriculum. This does not mean classical representations of computational memory would not be taught, but that new learning would be added to the body of disciplinary knowledge (Bernstein, 2000). However, this is a challenge when considering it alongside the strength of classification. Where a subject has a strong classification, it is clearly bounded and insulated from outside, which appears to include additional knowledge not being added (Bernstein, 1975; 1990; 2000; Thomas, 2018).

Even since Bernstein's last publication, the nature of learning has changed considerably. Many learners can now navigate online videos to find demonstrations or exemplars for aspects for a wide range of subject areas and topics. More formal online learning packages take learners through a step-by-step course. Many schools now subscribe to online learning packages to supplement their teaching for use in both formal school environments and at home. Knowers now have far more opportunities to communicate their knowledge with learners via online platforms and learners are not limited only to those teachers they come across in their formal education settings (Czerniewicz, 2010; Thomas, 2018). There is also more opportunity for learners to repeat and revisit learning. If something is not clearly understood the first time, this can be explored again from different online sources. Tools such as online games can also be used to support learners in practising skills and revisiting knowledge. There are a wide range of quiz and learning apps targeting the education market (Thorpe, 2024). These more recent approaches to learning are prevalent in computing and make the categorisation of pedagogic discourse more complex. As previously mentioned, in developing knowledge of using software, learners may receive formal instruction in a classroom, or they may learn it from interactions with others within their community. Alternatively, many learners may now be learning through an online course, a series of videos or simply searching online for the knowledge as and when they require it. Potentially, this does not fit comfortably into either model of vertical or horizontal discourse. A community in an online space moves beyond the bounds of a community as outlined by Bernstein (Bernstein, 1990; Thomas, 2018).

In many ways, the two forms of discourse are seen as oppositional rather than complementary (Bernstein, 2000). This may not be the case in the use of online resources and interactions in developing knowledge in computing. A horizontal discourse may supplement a vertical discourse, although perhaps in a more formalised way than outlined in Bernstein's original definition of horizontal discourse.

The way horizontal and vertical discourse may supplement each other in an online environment may also influence the strength of frame of the subject. The more a learner uses online resources at a community-based level, the more a learner may want to know about a body of knowledge, and it may increase their curiosity. This is a particular recent development in the use of AI (Perrotta and Selwyn, 2020). This creates an opportunity for vertical discourse to be extended, based on the experiences of pupils outside of formal learning. Much of Bernstein's work was carried out prior to the wide usage of the internet in education and certainly before the use of mobile technology and distributed content development. That said, Bernstein (2000) was highly aware of market forces and the economic drivers behind certain developments within education.

3.3.3 Totally pedagogised society

In some of his latest work, Bernstein introduces a development in education resulting in a 'totally pedagogised society' (TPS). Somewhat speculatively, Bernstein (2001) outlines a future where all aspects of society are pedagogised as a means of social control. A simplification of this concept identifies that, rather than an early education followed by employment, that pedagogy is imposed at all stages of life with individuals being trained for a job at the point of need and then retrained for another one once that need has ended. Parallels can be drawn with the TPS and a 'future 2' educational scenario (Young and Muller, 2010) with boundaries of knowledge weakened alongside a blurring of labour market sectors.

The TPS concept provides a framework to identify the potential influence of market forces, and ultimately the state, in education. Although one of the least formed and lesser used of Bernstein's theories, the TPS is relevant to the consideration of computing education. An alternative reading of the TPS is that it is a precursor to the impact of online and self-directed learning (Czerniewicz, 2010). Whilst much of Bernstein's theories are applied to formal school and university education, the TPS features in research of adult education and lifelong learning (Ball, 2009; Tsatsaroni and Evans, 2014; Christidou et al, 2012).

The application of this theory in these broader contexts may have particular relevance to computing, particularly the strand of digital literacy, but also the application of computing to future careers. This subject area has the most opportunities for learners to build knowledge online and target their learning to a specific skill or piece of knowledge they need in the moment (Thorpe, 2024). The TPS changes how individuals may approach learning and be influenced through different authoritative voices in learning (Bernstein, 2000). His examples included teenagers receiving careers guidance and families attending courses in parenting skills (Bernstein, 2000; Singh, 2017). This theory encapsulates the growth in industries (both agencies and agents) in the production and dissemination of pedagogic discourse.

An important aspect of the TPS not directly addressed by Bernstein is the learners' perceived shift towards a TPS (Singh, 2017). If pupils believe they can learn all they need online, then the commitment to a vertical discourse may be reduced. Subjects with a weak classification may be more vulnerable to this than other subjects. This then impacts the strength of frame, where learners have less commitment to a subject; the teacher then may need to be more flexible in their approach in order to engage them (Apple, 2002; Pluim, Nazir and Wallace, 2020).

3.3.4 Pedagogic devices

To fully explore the interrelated processes of the frame of a subject and the process of recontextualisation, it is necessary to identify the actual components that form pedagogic processes (Morais and Neves, 2011). Identification of these helps to identify the influence and power each one holds within the process. The pedagogic device is a critical feature of Bernstein's approach to exploring symbolic control in education (Berstein, 1975; 1990; 1996; 2000; Laminas, 2002). Bernstein's (1980) definition of pedagogic device is as an abstract construct, a condition for the production, reproduction and transformation of culture. Essentially, these are the rules or procedures via which knowledge is converted into classroom talk, curricula and online communication (Singh, 2002). Bernstein, and many others, have taken the pedagogic device to a more concrete definition, for example, spoken word in the classroom (from teacher and pupil), printed teaching materials, online teaching materials and production of classroom activity (Bernstein, 1975; 2000; Danzig, 1995; laminas 2002; Arnott and Raey, 2006; Ivinson and Duveen, 2006; Power, 2006).

Pedagogic devices range from the macro-level, influencing state policy and curriculum documentation, through to micro-levels of classroom interactions. Clear definitions will aid discussions about pedagogic discourse. The pedagogic subject is the student. The transmitter is the teacher, or materials such as textbooks. Bernstein mentions a computer within this discussion (Bernstein, 1990; Singh, 2002). As a result of this being written prior to the huge growth in web-based content being used in education, I suggest that Bernstein would now agree that the online content is the transmitter rather than the computer device itself. This discussion becomes more complex with the use of AI, where algorithms may be determining the content transmitted to students. In this case, the AI algorithm itself becomes something more than the transmitter (Perrotta and Selwyn, 2020). The AI is more akin to the macro-level factors, having influence over curriculum and access (Levinson, 1999). Where apps and AI powered platforms are used within subject pedagogy, it is important to consider how they are being used, as a transmitter of knowledge determined by the local knowers (teachers in the classroom), therefore within the PRF, or as part of a centralised system, therefore being a part of the ORF (du Boulay, 2019).

The classroom and curricular organisation are described as the pedagogic context and can be included as a device. These include structural aspects such as funding, curriculum time and provision of resources (Maton, 2006). In the case of computing, a classroom is quite a complex resource. Whilst the physical environment may be similar to other classrooms in a school, the technological devices themselves can vary. The choice of devices, age, version of the software and other technological considerations are made at leadership level. The level of investment may be an indicator of the strength of the subject classification within the setting. This contradicts the previous suggestion that the computer is not the transmitter and the device itself is unimportant. Whilst that is true, devices do need to be functional. Similarly, leadership decisions will influence the investment in staffing, other resources and curriculum time, which all contribute to the pedagogic context (Singh, 2010).

The communicative pedagogic competence is a critical element to the exploration of recontextualisation. This is the talk between teachers and pupils (Christie, 1999; Morais and Neves, 2002). Bernstein explored classroom communication including whole class teacher monologue, triadic dialogue (teacher question – student response – teacher evaluation) and seatwork activities (student to student interaction) (Bernstein, 1996). Researchers in the field have adopted these principles to carry out detailed critical discourse analysis within classrooms to explore processes of recontextualisation (Chouliaraki, 1996; Iedema, 1996).

Prior to precise discourse analysis between teachers and students, a critical step to explore is text transformation. Bernstein (1996; 2000) identifies two types of text transformation. The first is the conversion of knowledge from the ORF to the PRF. Is the official documentation/curriculum etc. being reproduced as intended by the ORF? This is the instructional discourse, the formal curriculum to be delivered (Bernstein, 2000). The second is how teachers may be influenced by those they are teaching, their families and communities. This is the regulative discourse as a recontextualising principle (Bernstein, 2000). Singh (2010) argues that being influenced by those they teach may result in the regulative and moral discourses of the school or classroom being more effective. In computing, this may be to provide a context that is relatable to the students, or to teach an aspect of computing that teachers have identified students using outside of school such as a particular software or social media platform. High levels of flexing towards learners' own experiences may be an indication of a weak frame, indicating that the acquirer (learner) has more control in the pedagogic discourse than that of the transmitter (teacher) (Bernstein, 1975; 2000).

Bernstein (2000) identifies that, where relationships are weak internally between staff in terms of pedagogic discourse, this leaves subjects more open to public discussion and challenge. Staff who are unable to collaboratively plan schemes of work or have time to meet and discuss their classroom approaches, may be more influenced by others outside the school in their work. For example, a lone subject teacher in a school may be more tempted to download resources from the internet in the absence of colleagues to collaborate and plan with. Subjects with a strong frame, that are well insulated, are less open to influence from external bodies (Singh, 2002; Morais and Neves, 2011). Ultimately, this may strengthen the influence of the ORF where teachers do not have the confidence to deviate from it, or it could result in a dichotomy of practice (Archer, 1995).

In a computing context, it is also important to consider pedagogic devices from a time progression perspective. In computing related subjects, subject knowledge and teaching resources can quickly became dated due to the rate of change (Somekh, 2007). If the ORF is not keeping up-to-date with developments in the field, this may leave the recontextualisation open to influence from updated or new technologies and result in a weaker frame. This is an aspect of recontextualisation that is not directly recognised by the Bernsteinian model as the rate of change in the computing subject knowledge is at a faster pace than that outlined by his own model of a cultural relay of knowledge

(Bernstein, 1990). Therefore, by the very nature of the subject being one of rapid change, it may already have a much weaker frame than some more traditional school subjects.

Beyond the formalities of documentation and materials, Bernstein describes an invisible pedagogy (Bernstein, 1975; 1990). Durkheim initially identifies this as beyond what is taught in and learned in the specified textbooks and teacher manuals (Durkheim, 1961). Dreeben first introduces the term hidden curriculum (Dreeben, 1968) and this is used widely, particularly to explore the influence of politics in education (Apple, 1971) and the enactment of policy (Ball, Maguire and Braun, 2011). The hidden curriculum identifies measures such as conformity and obedience within an educational setting. It also draws on the values and information beyond the curriculum expressed by teachers to pupils and between pupils (Apple, 1971). Whilst both the hidden curriculum and invisible pedagogies explore the sociological aspects of educational settings, the latter has more of a specific focus on codes and social class, reflected in the pedagogic discourse. This is explored in more detail in the next section, section 3.4.

3.4 Learner experience

This section focuses on concepts that will help me to answer my third and final research question: What was the perceived impact for learners as a result of the National Curriculum in Computing?

3.4.1 Social class and inclusion

A key feature of Bernstein's sociological approach to pedagogy is that of social inclusion, embedded in all aspects of his work (Bernstein, 2000; Sadovnik, 2011). Whilst some of Bernstein's' research-based observations, particularly around gender, may now be quite dated, the theory for exploring class and power relationships in pedagogic discourse remain (Singh and Kwok, 2023). As described in Chapter 2, section 2.4, inclusion, particularly around gender and class, are important considerations of current computing education with a lack of female learners and those from lower socio-economic backgrounds opting to study the subject (Kemp and Berry, 2019).

The definition of language codes begins in the earliest of his work and continues through his theories and research (Bernstein, 1971; 1975; 1990; 2000). Language codes take a socio-linguistic approach to specifically exploring language within pedagogic discourse. Elaborated code is defined as the most formal language within the discourse, providing a greater range of vocabulary and reasoning power. Restricted code is that which is more 'public language', a less formal vocabulary providing the user with a smaller body of vocabulary and so more limited power of reasoning (Bernstein, 1971; 1975; 1990). Bernstein himself identifies that language itself does not prevent the expressions of ideas or restrict the level of conceptualisation (Bernstein, 1975), but it cannot be ignored that any restricted code may prevent learners from accessing or expressing understanding of disciplinary learning.

During Bernstein's later work, he outlined a shift from education reproducing class structures to one where education constitutes social order through a state-managed process of symbolic control (Tyler, 2004, p 20). Recent scholars applying Bernstein's theoretical frameworks to their own research have a clear sense of social justice and use it to gain an understanding of social inequalities in education (Singh, 2002; Ivinson, 2018). These researchers take on Bernstein's principles of linguistic codes to explore social inequalities in education.

The use of the linguistic codes has much overlap with other sections of this chapter. Bernstein makes a distinct link between the strength of classification of a subject and the associated elaborated code. If a subject has a strong classification, it will have a greater level of disciplinary language, therefore increasing the level of elaborated code. Therefore, a simplification of the model suggests that subjects with a stronger classification are most open to those learners from middle class backgrounds who are already in possession of elaborated code and are most able to access subjects with a stronger frame. In a study based on this model, Maton (2006) explores the low uptake of music GCSE, particularly by pupils from lower socio-economic backgrounds, and their perceptions of an elite (elaborated) code within the subject.

In some subject areas, pupils from working class backgrounds do not underperform or disengage with the subject as much as they do in computing, for example, in geography or history (DfE, 2023). What Bernstein pays less significance to in this model is the impact of prior schooling. For pupils of secondary age in the UK, they have already been influenced and learned from 7 years of primary education. Beyond class, this will have influenced subject specific levels of elaborated code in computing (Jones, 2013). As outlined in Chapter 2, section 2.2, the implementation (strength of classification) of computing education at primary level is less developed and more varied than in secondary education (The Royal Society, 2017).

The use of elaborated and restricted code is also linked to Bernstein's discussions around horizontal and vertical discourse. Horizontal discourse mainly takes place with the use of restricted code. Bernstein identifies that middle class learners have a more developed elaborate code beyond that built within the formal learning environment (Bernstein, 1990; 2000). This has been explored widely and linked to the term of cultural capital (Bourdieu, 2010). Traditional views of cultural capital beyond activities such as reading at home, include wider experiences such as visits to museums or the theatre. In computing, there is potential that this could move beyond class divisions created by finance, prior experiences and time, as cultural capital can be built in an online space (Overland, 2024). Online content can provide learning opportunities and subject resources without the need to travel or for high costs. Within the context of computing, this potentially broadens Bernstein's scope of the use of language by working class learners. However, a lack of access to online content may exacerbate differences between the classes (Paino and Renzulli, 2013).

3.4.2 Gender and inclusion

Gender dynamics are not addressed directly by Bernstein to consider how they might contribute to his code theories (Bernstein, 1973; 1990; Collins, 2000). Despite this, researchers have adapted the theories to specifically explore gender issues in education (Chisholm, 1994; Delamont, 1995; Creese et al, 2004). Delamont particularly identifies opportunity for Bernstein's work to be applied through a feminist lens. Whilst a feminist lens is not a detailed focus for this study, gender representation within computing is particularly significant in the data and learner outcomes. Therefore, it is important to consider how the theories of Bernstein can be applied to exploration of gender issues within the data analysis.

In order to do this, it is necessary to delve deeper into the development of Bernstein's writing on pedagogic discourse, with particular reference to his model on cultural transmission emerging from a paper from 1981 (Bernstein, 1981; 1990, Daniels et al, 2004). Bernstein identifies that, at the time, much sociology of education was focussed on what was being reproduced through education, including class, gender, religion and race (Apple, 1982 in Bernstein 1990) rather than the discourse itself being integral to the process (Bernstein, 1990). Bernstein identifies that education is not only a reproduction of cultural norms but amplifies and distorts it through pedagogic discourse. A double distortion, firstly distorted in the interest of the dominant group, is secondly distorted in the culture and consciousness of the subordinate group. For example, in computing, the dominant group is predominantly male, and both researchers and industry professionals in the field are male (Shadbolt, 2016). Therefore, the male voice will be dominant and, even if unintentional, their voice and perspective will be dominant within the ORF (Delamont, 1995). In the second distortion, the subordinate group (in this case females) will also have their own views of whether they belong or can relate to the subject themselves. However, it has been found this does vary with the socio-economic background of the subordinate group (Chisholm, 1994; Delamont, 1995). A teacher may attempt to encourage girls in computing through adding a female context to an activity. What Bernstein identifies is that how the learners actually then receive that message is part of the pedagogic discourse, not simply that it was delivered. Bernstein identifies this process, where teachers reinforce cultural positions such as male dominance in computing, as cultural transmission (Bernstein, 1975; 1990).

Whilst Bernstein does not refer to a specific regulative text relating to gender in learning, the identification of sub-cultures and membership of such can be applied to gender within the classroom. One such study is from Creese et al. (2014), which applies Bernstein's theory of instruction to classroom practice and gender difference explores the instructional practice, instructional context and regulative practice. In this case, it would be anticipated that the differences between sub-cultures would be most evident in the regulative practice. However, it was identified that where the subject had a weaker frame, there was more variation at an instructional level. Based on this research, potentially the regulative text within computing classrooms may be more gendered where the framing of the subject is weakest. To explore such questions, my research design considers the broad, interrelated themes from Bernstein's theories into a computing context, including representation of female learners.

3.5 Applying a Bernsteinian framework to research

This chapter has bought together the theories and models of Bernstein that are most relevant to this comparative case study exploring the implementation of the National Curriculum in Computing. There is an intentional omission of Bernstein's extensive work on discourse analysis (Bernstein, 1973; 1975; 1977). This work is extensive and underpins many applications of Bernstein's work in research (Atkinson, 1995; Sadovnik, 1995). In such research, analysis of classroom talk provides detailed insights into the use of restricted and elaborate codes within language. I have studied this aspect of Bernstein's (2000) work, as many of the findings inform the development of his models over the decades. Whilst informative, such detailed discourse analysis is beyond the scope of this study and does not precisely align with my research questions. Within the two cases presented in Chapter 5, there are references to the use of disciplinary language, but this is not intended to be an attempt at detailed discourse analysis. Instead, the aim of this study is to provide insights into the pedagogic devices and the strength of subject classification.

The next chapter, methodology, discusses the research design and methods, and how this aligns to the research questions and the theoretical framework outlined in this chapter. The key concepts taken from this chapter are summarised as follows.

Question 1: How is the National Curriculum in Computing presented to school leaders and teachers? This links to section 3.2 in this chapter and is dominated by determining the strength of classification of the subject (Bernstein, 1971). By determining the strength of classification, this includes the authoritative voice of the ORF, leadership decisions and the insulation of the subject, as in the level of influence from external sources (Bernstein, 1975; 2000).

Question 2: How are teachers delivering the National Curriculum in Computing? This is focussed on the pedagogic discourse and the strength of frame of the subject (Bernstein, 1975; 2000). This explores how knowledge is transmitted from teachers to learners and the invisible pedagogy, as determined by the PRF. This primarily links to section 3.3 of this chapter.

Question 3: What is the perceived impact for learners as a result of the National Curriculum in Computing? This explores the strength of frame of the subject from a learner perspective, alongside their experiences of pedagogic discourse (Bernstein, 1971; 1975; 1990; 2000). This also explores aspects of the use of elaborate and restricted code and how learners feel included within the subject, outlined in section 3.4 of this chapter.

Chapter 5 presents each of the case studies as a continuous narrative without placing distinct borders around the data. In contrast, Chapter 6 mirrors the structure of this chapter, discussing each research question in specific relation to the Bernsteinian concepts and uses data from each of the cases to illustrate the discussion.

Chapter 4: Methodology, applying a Bernsteinian framework to case study research

As outlined in the literature review, this is currently a time of transition in computing education in England and the extent and success of implementation of the computing curriculum are varied. This chapter outlines how I investigated the realities of the current computing curriculum in computing classrooms and the impact for both teachers and learners.

As a starting point to my research design, I return to my research questions and how they align with the theoretical framework and the input, process, output model outlined in my introduction (section 1.2). These are:

1. How is the National Curriculum in Computing viewed by school leaders and teachers?
2. How are teachers delivering the National Curriculum in Computing in their schools?
3. What is the perceived impact for learners as a result of the National Curriculum in Computing?

To answer these questions, I chose a qualitative approach to build a detailed exploration of computing provision in two case study schools.

Each aspect of the design of the case study will be considered in turn starting with a rationale for identifying the choice of 'cases' to work with.

4.1 Aligning the research questions to the theoretical framework

As outlined in the introduction, in their simplest form, my research questions align with an input, process, output model of systems thinking. These can be aligned with the Bernsteinian approaches outlined in Chapter three:

- The input to the model, the influence and design of the computing curriculum, relates to the field of production, the ORF and the strength of frame of computing as a subject (section 3.2). A focus on establishing the ORF will explore official documentation including political texts (Ball, 1995).
- The process of the system relates to the pedagogic discourse and process of recontextualisation (sections 3.3 and 3.4).
- The outputs of the model relate to the pedagogic discourse and the experience of learners (section 3.5).

The diagram following (Figure 4.1) summarises how these aspects align with the Bernsteinian concepts discussed in the previous chapter.

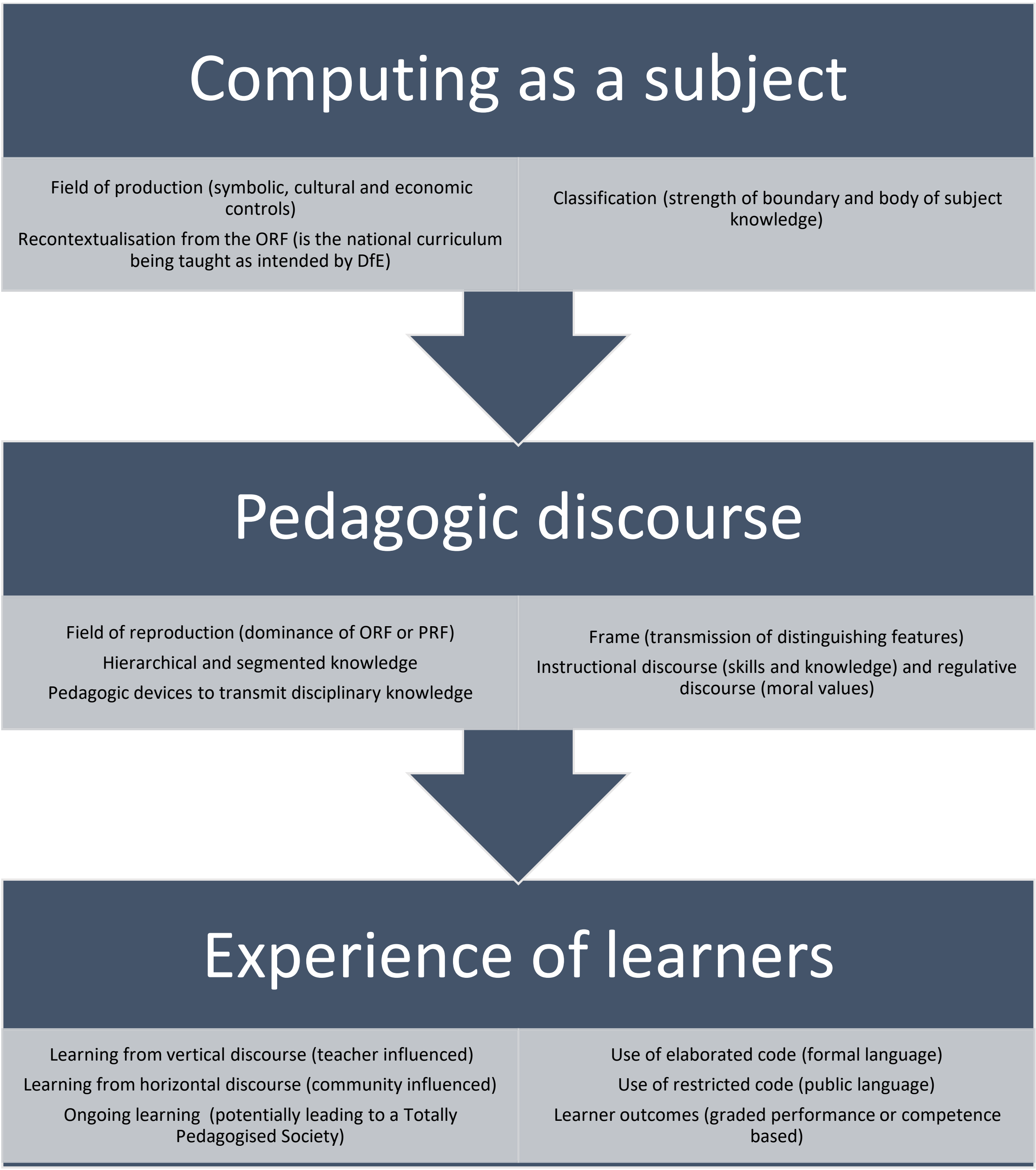


Figure 4.1: The three stages of research question aligned with Bernsteinian concepts.

Computing as a subject: I have explored the range of documentation informing leaders and teachers about the National Curriculum in computing (see Chapter 2, section 2.7). This forms part of the official recontextualising field. The key research question is not what these documents are, but how influential they are in determining the practice of teachers, underpinned by the strength of identity (classification) and framing of the subject. This potentially varies between schools. A strong classification will impact structural decisions in schools such as specialist staffing needs and timetable allocation to the computing subject.

Pedagogic Discourse: This aspect of the model is fully reliant on teacher voice. It needs to explore how the teachers are taking computing as a subject and transmitting it through their decisions, values and practice.

Experience of learners: This requires learner voice. Alongside this teacher voice will also be sought how pupils are performing in the subject. An exploration of language and learning articulated by the pupils will give an insight into the use of elaborate code although it will not include classroom talk (gathered through observations) as pupils may be at different points in the curriculum or not even studying the same concepts.

The next section will pull together these aspects of data collection into a comparative case study approach.

4.2 Research design: A comparative case study approach

The three research questions (see Figure 4.1) warrant the need to collect a rich and deep level of data, especially regarding learner voice. A comparative case study approach can offer this. Through carrying out two detailed case studies and comparing them for similarities and differences, it allows a consideration of the causes and implications of complex issues (Stake, 2006).

Beachside Comprehensive is a seminal case study in education (Ball, 1981) which built on the prior experiences of Hargreaves (1967) and Lacey (1970). The work of Ball is widely discussed in the literature review (Chapter 2) and the themes and parallels in the research process are many.

Hyett et al (2014) explain the difficulties for researchers to define and understand case study as a methodology. Research guides are littered with wildly different examples from a range of fields that vary radically in size, scope, focus and method (Thomas, 2011, Hamilton and Corbett-Whittier, 2013, Chadderton and Torrance, 2011). Using Stake's widely acclaimed criteria for qualitative research, Hyett et al developed a checklist for undertaking 'quality' case studies in research (Hyett et al, 2014, Stake, 1995). This is a highly contestable process because case study design is individual and should be determined to meet the needs of the individual case and the Quintain (the phenomena being explored) (Stake, 2014). However, the use of a checklist such as Stake's does highlight potential pitfalls of case study design and add a level of rigour. Despite the subjectivity of such an exercise, it is important to be aware of potential gaps in case study development as a methodology. For example, researchers may not provide a clear methodological description or justification for their case study or explain why they made the case selection that they did.

> *In the 34 case studies reviewed, three described a theoretical framework informed by Stake (Stake, 1995) two by Yin (Yin, 2009) and three provided a mixed framework informed by various authors, which might have included both Yin and Stake. Few studies described their case study design, or included a rationale that explained why they excluded or added further procedures, and whether this was to enhance the study design, or to better suit the research question. (Hyett et al, 2014, p.9)*

Data on access and performance in national computing qualifications shows regional and demographic differences. Selecting two contrasting schools in different locations provided an opportunity to compare data and identify both similarities and differences, potentially giving greater insight into the curriculum implementation. It is important to consider researchers are not invisible and will be part of the classrooms and the interviews whilst collecting any data. It was therefore imperative to consider the selection of the two schools and my relationship with them. Thomson and Hall (2017) also explore the importance of building a relationship with the school or set of schools. Initially it seemed most straightforward to research with schools that I already worked with in a professional context, but this was problematic, both from an ethical perspective but also in terms of developing an 'honest' view of the computing curriculum implementation (Lacey, 1993). I decided that starting afresh with new schools would avoid potential power issues with educators who were engaging with me on CPD or mentoring my student teachers. This helped to maintain a professional distance (BERA, 2018). Also, for many of the schools I already worked with, we had already engaged in much discussion around the research foci. In fact, it was the comments and suggestions of many of these educators which sparked my initial interest in this research. Therefore, accounting for both research design and ethical considerations, I selected schools that I had not worked with in any capacity in the past. A case, in addition to being defined in location and specifying those involved, needs to be defined within a timeframe (Thomson and Hall, 2017). Starting afresh with unknown schools prevented a historic context shaping the data collection or influencing the researcher–participant relationship. I was able to focus on their understanding and interpretation of their computing curriculum development rather than be influenced by any previous visits or knowledge of the schools myself. The process is outlined in Figure 4.2. This research is designed to be a snapshot of the implementation of the computing curriculum and how the school arrived at this point rather than a diachronic case study revisiting the case at different times (Thomas, 2011).

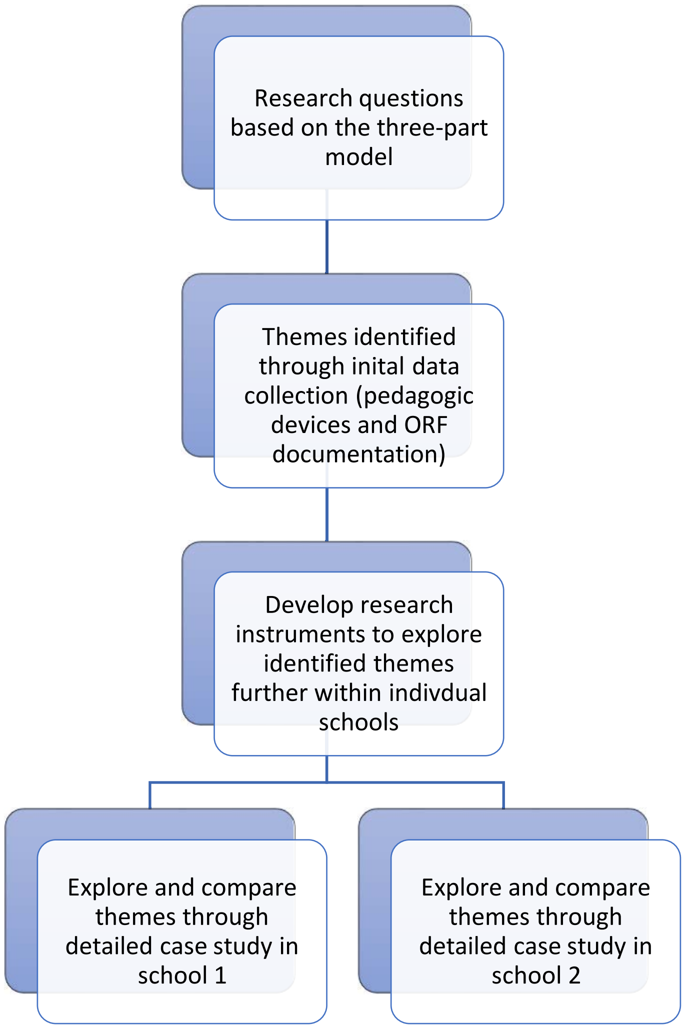


Figure 4.2: The process to identify themes and develop a detailed understanding of computing education to compare the two case study schools.

It would seem an obvious assumption that the ‘case’ in question will be a computing department within a school. However, being clear about the boundaries of the case is crucial (Thomas, 2011; Yin, 2009; Stake, 2006). Thomson and Hall (2017) challenge the boundary of a school environment. On a simplest level, does it include indoor and outdoor spaces, different buildings (especially if schools are on a split site or part of a collegiate group of schools), does it include all educators and pupils? Parents? The local community? Employers? Does the school also have an online presence or distance learners, in which case there are no set geographical boundaries? So it is essential the boundaries of the school are defined by the researcher. In this research, the school is the specific buildings and the pupils and educators within them.

The term pedagogic device has been used to describe a range of resources in education. As part of my study, I will be open to a range of pedagogic devices. These may include online and digital resources and communications alongside paper-based and physical materials. Alongside the devices themselves, it is important to consider the context and views of the teachers who are making use of them. The selection and reasons for their use will be just as much, if not of more, significance than the devices themselves. The use of pedagogic devices provides particular insight into the strength of frame of a subject. Where the framing is weak, the acquirer is accorded more control over the regulation (Bernstein, 1981, p 345).

The voice of learners is seen as critical by Bernstein (1971), who refers to learners as pedagogic subjects. It is important to not only listen to what learners say but to consider how they say it contributes an insight into how influential the pedagogy has been, for example, in increasing the use of disciplinary language (Brosseuk, 2021; Creese et al, 2010; Ensor, 2015; Ivinson, 2018). Bernstein warns of the complexities of capturing learner voices, as researchers are rarely free of the contradictions and dilemmas they are set up to control (Bernstein, 1990, p 159). Learners will potentially have a perception of the researcher as having a position of authority. This may therefore influence what they say and the freedom to speak without self-restriction.

Within my study, it is essential to consider the learner voice. Learner voice can take different forms: classroom talk, subject talk, identity talk and code talk (Arnot and Reay, 2006). Classroom talk is the talk between learners and teachers within a lesson setting (Bernstein, 1996). I will not use specific subject-based activities or classroom observations. Reasons for this are twofold. Learners will be at different points in the curriculum. They may not even be studying the same concepts as variability of curriculum is an element explored through one of the research questions. A blend between identity talk and code talk will be used to explore learners' own perceptions of the subject alongside their learning experiences. The code-based level of analysis explores what Bernstein defines as the elaborated code and restricted code, including pupils' use of disciplinary language (Bernstein, 1973; Robinson and Creed, 1973). Within computing education, this will include not only hearing the views of learners on their experiences, but also exploring the level at which the subject permeates their use of language, for example, the use of disciplinary vocabulary when describing their learning (Arnot and Reay, 2006).

The learner voice alone will not be sufficient to secure sufficient insight into the pedagogic discourse taking place. The voice of the teacher is also of key significance, particularly when exploring the influence of the ORF on the PRF.

Parents and wider stakeholders will not be included, although any targeted information prepared by educators for these audiences will be included as part of the documentation review. This boundary has been drawn to ensure the data collection is manageable and has specific bounds. Including parents would extend the research to explore wider issues around influence and career choices. This may well be pertinent to future research and exploring policy development, but the focus here is to remain on implementation of the given policy. That said, the pedagogic devices are yet unknown. These may include apps or online platforms that learners use flexibly both at home, in school and even in other locations. The physical space will be limited to computing classrooms with the school.

The research will be in the form of a two-case comparison. The same data collection approaches will be carried out in two contrasting schools. Stake explains this as a form of instrumental case study where the phenomenon (Quintain) itself is of particular significance rather than the individual case (Stake, 2006). Stake does raise an important caution, that each case is individual, and a researcher must not lose sight of the context, specificity and character of each case. Stake's use of Quintain aligns with the recontextualisation, via the pedagogic discourse. Recontextualisation provides a more precise identification of the process to be studied, so this will be the term used. Whilst the overall recontextualisation is key in this research, during data analysis it is essential that the importance of the individual nature of the cases involved is not lost. The recontextualisation and pedagogic discourse may look considerably different in each of the cases. By comparing the two cases, it will allow for exploration in the 'biographies' of the schools and evoke further questions around the cultures of the two environments that may otherwise have not been identified as significant (Thomas, 2011).

4.2.1 Selection of schools

The selection of actual schools was problematic and required careful consideration. Yin (2009) outlines the option of exploring a 'representative' or 'typical' case. This approach was not possible as it was not clear what constituted a 'typical' implementation of the computing curriculum, let alone be able to identify where this might be happening prior to any research being carried out. As schools are so individual in nature, even if a 'typical' case could be identified, this would not necessarily translate to a different school. An alternative approach is to look at outlier cases (Thomas, 2011). I would need to identify schools experiencing particular success or failure with the implementation of the computing curriculum. However, there are reasons to avoid both ends of the spectrum.

Schools perceived as successful are often already prominent in the computing education community either through the support they offer to others or through being held up as positive examples at local levels through CAS hubs. The prior perception of 'success' may distort the data collection process and be seen as an opportunity to show off the best aspects rather than allow access to some of the more challenging situations they have experienced. In contrast, it is difficult to engage with schools where educators feel they have not had success and approaching such schools would not be a good start to building a positive relationship with the computing department.

Instead, to recruit contrasting schools, I focused on different geographic location. Data collected by both Kemp (2016) and The Royal Society (2017) shows distinct differences in regional provision of computer science provision (see the geographic access map in Chapter 2, Figure 2.3). The two schools selected came from areas with regional differences and they also had very different demographic intakes of pupils (see Figure 4.3).

	% Schools offering GCSE Computer Science	National Ranking for offer of GCSE Computer Science	% Pupil uptake for GCSE Computer Science	National Ranking for pupil uptake on GCSE Computer Science
City in West Midlands	37	123	10	88
County in South East	49	57	9	104

Figure 4.3: National comparison data for Local Authority areas where the case study schools are located.
https://royalsociety.org/topics-policy/projects/computing-education/ [accessed 5/3/19]

The research was not designed to 'assess' the level of implementation of the computing curriculum and was not seeking particular stories of failure or success or 'how to' guides for implementing the curriculum. The purpose of the case studies was to explore the computing curriculum within a unique set of circumstances that could then be considered in relation to other contexts to improve understanding (Stake, 2009).

4.3 Data collection methods

The focus and the scope of case studies are critical in identifying appropriate data collection and research instruments (Thomas, 2011). Within this study, the boundaries are clear, given the focus on computing education, heads of department, teachers and pupils. In practice, it was easy to become diverted. For example, in one school I was invited to meet with the technical support team and in another with their trainee teachers. Whilst this could have added a rich context to the study it might have presented challenges through attempting to cover too many perspectives within the time frame and other study constraints. Not having specific case bounds is a common error in case study research and allows others to question the legitimacy of the outcomes (Corbett-Whittier, 2013).

Thomson and Hall (2017) outline the process of designing a place-based ethnographic case study. Whilst this is not ethnographic in either time or design, it does borrow some of the tools and strategies for such an in-depth consideration of a school. Other key researchers providing guides for using case-study as an approach also advocate similar research instruments, such as semi-structured interviews, but the same emphasis is not given to the importance of context and relationship building to gain deep insight into the school (Yin, 2009; Stake, 2006; Hamilton and Corbett-Whittier, 2013). When researching curriculum implementation, there is a danger that this may be viewed by the school as an investigation into 'compliance'. As outlined in the literature, this is not the focus of this research; but it was important this was very clear in the gatekeeper and participant information. I therefore wanted to avoid the use of research instruments that schools may have experienced from Ofsted or senior leadership teams to check compliance such as formal lesson observations or scrutiny of pupil work or assessment results. Therefore, the interview questions for teachers and learners were designed to delve into the computing curriculum development but also build a relationship of trust and openness between myself and the case study schools. For the research aims to be realised, it was important to have an open and honest dialogue between participants and the researcher.

In contrast, some formal documentation was considered but rather than as 'scrutiny' this was to explore the pedagogical devices such as the structure, hierarchy and timetable (Bernstein, 2000) to gain an insight into the culture of the school rather than as a monitoring process. The following sections outline the research instruments used to build details of each case.

4.3.1 A collation of pedagogic devices

Schools generate a lot of documentation, both for internal use but also to share with parents and the wider community, often via online means. Capturing relevant documentation for consideration is a useful process and one that can be carried out with minimal disruption to the school (Thomson and Hall, 2017). Completing this exercise prior to going in to the school to carry out research with participants led to more targeted questioning and informed dialogue (see Figure 3.1). For example, one of the schools offered both vocational ICT and academic computer science qualifications so needed to be asked comparative questions whereas this was not applicable to the other school. As time within school with the participants was limited, this initial data collection was a beneficial process for all involved (see section 4.4.2).

As already outlined in the literature review, terminology and language within education is widely varied. This extends to documentation. What is a ‘scheme of work’ in one school may be a ‘scheme of learning’ in another, which in a third school may be a ‘midterm plan’. It was essential that I was very clear as to the type of documentation I wished to explore rather than just using the terms that I am most familiar with. I also asked staff if there was other documentation that they thought would be useful to share. This clarity was particularly important during the initial communications with the schools, as these were via email and telephone where miscommunications can be more common.

Recruiting both schools was achieved through third parties, colleagues in other universities. Whilst this did not remove all issues around participants being aware of my position and expertise, it did minimise them as far as possible. I had never worked with the schools previously due to the geographical distance and none of the teachers involved had attended any of the CPD I had delivered.

Once initial introductions were made via the third parties, I sought permission from the headteacher, fully explained the nature of the research, and sent through the information sheets for the pupils, parents and teachers. This was a lengthy process. One of the schools I was initially due to research had to withdraw due to staff illness and there was often quite a delay in routes of communication between the head of computing and the headteacher due to the usual business and priorities of schools. Both schools needed time to consider their involvement in the research, including the considerable time commitment for both teachers and pupils. This is likely to have led to some bias, as staff who are particularly keen to be involved in projects and freely give of their time are more likely to have agreed to participate. This will be a consideration when outlining the context of the schools.

After initial permissions were granted, both heads of department sent through key documentation and provided further information at later stages whenever required. I was also able to collect documentation openly available on the school websites.

The documentation included in the review were:

- Schemes of work
- Details of curriculum time and qualifications offered
- Documentation on how the curriculum information was shared with pupils and their families, e.g., prospectus, options booklets, school policies, etc.
- Information on formal assessments and when these took place

It is recognised that some of this documentation was available online and so 'live' and open to change. To prevent issues of the documentation changing during the period of the data collection and subsequent analysis, screen shots of web content were taken at the time and were stored securely alongside the other data.

4.3.2 Interviews as a research method

Interviews are a critical aspect of data collection but, unlike collecting documentation, there is a lot more to be considered in terms of both the purpose and method of interviews as a process. This is particularly pertinent to a Bernsteinian approach, where the language use itself forms part of the data (Bernstein, 2000; Arnot and Reay, 2006;

Ivinson and Duveen, 2006). I wanted to be able to explore the individuality of computing in each school whilst also being able to use the data to make comparisons between the two case study schools. The interviews needed to feel conversational to allow interviewees to feel at ease and explore their views. The interviewees also needed to feel at ease in their use of language, as use of elaborated code or restricted code might feel forced. For example, interviewees who see the interviewer as formal or authoritative may make use of elaborated code, even though this would not be their usual voice. Whilst this cannot be fully alleviated (see the analysis, in section 6.2) it can be minimised as much as possible.

Brinkman and Kvale (2015) use the metaphor of the interviewer as either a miner or a traveller; a miner who delves to find nuggets of information, or a traveller, who journeys through with the interviewees to construct information and develop stories during the process. Taking the course of a traveller, the questions needed to be flexible and responsive during the interviews themselves, perhaps changing or developing from one interview to the next. Using interviews to probe for information suggests a more formal process by which the questions are more exact and fixed in nature. The interview questions allowed for follow-up questions and discussion around a theme rather than being precise. This was more appropriate for the pupils, some of whom gave quite concise answers and needed to be 'probed' for further detail or clarification. The teachers and heads of department were able to discuss at length around the questions asked, requiring less interviewer intervention and, as a result, the interviews were more conversational. A slightly different interview approach was therefore adopted in interviewing adults and children, and it was essential to develop a craft of encouraging talk rather than leading or affirming contributions (Brinkman and Kvale, 2016).

Key questions were identified and used in both schools following the thematising and designing stages, as outlined by Brinkman and Kvale in the 'seven stages of interview research' (2016). Occasionally, the order of the questions would vary due to the flow of the conversation and natural links between topics being developed. In some cases, although the questions were worded identically, the respondents found a different focus or emphasis in their answer compared to other participants. This is not by design of the interview but more a reflection of the respondent's own experiences and priorities and is an important consideration within the data analysis. Although I gave myself permission to use follow-up questions to develop certain points or clarify the interviewee position, I tried hard to ensure this did not steer or detract from the respondent's own natural direction of discourse (Kvale, 1996). My natural demeanour is to be quite conversational and 'chatty', so developing a level of restraint with a balanced approach to interviews was critical.

The purpose of the interviews was made clear to the participants, along with the details as to how the data were going to be used. This was particularly important with the teachers and heads of department so they did not feel the process was judgemental or inspectorial in nature. I spent time with them prior to the interviews and in many cases they had already explained aspects of the curriculum or provided a number of anecdotes or key pieces of information. On occasion, I did ask them to repeat the information as part of the interview to ensure the data were captured appropriately and not open to misinterpretation, which could be the case if reliant on field notes about conversations rather than actual transcriptions. The teachers responded well to these requests although they might have shared less detail than in the original telling.

4.3.3 Teacher perspectives: interviews

These took the form of semi-structured interviews. Semi-structured interviews have their merits in allowing the interview to feel more natural and conversational than a highly structured approach, although to be able to 'get at' the information requires considerable skill in interview technique (Barbour and Schostak, 2011). It requires the interviewer to be a listener whilst also considering the next question or to revisit any aspects where the interviewee may not have fully answered. The interview schedule included key questions devised prior to going into the schools to aid the ease of the interviews for the participants, but also to help myself as an interviewer. The starting questions were developed following prior identification of key areas to explore and discussion with colleagues following the pilot study. They varied slightly between the two schools to take account of structural differences, e.g., where different qualifications were offered. These differences were identified at the documentation review stage of the data collection (see Chapter 5, sections 5.4 and 5.8).

4.3.4 Pupil perspectives: group interviews

Following completion of the pilot study (see section 4. 5), small group interviews were determined to be most effective for the pupils. From a safeguarding position, it would be unsuitable to interview pupils alone (BERA, 2018). In large groups, it was also found that not all pupils were able to have a voice as some pupils dominated discussion. A critical part of the research is to hear from different groups of pupils, especially those who are potentially under-represented in computing. Whilst teachers were interviewed individually, I felt the pupils would feel more comfortable with a small number of their peers present to feel more comfortable in the interview and to support each other in the development of ideas. They were placed in small groups (of two or three) by their class teachers and were grouped according to their year group and course they were following. For example, those who were following GCSE Computer Science courses were in the same group. A number of groups were interviewed to cover a full range of age groups and curriculum experiences (those involved in computing related courses and those who were not) to allow all voices to be heard. Previous studies have often focussed on those who have opted for computer science rather than those who have not, so in this research it was important all voices were represented. This lack of voice has particularly been the case when exploring gender imbalances in computing (Guzdial, 2015).

It is recognised that a natural grouping of 'types' of pupils may have emerged. Participation in the study required seeking agreement from parents, taking an information and permission sheet home for parents to sign and to return it to school. The teachers identified that, not in all cases, but more often than not, it was the more enthusiastic or more conscientious pupils who volunteered to take part and returned the appropriate forms. This was noted in my field notes in both of the schools.

In the small group interviews, questions were pre-planned, again semi-structured allowing for follow-up questions and prompts where necessary. An example of the questions used with learners can be seen in appendix 11. I have over 20 years' experience teaching and working with children and consider myself quite skilled in building relationships and engaging in meaningful dialogue even during a short space of time. I used this experience to ensure all pupils had an opportunity to speak, even those who may naturally be introvert or overwhelmed by more vocal characters in the group. At the same time as steering the group, I was careful not to lead and pre-empt points the participants made. In building positive relationships with the pupils to encourage them to feel able to engage in open discussion about the computing curriculum, I first chatted with them about something unrelated, such as their lunchtime or the lessons they had just been in prior to introducing the research and the voice recorder. That helped us gain an understanding of each other and create a flowing conversation (Barbour and Schostak, 2011).

4.3.5 Visual images as a pedagogic device

The purpose of the visual aspect of the case study was to explore how the computing curriculum was being 'presented' to pupils and educators within the teaching spaces (Barthes, 1964). Pedagogic discourse is not language alone, but includes any methods of transmission (Bernstein, 2000). In the computing department context, this included wall displays that pupils see daily, information on websites and the school computers as they log on and other symbols or artefacts that I noticed during my time in the computing departments. These are noted in field notes and, where possible and permissions are granted, captured as digital photographs. Prosser and Schwartz (1998) outline the challenge for identifying models of good practice for research design in visual studies. Since that time, the ability to capture visual imagery digitally has resulted in this being a much more popular approach although some of the methodologies remain quite ambiguous. In this research, the visual study contributed towards the building of understanding of the case rather than being a research project in its own right.

Within school, the curriculum is also 'presented' to the pupils themselves through teacher communication, documentation, resources and visual representations of the subject, such as posters on display (Figure 1.1). The staff within the schools had selected or developed their own range of visual content to portray the curriculum area within the classroom environment, particularly as classroom displays. This is mostly targeted at the pupils but can also be viewed by other staff, visitors and parents. The environment and equipment also gave insight into the way the curriculum was supported and prioritised within the schools. Information on these aspects was collected as a series of images. Prosser (2007) outlines this as a ‘cultural inventory’ method, a facilitation of cataloguing the material culture of classrooms.

The visual aspects of the classroom, such as wall displays, provided insights into the way the computing curriculum was ‘presented’ by teachers and the way the subject was received by pupils. Whilst written documentation provides a formal presentation of the computing curriculum, visuals, resources and physicalities of computing teaching spaces are a less formal but perhaps a more ‘honest’ medium for presenting an image of the subject. For example, in one school, the wall display listing the topics being studied was contradictory to the formal documentation outlining the topics for study. Without these differing sources, it may not have been apparent that there could be any discrepancy between what was presented and what was taking place, but this difference in data proved instrumental in guiding further exploration.

Whilst in the schools, I took digital images of the classrooms, displays and other features of the computing education spaces. The photographs did not include any images of children or teachers within the schools. The avoidance of pupils and teachers in the images was intentional as the focus of the visual cultural inventory is to capture the presentation of computing rather than the actual activity itself (Prosser, 2007). At times, this was quite problematic as classrooms tend to be very busy places, so images tended to be taken at the end of the day so classrooms were not always looking at their best.

Where images of learners or pupil names were inadvertently captured (for example, there was some pupil work on display and this was captured as part of the classroom photograph) these were blurred out using image editing software prior to the analysis stage. School logos and other identifying features were also removed from the images.

There was no formal schedule or ‘checklist’ for taking the images. I tried to capture as many aspects of the computing classrooms as possible. In the majority of cases this worked well; however, some aspects were missed. For example, in one school, windows were not evident in any of the images whereas the other data set contains a number of these.

4.3.6 Field notes and informal observations

In order to complete all the research activity, it was essential to be based at the schools for several days at a time. Fitting in the full range of interviews with pupils, teachers and heads of department was quite complex given the constraints of school timetables. This meant there was also time spent within the schools that was unstructured, e.g., during lunch and break times, during lessons when there was no-one available to interview. The schools also scheduled time for me to peruse the documentation and displays, which was often in classrooms whilst other things were going on. It was essential this time was also fruitful in terms of providing opportunities to understand the complexities of what was going on within the school. Thomson and Hall describe this as ‘hanging about with serious intent’ (Thomson and Hall, 2017, p 163). During the pilot study (section 4.5), I interviewed groups of pupils but in-between times I was in their classrooms, perhaps waiting for the teacher to conclude the start of the lesson or because the interviews were complete. This time proved highly valuable. Some of the pupils talked about the topics in their interviews they were currently studying. I could see it was the most recent and so memorable for them, but I could also see in action the approaches and resources the teacher was using with them. I could also see where those who had been most enthused about computing were positioned in the classroom, which provided an additional layer to the research which had not arisen during the interviews.

Thomas recognises the importance of such informal data collection and advocates the use of a diary to record ideas, reflections, thoughts, emotions, actions, reactions, conversations and so on (Thomas, 2011).

As a result of this opportunity to collect rich data, I kept a research journal to record such information whilst in the school. This included notes on informal conversations (although any pertinent points were asked again during a formal interview process), sketches of classroom layouts, notes on equipment being used including hardware and software, and notes on any particular key terminology being used. The schools were aware that the journal was being kept and it was explained in the participant information sheets. My own notes and personal reflections were completed immediately after a school visit but in a separate document. This allowed for the transparency of the research journal and ensured it was available for participants to look at should they request it (Hamilton and Corbett-Whittier, 2013).

4.4 Ethical considerations

Full ethical approval was granted from my institution via a formal review process. Here, I summarise the ethical issues that have been addressed linked to my initial research proposal and instruments (BERA, 2018).

Alongside the application for ethical approval, a range of information sheets for participants and a formal letter for the gatekeeper were produced (Appendix 1). The information sheets were sent digitally to the schools prior to the data collection and hard copies were also provided by the researcher during the data collection process (Appendices 2; 3; 4; 5; 6; 7; 8; 9). All participants provided informed consent. Parental information and consent sheets were sent out by the school prior to the research taking place and only pupils where signed parental consent forms were returned were able to take part in the study. In addition to their parents, it was critical the pupils themselves had a full understanding of the research and consented to take part. I fully explained the project before the start of all interviews and invited the pupils to ask any questions they may have had about the research. I also emphasised that they had opportunity to withdraw consent at any time and could stop taking part in the research without consequence. I created a relaxed environment to generate open dialogue in interviews. Potential risks during data collection included opportunities for pupils to disclose a safeguarding issue, particularly if they discussed their use of technologies outside of school. If this occurred, I planned to immediately terminate the interview and inform the school safeguarding officer. Having previously been a lead safeguarding officer in school, I was fully aware of this process. Fortunately, this issue did not arise, but it is an important consideration for anyone researching with children in a school environment and particularly when discussing uses of technology. I have an enhanced DBS certificate and, having previously been on a Local Authority Safeguarding Board, I am fully aware of the requirements of the school if a disclosure is made.

All group interviews with pupils were carried out in an open area but away from the teaching space. This was to ensure safeguarding requirements were met. The space was quiet enough for the recording to be clear, and to try and minimise influence of data collection by the presence of teachers from the schools. Pupils were interviewed in pairs or small groups, and I spent no time alone with pupils at any time to ensure there was no risk of allegations to be made.

All data collected in each of the schools was fully anonymised to remove all teacher and pupil identifiers, school names and logos. Digital data were stored securely within a password protected area and hard copies of data were kept within a secure workspace. All data will be destroyed within 3 years of the final publication of the thesis.

4.4.1 Access and assembling the sample

I was introduced to the participant schools through contacts located in the different regions. The incentive for participating in the study was the opportunity to inform research on the computing curriculum and to give a voice to all stakeholders, including teachers and pupils. Staff will receive a summary report from the final thesis and a succinct, pupil-friendly version will also be made available to the participating schools.

The computing departments were relatively small compared to other subject areas within the schools and so there was a reliance on a small number of staff. The process of engaging with schools proved quite slow and cumbersome due to the geographical distance. Ultimately, two schools were recruited via regional contacts. School A, an inner-city school in the Midlands, and school B, in a small suburban town in the South East of England. The characteristics of these schools are outlined as follows.

4.5 The pilot study

Once ethical approval was obtained, prior to the main data collection, the research instruments were piloted in a local school. The teachers and Head of Department involved were colleagues that I know well, and I sought their honest feedback about the approach. The main findings from this process and the adjustments made as a result are summarised here.

The teachers were more than happy with the line of questioning and felt all important aspects of computing were covered. Timing was a particular issue (teachers like to talk!). I was concerned that this might be much more of an issue with teachers that I did not know, and I did not want them to feel resentful at having to give up more time than was originally agreed. I discussed the removal of some of the questions with the teachers involved in the pilot but when listening back to the conversations we realised it was the follow-up conversations and non-directed points where the time was taken. When conducting staff interviews in the case study schools, I needed to be more mindful of time and direct participants to be concise if necessary.

The group interviews with the pupils were a challenge. One of the groups became particularly 'giggly' and seemed quite embarrassed to be open and honest in front of their friends. I worked with the teachers to try different sizes of group and dividing very close friendship groups. We found that groups of two seemed to work best as the pupils maintained focus on each other's comments and 'bounced' between each other. Gender was also a particular feature of the pupil interviews, both in their structure and in the themes the pupils were discussing. The pupils were keen to talk about differences between girls and boys in computing. Listening back to the interviews, where the groups were mixed gender, it was evident that not all pupils had an equal voice. In some cases, it was the boys who were particularly dominant, but this was addressed through smaller and single sex groups. I realised it was important to discuss this with the teachers prior to organising the pupil interviews within the case study schools. They would have the best knowledge of the pupils and the dominant characters and would be able to consider the best makeup of the groups prior to me carrying out the interviews.

As part of the evaluation of the pilot study, I also shared the transcripts of the pupil interviews with the teachers. The teachers identified that the pupils were mostly talking about the most recent topics they had covered in their lessons and that it may have been more relevant for them to be discussing topics from earlier in the year. This was not particularly surprising, but the teachers felt it did not really allow the pupils to consider their full computing experience and that would stifle aspects of the research. It was therefore decided to include a question near the start of the interview about all the different topics they have covered, and I would have a pre-determined list to act as a prompt if required. This was not to lead the pupils, but purely to act as a reminder and allow them to reflect on their full experience. It was clear from the piloting that it was critical to work closely with the teachers prior to the pupil interviews, both to organise the groups, and to ensure the questions were personalised to allow discussion on the appropriate topics the pupils have experienced.

This was all taken into account in the design and data collection in each of the case study schools and is explored at length in the following chapter.

4.6 The main study

The data collection took place during the academic year 2018 – 2019. This was 4 years after the National Curriculum in Computing came into effect (DfE, 2013). Following the data collection, the Covid-19 pandemic closed schools and impacted the delivery and assessment of school curricula. Some of the learners included in this study (those who were year 10 or year 12 at the time) did not complete their qualifications through external examinations, as originally intended by examination boards, and school leaders. Therefore, data on learner outcomes is not included as part of the study as it is not comparable with previous year groups and would create a distraction from the discussion (Crick et al, 2020; Kippin and Cairney, 2021).

It is of importance to note the impact of Covid-19 on the collection of attainment data and additional contact with the case study schools. During the pandemic, I was required to pause studies and so was unable to analyse the data within the timeframe I had originally intended. This closed opportunities for further dialogue including securing updated documentation or details on the outcomes for the learners I visited. This is addressed in Chapter 7, section 7.4.

In each of the schools, the exact data collection was determined by the structure and size of the computing departments, along with the availability of the staff and learners during my time in the school.

A summary of the data collected in each school is shown in Figure 4.4.

	School A	School B
Interviews with leaders	Head of Department #1	Head of Department #13
Interviews with teachers	One specialist computing teacher, who is also a member of the school senior leadership team. #2	One, non-qualified, computing teacher. #14
Interviews with learners at Key Stage 3 (age 11 to 14 years)	2 students, year 8, 1 male, 1 female. #3 #4	4 students, 3 males and 1 female, year 9, #15 #16 #17 #18
Interviews with learners at Key Stage 4 (age 14 to 16 years)	2 male and 2 female students, year 11, studying OCR National Certificate in iMedia, level 2. #5 #6 #7 #8 2 male and 2 female, year 10, students studying GCSE Computer Science, OCR. #9 #10 #11 #12	1 male and 1 female studying OCR National Certificate in iMedia, level 2. #19 #20 2 male and 2 female, year 10, students studying GCSE Computer Science, AQA. #21 #22 #23 #24
Interviews with learners at Key Stage 5 (age 16 to 18 years)	NA	2 male students, year 13, studying Cambridge Technical Award in ICT, level 3. #25 #26
Images from computing department learning environment	7 images of classroom environments and classroom displays. Figures 5.4 to 5.7	5 images of classroom environments and classroom displays. Figures 5.9 to 5.11
Curriculum documentation	Computing assessment maps for Key Stage 3. Specifications for GCSE Computer Science (OCR) and OCR National Certificate in iMedia at level 2	Specifications for GCSE in Computer Science (AQA), OCR National Certificate in iMedia at level 2 and Cambridge Technical Award in ICT, level 3
Additional pedagogic devices	Department vision and core values statements. Subject action plan.	Department web pages on hardware, educational technology, and year 13 ICT

Figure 4.4: A table to show the data collected in each case study school.

Data collection on the curriculum and other pedagogic devices was broad and not identical for each of the cases. In collecting documentation, I was led by what the heads of department wanted to share with me. I did not want them to create any documentation especially for the research (Thomson and Hall, 2017). I intended to use schemes of work to explore the topics being taught and the order for delivery, to see how leaders were designing learning. In school A, the Head of Department said these would be sent via email following my time in the school, but this did not happen. Although we did exchange several emails following the data collection, I did not pursue the schemes of work to prevent the Head of Department having feelings of being held to account rather than taking part in a research project (Hopkins et al, 2016). Data to explore the pedagogic discourse were taken from interviews with teachers, pupils, and the use of pupil work on display in classrooms. The interviews asked questions relating to the curriculum, so I could still identify what the learners were being taught without formal documents.

Whilst lessons were visited in both schools, these were not formal observations. It was an opportunity to build relationships in an informal way. In some instances, I did support learners with their classroom activities, especially when they found the activities difficult. At times, this did blur the boundaries of my role in the classroom as a researcher or an active participant (Ball, 1981). I have reflected on the role of the researcher in my final chapter (section 7.3) (Thomson and Hall, 2017). I wanted to ensure teachers and learners felt at ease, and any sense of formal observation may have detracted from that (Fielding, 2004). I built positive relationships with both the heads of department in each of the computing departments (Thomson and Hall, 2017). In both departments we maintained contact and I had an open invitation to return at a later date should I need to. Unfortunately, as mentioned, the potential for future work with the departments was prevented due to the Covid-19 pandemic.

4.7 Data analysis

I spent two full days in each computing department which included informal lesson observations, looking at the classroom environments and informal conversations with both learners and staff captured in field notes (Thomson and Hall, 2017). This, alongside the interview transcripts, generated considerable qualitative data that took time to 'get to know' (Opie and Brown, 2019). The presentation of my findings in Chapter 5 follows several iterations of categorising and exploring themes in order to gain an in-depth knowledge of the data (Watling, James and Briggs, 2012).

Braun and Clarke outline six phases of thematic analysis (Braun and Clarke, 2006): familiarisation of the data, coding, searching for themes, reviewing themes, defining and naming themes, and writing up. For me, part of the process of familiarising myself with the data was finding ways to organise it and explore it systematically. Following collection of the data, I needed to spend a long time revisiting the data in different ways to consider the emerging themes and how to start to organise it (Thomson and Hall, 2017). The teachers were keen to discuss their experiences, and interviews with pupils also generated long recordings. I listened to all the recordings several times. I started to transcribe them myself, which helped to understand the intricacies of the interviews; however, the time taken for the process was considerable (Thomas and Myers, 2015). As a result, I had the interviews securely transcribed by a third party. My recordings were of a high quality, so the majority of speech was transcribed accurately. The transcriptions also identified prolonged pauses and laughter; however, some of the more intricate details, such as small pauses or intonations were not captured (Jones and

Somekh, 2011). To fully digest the transcripts, I revisited them alongside the recordings to make corrections, particularly where subject specific terminology or acronyms were used and not identified correctly by the transcriber.

Stage 2 of the model for thematic analysis involves coding of the data (Braun and Clarke, 2006). Saldana describes coding data as a craft (Saldana, 2016). Part of this process includes data reduction (Watling, James and Briggs, 2012). My data consisted of a broad range of file types. To do that, I needed to make use of computer-assisted qualitative data analysis software (Saldana, 2016). NVivo 12 is the data analysis software most openly available to me through my institution and is suitable for those at a novice level (Kalpokas and Radivojevic, 2022). NVivo allowed me to store the data securely and is powerful in being able to explore themes and compare different data files simultaneously. Following the coding, retrieving the data to explore particular themes became very flexible. I could retrieve from a range of sources on one theme, look at particular groups, for example, teachers, and then see the codes that were prevalent, or I could look at one specific piece of data to see the precise coding (Thomas and Myers, 2015; Saldana, 2016). Whilst this became a powerful tool, it was important not to lose sight of the holistic cases themselves (Thomson and Hall, 2017). Despite using NVivo, the actual analysis remains in the hands of the researcher (Watling, James and Briggs, 2012, p 395).

The initial coding was inductive and procedural in nature (Saldana, 2016, p 174). For example, some learners described finding the subject difficult, which does not specifically fit with the theoretical framework (see Figure 4.1).

My next rounds of coding added deductive coding which was theory-driven. For example, teachers described the National Curriculum which aligned with my theoretically based themes, demonstrating influence of the ORF (Saldana, 2016; Xu and

Zammit, 2020). Part of this process was also to consider how initial inductive themes fitted into the theory. For example, learners finding the subject difficult provided insight into the pedagogical discourse and how learners experienced the building of knowledge. As another example, rather than just having a category of classroom activities identifying worksheets and onscreen activities, in the second iteration, I divided this into subject knowledge and categorised it by the three strands of the National Curriculum in Computing. This gave a much greater sense of the strength of classification of the subject and how the classroom activity reflected this (Bernstein, 1975; 1990; 2000). Saldana describes this as taking categorisation from the real to the abstract, a form of abstraction allowing for higher level thinking around the themes (Saldana, 2016, p 276). The table in Appendix 12 identifies the final list of codes. The rationale column explains why the codes have been included, both as inductive themes from the data and the deductive layer showing where they link to the theoretical framework (Thomas and Myers, 2015; Saldana, 2016). An extract of coded data is included as Appendix 13.

Despite having a comprehensive list of codes and working with the data alongside my research questions, coding the data is still very much a subjective process (Saldana, 2016; Opie and Brown, 2019). Even with the same data and the same categories of code, another researcher may code it a slightly different way. Edwards and Westgate also identify the richness of classroom talk and the challenges that brings for a researcher (Edwards and Westgate, 1994). They identify it is important to understand the context and backgrounds for young people included in research as their use of language and choice of words may be as much part of the story as what it is they are saying. This fits very much with the Bernsteinian approach to exploring the use of elaborated and restricted code in the classroom (Bernstein, 1971; 2000).

In this thesis, the case studies presented in Chapter 5 and discussed in Chapter 6 reflect the fifth stage of my thematic analysis, defining and naming themes, and the sixth stage, writing up, as defined by Braun and Clarke (2006). The particular themes and narratives emerging from each of the case studies are presented with relevant notes and signposting to guide the reader through the data in each of the schools in Chapter 5. A detailed analysis of each of the themes is presented in Chapter 6.

Chapter 5: Findings

This chapter explores the data collected in each of the case study schools and the initial findings from each of the cases. commentary on each of the schools, beginning with the context and then the data relating to each of the research questions. The chapter concludes with a summary of the key themes from the data to be taken forward to the analysis in Chapter 6.

5.1 Case A: school context

School A is an inner-city school in the West Midlands. The school is in a modern building, a former office block, in the centre of the city. During the data collection, the school was part of a Multi-Academy Trust (MAT). It has since closed and reopened under a different MAT. Therefore, data regarding attainment and other factors such as attendance and numbers of pupils on free school meals are not available (DfE, 2023). The school is in an area of high deprivation, categorised as quintile 1, the most deprived areas in England (ONS, 2019). At the time of the study, the school was graded 'good' by Ofsted (Ofsted, 2017) and has since been inspected and graded as 'requires improvement' (Ofsted, 2023).

The school population is made up of many different ethnic groups and the stability of the learner population is low, which means pupils are more likely to arrive or leave the school partway through their education. The overall results for the school are well below national average and below the local authority average. The school, in the centre of a large city, has limited outdoor space and classrooms are across 5 floors. Pupils mainly live locally and walk to school or arrive by public transport. The school is in the central business district and windows of the school look directly into office blocks and businesses. At the time of the study, the school had a population of approximately 500 pupils aged 11-16 years, smaller than average for a secondary school. The school does not have a sixth form and pupils continuing their studies select from further education colleges and sixth forms in the city.

At the time of the data collection, the school provided pupils with two computing lessons per week throughout key stage 3. Key stage 3 took place during years 7 and 8 (ages 11-13 years). Following key stage 3, pupils could select to study computing through two different options, GCSE Computer Science, or an OCR National Certificate in iMedia (OCR, 2019). Data collection took place in November 2018, and the data collected are summarised in Figure 4.4.

The Head of Department (HoD) has a degree in computer science. Another specialist member of staff also has a degree in computer science. Both are female, from a minority ethnic group. There are no other specialist computing staff in the school and a small number of lessons are taught by non-specialists. GCSE Computer Science results were not available, as the first cohort of pupils had not completed the course. The Btec iMedia results were 86% grade 4 or above (Btec equivalent grades of pass, merit or distinction). Results for the cohorts included as part of the study were not considered due to the impact of Covid-19 (Crick et al, 2020).

5.2 Case A: Computing as a subject

As a starting point to explore the classification of computing within the department, both staff interviewed were asked about the developments in their computing curriculum (Appendix 10). Coded data includes mention of subject names and Government, management or leadership coded data reflecting the Official Recontextualising Field (ORF) (Bernstein, 1995; 2000).

#1: This school has been open since 2013. When I came, they weren't doing any computer science. They weren't doing any programming. They weren't doing Scratch.
I've slowly filtered out the ICT and tried to make it computing, which I understand is ICT, digital literacy and the computer science element of it, as CAS and the British Computer Society has recommended. I find it is working. I think it still needs a little bit more embedding, which I'm seeing happening over time, but yes.
Extract from: Head of Department (HoD) Interview #1
Notes: The HoD views themselves in a position of transition to the new curriculum.
Authoritative voices

Figure 5.1: Extract from head of department interview. Blue highlights the influence of the ORF, yellow indicates statements relating to curriculum implementation.

At the start of the interview, the Head of Department (HoD) made specific reference to the computing curriculum as the ORF (Figure 5.1). The HoD does not mention the National Curriculum but identifies the three strands. There is a contradiction in the comment in terms of 'filtering out ICT,' whilst also identifying that ICT is one of the strands. Using the code of ICT curriculum to follow this thread, there are further tensions evident in the removal of ICT. The HoD wants to follow the direction of the ORF although does not believe it is in the best interests of the learners. Later in the interview, the HoD was asked if they would make any changes to the curriculum (Figure 5.2). There was emphasis on agreeing with the government-driven shift in curriculum, using highly positive language (such as using the word 'fantastic'), whilst at the same time personally not fully agreeing with it.

"So I think that we do need to have some kind of…
I think that what's happened is we've gone all computer science and forgot about the ICT. I think it needs to be a healthy balance.
The children need to know what their differences are and be able to choose, "Okay, am I going to be a creative IT person, am I going to be a more scientific or logical computer person, or am I going to be an ICT person?" I think there are three things that we need to look at.
I think that what's happening, from the government down, is computer science, and STEM, and technology, and maths, and engineering. Which is fantastic. I'm not saying we shouldn't have that. But you need the other side as well. So if I was going to make any change…"
Extract from: HoD Interview #1
Notes: The HoD is emphasising their agreement with what they view the government agenda to be but identifying that there should be a healthy balance.
Differences in creative IT, scientific computing and ICT. The implication is that these are separate routes for learners.

Figure 5.2: Extract from head of department interview. Purple highlights views on ICT and computer science, yellow indicates their level of agreement with the ORF.

This tension continues when discussing whether they feel learners are ready for their next steps and any changes the HoD might like to make to their curriculum. Where the ORF is weak, there is more strength within the Pedagogic Recontextualising Field (PRF) so providing teachers with more freedom (Bernstein, 2000; Apple, 2002; Morais and Neves, 2006).

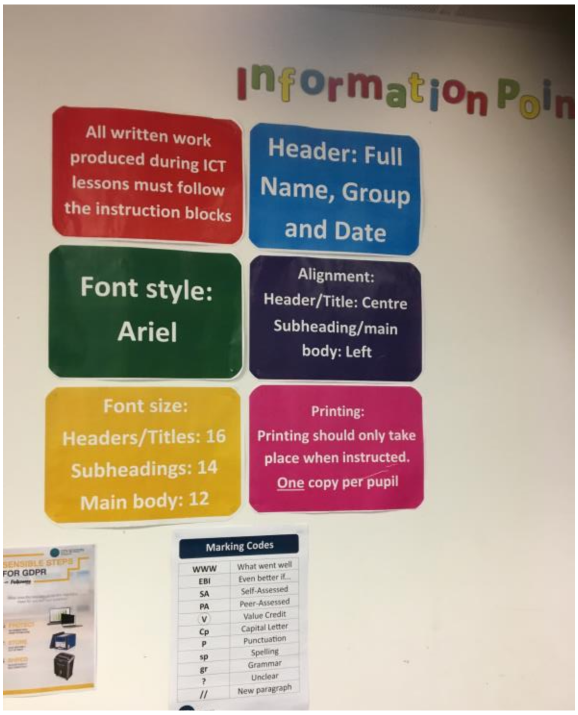


Figure 5.3: Classroom display of instructions next to the printer.
In the HoD's classroom, the red label identifies pupils are printing in ICT lessons.

The display uses the subject name of ICT (Figure 5.3), which may be a legacy sign from the previous ICT curriculum being in place. Any legacy information may provide contradictory messages for learners and so weaken the classification of the subject (Bernstein, 2000; Morais and Neves, 2002).

The instructions on the wall are very precise, outlining the presentation and printing of work. This indicates a strong frame for this aspect, with very little freedom for personal preference or design. It is not clear if these instructions are followed as no learners printed any work during the time of the data collection and learners stored their work digitally.

"If I'm honest with myself, I would say no, but I think that's where the ICT element needs to come in a little bit more.
You've actually got me thinking now how I could implement that more. I implement it now by doing as much modelling as possible. When they're doing a table, instead of just showing one I will show them all on the board. If they've got to do…
We used to have a unit on Excel in Year 7. To try and fit more computing in I took it out. I'm now thinking maybe for that functional skills aspect I should put it in. But because I don't do functional skills at Key Stage 4 I could use that unit for something else. It's swings and roundabouts. How am I going to fit it all in?
Yes, I would say I don't feel 100% confident in that, in terms of every single… I think most children, but if you're going to say everybody I would say no, because I can see pitfalls where they can't do basic things, so that's why I would say that."
………
I think I've already said it, so I will just repeat it. I think that we need to be careful of not going fully computer science. We need to pull along with also having that mix. ICT functional skills, digital literacy.
……..
So I think that we need to educate the children on that, but definitely I think my main thing that's coming to light to me now, this is my sixth year of teaching, is that we need to not leave behind the IT skills, because I think they're very important. We're going to have children going into jobs that can't use spreadsheets, that can't write a proper letter, that can't use a database or design a database, because they're not taught it, because it's not seen as computer science.
I know at university you will do databases and SQL, but if you don't take that path you're never going to get to that, and you might have to use a database in your job. I know we do. We have Progresso and all of that, which is a form of a database. To be able to write queries and get the reports that you want. And it's a skill. A lot of jobs will ask you, especially in the computing sector, "Are you apt in SQL?" They expect it. And it would be interesting to see how many people are nowadays, because I did it at university
Extracts from: HoD Interview #1
Notes: The HOD mentions ICT Skills, functional skills or similar.
A consideration of what the computing sector will expect, The HoD views these do not align with the current curriculum indicating industry is not perceived to be part of the ORF.
Skills that pupils will not have, although jobs will need them.

Figure 5.4: Extract from head of department interview.

In these extracts (Figure 5.4), the HoD is reflecting on the curriculum and the pupils' preparedness for future work. The HoD has been teaching for six years, so has spent more time under the new curriculum of computing rather than the previous ICT; they identify with the importance of the previous curriculum and do not seem to have full 'buy in'. This would indicate weak subject classification (Bernstein, 2000). Of note is their recurring reference to skills, both ICT skills and functional skills. As outlined in Chapter 2, section 2.2, functional skills are vocational qualifications, that no longer contribute to overall measures of schools (Leckie and Goldstein, 2017). The HoD identifies the shortfalls of the pupils being ready for next steps as a gap in skills rather than knowledge. The HoD relates this to their own specialist degree in computer science and shares the example of using databases. As a 'knower', or subject specialist, a teacher is expected to transmit their specialist knowledge, often through inferential activities (Winch, 1973; Bernstein, 1975). In this case, one of the specialist aspects of knowledge as identified by the HoD, the use of databases, is not taught although they identify it is needed in the industry. Whilst data structures are included in the National Curriculum, these are embedded within programming (DfE, 2013). This indicates a misalignment between the HoD's specialist subject knowledge and that outlined in the National Curriculum (Bernstein, 2000). Through the process of recontextualisation, knowledge is converted from the ORF to the PRF. The misalignment between teachers' views and the ORF can result in the regulative discourse rather than the instructional discourse to dominate, with teachers taking more autonomy to be influenced by learners and the community (Bernstein, 1990; 2000; Morais, 2002).

In the second paragraph of this extract (Figure 5.4), the HoD says 'you've actually got me thinking now….' indicating that the conversation may be a catalyst for the HoD's own thinking about the curriculum design and reflecting 'I don't know how I would fit it all in'. Potentially there is a tension between what they would like to teach and the given curriculum time, indicating organisational and management factors influence the curriculum design.

The other teacher interviewed is the only other specialist computing teacher in the school. They are also a member of the senior leadership team. This senior leader line manages the HoD whilst also teaching under their leadership within the department.

“I think it’s there to be adapted by schools. I think I’m coming more from an academy perspective in terms of the curriculum provides opportunities for the students to engage in digital literacy, computing skills, programming, so it identifies the need for programming from an earlier stage or earlier age, but I find that it’s a stepping stone or a tool to enable staff to then provide that scheme of work that will enable students to overall reach Computer Science, rather than computing, and engage in the computational thinking and things like that.
I think it’s a stepping-stone towards the importance of computing, but I don’t think we’re quite there yet. “

……..

“so with me, since I qualified, so I’ve been qualified a very short time, three or four years, so I at uni did Computer Science, so coming into the school when I initially came, my colleague H o D was already in here delivering Computer Science, so there wasn’t much of a change we had to do in this school in terms of curriculum.
We did have to look at introducing more programming and more focus on digital literacy, and I’ve worked in about seven schools, although I’ve only been qualified for four years, and in other schools you find that it’s ICT teachers that are very intimidated by the content that is expected of them, so they will kind of hide a little bit and will shy away from going onto the concepts and will do Excel and PowerPoint and those skills. While I understand it is quite intimidating, there are organisations such as CAS, computing At Schools, and hubs that offer that support. I think over time it’s slightly changing but we’re in a luxury; we have two computer scientists in this building, not every school has that.
With our school I think the development of Computer Science has been phenomenal because of H o D as a leader in that department. However, I think across the board in schools that is not the case, when I have been to other schools. It has not been that way.”

Extract from: Teacher interview #2

Notes: The teacher is also a senior leader and identifies the school is further along in their curriculum development than many others.

Authoritative voices

Figure 5.5: Extract from teacher interview. Blue highlights the influence of the ORF, yellow indicates statements relating to subject expertise.

The teacher mentions here the development of the computing curriculum and particularly emphasises the focus on computer science (Figure 5.5). In contrast with the HoD, there is no mention of IT or ICT, although this teacher will have started their career once the National Curriculum in Computing was already published and the previous ICT Curriculum was obsolete. New recruits to the profession may therefore have more commitment to the ORF as it may have more influence over teachers at their training or earliest stages of practice. The teacher identifies the strength of the school in having two computer science specialists compared to other schools with ICT teachers who feel intimidated by the subject knowledge. This teacher identifies weaker schools ‘do Excel and PowerPoint and those skills’, some of which the HoD identifies as missing from the current curriculum. This suggests the interviewee believes the school has a stronger classification of computing than in other schools and weaker schools will have more of a focus on the regulative discourse (Bernstein, 2000; Morais, 2002). This also signifies the teacher does not perceive the ORF to be strong, as the messages are not being embraced by all schools.

"I think the expectation of what children need to have at an earlier stage will change. I think there will be recognition that actually we need more students applying for Computer Science for GCSE. For that to happen, we need to invest more in it in Key Stage 2 in that primary, and then we need to heighten its profile in secondary schools. I don't think the profile of Computer Science is where it needs to be. A bit of that is the unknown; there are not many experts in that field in education, therefore the focus isn't there, if that makes sense. "
Extract from: Teacher interview #2
Notes: The teacher sees the next priority is to raise the profile and increase numbers opting for computer science, starting at the primary age of education (KS2 are age 7 to 11 years).

Figure 5.6: Extract from teacher interview. Yellow indicates statements relating to the profile of computer science.

The strength of the classification is not seen by the teacher as strong, as the subject does not have a high profile (Figure 5.6). The teacher sees the need to strengthen the profile through visible experts in the field. This would potentially broaden the ORF by having more expertise to influence schools (Bernstein, 2000; Brossuek, 2021).

Figure 5.7: Posters produced by code.org promoting the hour of code on display in computing classrooms.

The posters (Figure 5.7) are on display in each of the computing classrooms featuring prominent public figures of Malala Yousafzai, Barak Obama and Mark Zuckerberg. Posters adjacent to windows are next to views of neighbouring office blocks. Through the windows pupils can clearly see a high number of workers at desks using computers. The posters promote the importance of coding and the poster promoting Malala Yousafzai mentions the importance of the representation of girls in creating technology. Code.org is a United States of America (USA)-based organisation which hosts a range of teaching resources and self-directed activities linked to coding (hour of code, 2014). Annually, they encourage all schools to take part in the 'hour of code', although the teachers confirmed their posters are on display in their classrooms all year (from field notes). These are the only externally produced resources on display in the classrooms. Whilst these posters are not UK-based, the teachers have identified them as important, having them on permanent display. The ORF includes doctrine from sources seen as having influence (Bernstein, 2000) and these public figures carry an authoritative voice. Two of the posters promote an instructional discourse directing learners to programming.

The Mark Zuckerberg poster sits alongside a display on personal learning and thinking skills. This display outlines the skills as being independent enquirer, self-manager, creative thinker, reflective learner, team worker and effective participator. This aspect of the display indicates a regulative discourse, focussing on values (Bernstein, 2000). Both staff members identified Computing At School and the British Computer Society as authoritative voices, providing information and support. Other authoritative voices were the examination boards. I am including discussion in qualifications as part of the pedagogic discourse as they were discussed in functionality terms rather than the influence. This overlaps with the pedagogic discourse, so is discussed more in section

5.6; however, visual reminders in the classroom emphasise the importance of specifications and how these shape the school curriculum at key stage 4 (Figure 5.8). The prominence of the qualification requirements indicate their powerful influence over the content, pace and activities in key stage 4 lessons, so creating a strong frame (Singh, 2002).

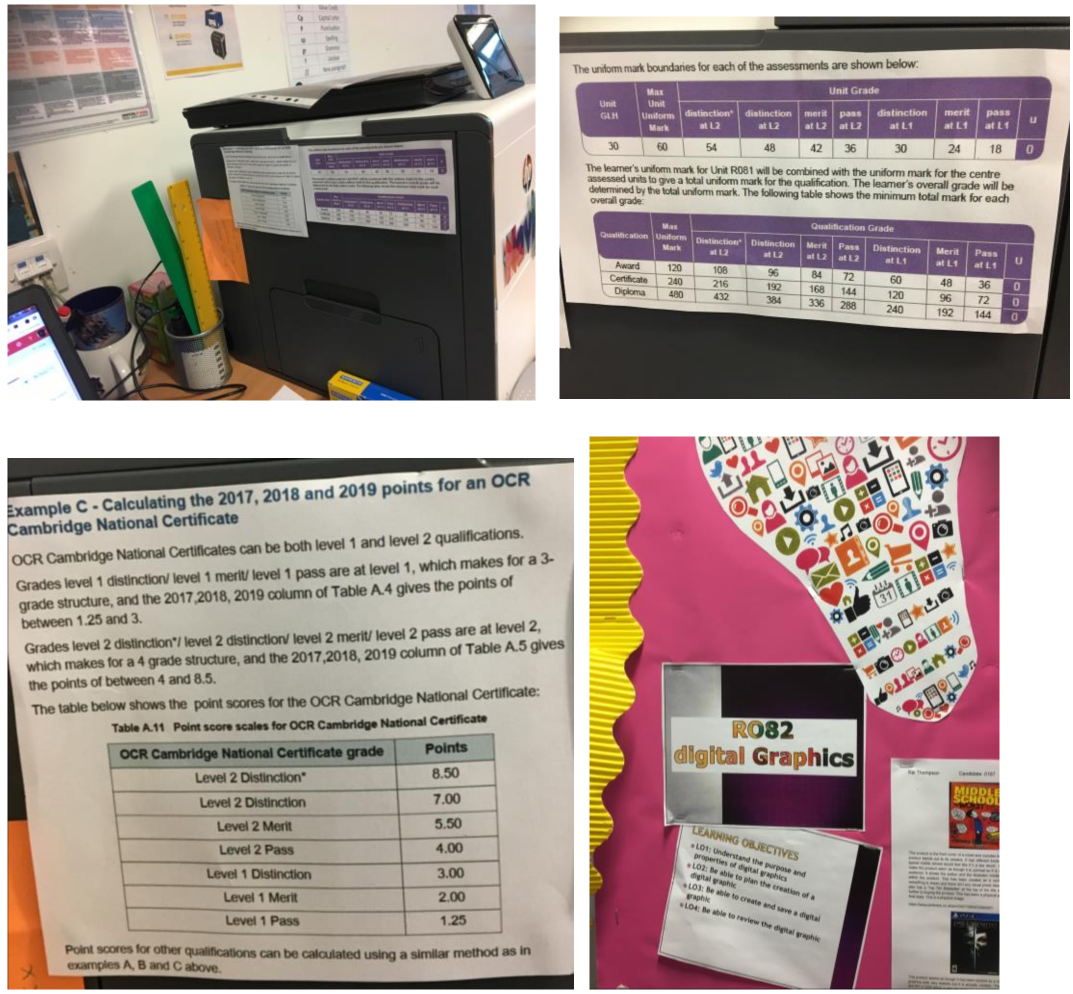


Figure 5.8: Classroom images linked to qualifications or assessments. The teacher's desk has a permanent display of the mark scheme for the OCR National course in iMedia. During the data collection, this was referred to several times during the iMedia lessons to direct pupils to what tasks to do to secure marks. Classroom displays of pupil work are labelled with the OCR unit codes.

In this school, key stage 4 makes up three years of education, years 9 to 11 (age 13 to 16 years). This is an additional year to the structure of the curriculum in many other schools (Harford, 2020).

> "For Key Stage 4 we do iMedia, OCR Cambridge Nationals. It's called Creative iMedia, Cambridge Nationals, and they do the certificate.
> So that's the four units, two mandatory and then two optional. We actually changed that from the ICT. Now, for that, that was changed for the school benefit, because of the league tables, rather than what was best for the children."
> ....
> "I did say originally OCR. It took them to go round and round and back to then OCR. I was like, "Well, I said that in the first place." But because I wasn't, I guess, senior enough they didn't want to listen to me."
> ....
> "But I would like to see more specialists in the department. I would like to see the department just given a little bit more clout, because it's always…
> I know that maths, English, science, but I do really feel for this generation moving forward, the way the world is going, computing needs to be taken a little bit more seriously by schools and by SLT, to help just up the profile and to help it move forward as a department within schools. I would like to see that."
> Extract from: HoD interview #1
> Notes: The HoD has identified that those in more senior positions have made decisions, or need to do more, in the best interests of the learners or the subject.

Figure 5.9: Extract from head of department interview. Yellow highlights the influences on senior leaders in school.

The HoD is in a middle leadership position and there is a sense of frustration that senior leaders are not listening to the views of the department and that they lack agency (figure 5.9). The language used indicates a sense of powerlessness (Thomson and Hall, 2017). They indicate that computing does not have the same status as

English, mathematics and science although they feel it should for the current generation. In the extract from the teacher interview, even though the teacher is a member of the senior leadership team, they identify more needs to be done to elevate the profile of computing, starting with primary education. This indicates frustrations may not be directed in the same way, depending on the level of management of the teachers, with middle leaders looking to internal senior leadership and senior leaders looking externally. Whilst the ORF is 'official', and so includes external direction such as the National Curriculum, there is a layer between the ORF and the subject departments themselves (Loughland and Sriprakash, 2016). In this case, for the HoD, the layer is perceived as the senior leadership team. This tension continues in securing time for learners to complete their qualifications (Figure 5.10).

“I think sometimes when it comes to this time of year, with Year 11, you start to get collapsed days with other subjects, and because I'm not a core subject it will be like, “Okay, they’re going to miss two lessons of computing.”
Often I'm then expected to stay after school to make up that time. Even though no-one says it to me, when else is it going to happen if I don’t take it upon myself to do it?”
“So I think that is a barrier. Whereby, as I said before, not seeing the importance of the subject and the time that it’s taking. They need the same. Whether English, maths, science, needs time, I think.”
“It’s hard for schools, and I understand that you get judged on your English, maths and science, but I'm still expected to get the results at the end of the day. I can’t use an excuse, “Oh, well, you took them out four times.” That’s going to be like, “But what did you do?” “Well, I had intervention.” But then some children had intervention for geography and history, and they already booked them in.”
“So then time management of the pupils. People deciding, “Okay, they're going to do maths, English, science intervention,” then taking all the time.”
“Or then sometimes art has like a ten-hour exam I think it is. So they will just go away. You won’t see them for like two days. (Laughter) So I think time management. Obviously, I'm giving you my barriers. I don’t always have the solutions. And I understand that it’s timetable and logistics, and I get from an SLT point of view that it’s not the easiest thing to do.”
Extracts from: HoD interview #1
Notes: The data were collected during the spring term; this is a time in the school when learners in year 11 are completing coursework and preparing for external examinations.

Figure 5.10: Extract from head of department interview. Yellow highlights the influence of examination requirements on curriculum enactment.

In this extract (Figure 5.10), the HoD outlines a barrier to computing for pupils is the time taken for other subjects, particularly core subjects, but then also a level of competition with other subjects. For example, art examinations or revision sessions in the humanities (Bernstein, 1975; 1990; 2000). It is not clear that this is due to other subjects having a stronger classification, although it does emphasise priority given to English, mathematics and science. The HoD then talks of having to give their own time to make up for that lost to other subjects. It is important to identify that this is a challenge felt by the HoD when moving into considering pedagogic discourse, especially where cross-curricular mentions are made. The data presented so far provide a context for the pedagogic discourse in that teachers identify time pressures and competition with other subjects restricting their freedom to deliver the curriculum as they would like (Bernstein, 1990; Archer, 1995; Erben and Dickenson, 2004).

5.3 Case A: Pedagogic discourse

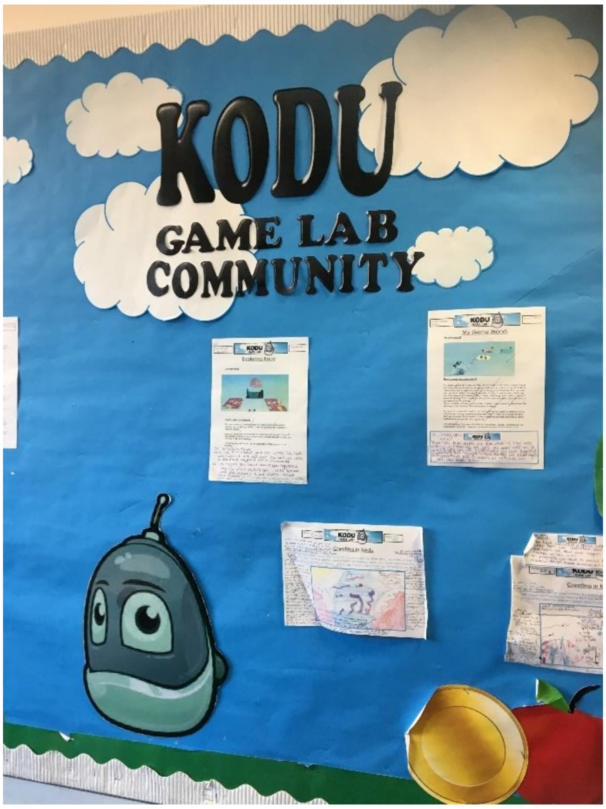
The second research question, how are teachers delivering the National Curriculum in Computing? requires an exploration of the topics, pedagogy and teaching of computing. For this section, the data discussion is focussed on pupil interviews, alongside those of the Head of Department and computing teacher. Display work is included as part of the data collection. Due to the nature of the data, it is difficult to group specific aspects of pedagogic discourse. The use of codes has been applied to loosely group what is taught when, the pedagogic approaches and resources used, indicators of hierarchical/segmented knowledge, instructional/regulative discourse and cross-curricular links (Sadovnik, 1995). As a collection, these data explore the transmission of knowledge, categorised by Bernstein as the strength of frame of the subject (Bernstein 1973; 1975; 1996; 2000). Whilst this is the focus, there is considerable overlap with the other research questions with some data having several codes attached. This is reflected in the accompanying commentary.

The computing curriculum begins in year 7. In the first extract pupils describe their first computing work in the school, some of which is also on display.

Respondent 2: To have players and a setting and a background and all that.
Interviewer: Yes, so out of all of the topics, what topics have you most enjoyed?

Respondent 1: I enjoy all of it, because I think it's fun, learning new stuff, so if you say what the funniest will be, I think it would be Kodu because I can create my own world. I can do anything I want in there. So I think that will be the most fun to me.
Interviewer: Okay.
Respondent 2: I agree with [Name], but I mostly like Python that I'm doing now in Year 8, because with Python I can explore different things that I have never actually experienced before. It's fun and it's interesting, and even though I did enjoy Kodu it's just like it wasn't really that in depth for me, so I find Python quite interesting with all these new codes. They have operators. Like addition and multiplication, I didn't even know existed in computer science. So it's really interesting.
Interviewer: Okay. So in the lessons, what sort of tasks do you like doing? Do you do stuff on paper, do you do stuff on computer?
Respondent 2: I do now- Is normally a worksheet, and then we go onto the computers.
Interviewer: Okay.
Respondent 1: Sometimes we might not get onto the computers because we don't have much time because we are explaining the work more, but we will get to go onto the computers one or two times per week.
Extract from: interview with 2 year 8 pupils (one M and one F) #3 #4
Notes: Respondent 1 finds computer science fun, for example using Kodu, a game design package developed and run by Microsoft.
Respondent 2 enjoys the challenge of Python and the increased challenge of operators.
Pedagogic approaches – a delay in getting onto computers as completing paper-based activities. This is a statement rather than any positive or negative views on it.

Figure 5.11: Extract from KS3 pupil interview. Green and yellow highlights the enjoyment of the curriculum, purple indicates some of the barriers pupils may experience.



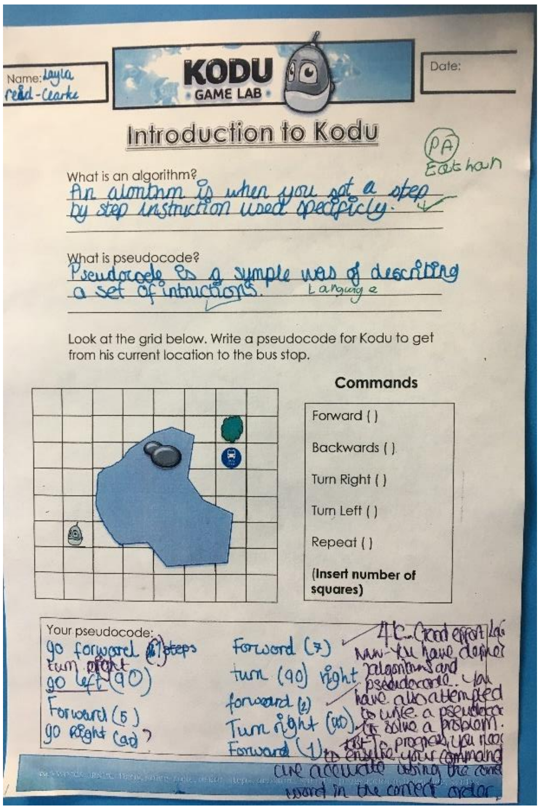


Figure 5.12: Displays in the classroom of reports and questions related to on screen work in Kodu.

Kodu Game Lab is an education programming environment developed by Microsoft, often used to introduce novices to computer science concepts and programming (Stolee and Fristoe, 2011). Kodu language is event driven and can be used to teach Boolean logic, variables, objects and control flow. This is on display in Figure 5.12. In their study, Stolee and Fristoe caution that whilst a concept is expressed in a Kodu project, this is not a guarantee that it has been learned. This has been found to be similar with other visual languages such as Scratch (Moors et al, 2018). Packages such as these form part of the grammar of computing, which are accepted tools that support learning of powerful knowledge (Young and Muller, 2013).

The learners and teachers identify regular use of written work to explain their use of key concepts and to check understanding. The learners can identify how this prepares them for the next steps in moving to text-based programming (Figure 5.11). These are inferential activities, indicating an instructional discourse (Bernstein, 1996). Whilst the work on display is most akin to the National Curriculum Programmes of Study at key stage 2 (use sequence, selection and repetition in programs; work with variables and various forms of input and output) (DfE, 2013) this builds disciplinary knowledge needed to begin to use text-based programming, as required at key stage 3. Teachers have previously identified that pupils do not arrive with strong prior knowledge from primary schools. This process does indicate a hierarchical building of knowledge (Bernstein, 1975; 2000), although the efficacy of this approach is not within the scope of this study.

"But sometimes with the Year 8s and the younger ones they're like, "Oh, Miss, when are we going to logon?" Sometimes there's not really a thing for them to logon for, but I will put it in there, just to give them that motivation that, "If we do this we're going to be able to log on.""

"But I'm very much about the theories and them having the understanding of what they're doing and what computing is about, rather than just going onto the computer. And I think that stems from... When I do parents' evening they're like, "My child is always on the computer. They're really good at computers." And I'm like, "But what are they doing? They're browsing the internet. They're going on games. It's not computing. It's not the same thing.""

"So I do have those lessons where they don't go on the computer. And I'm very much a fan of the unplugged theory of them understanding how they're doing things, why they're doing things, to plan before they actually go on the computer."

"Then I can say, "Now you've planned it you can create it on the computer." I don't let them miss that step."

Extract from: HoD interview

Notes: The HoD uses unplugged activities to check understanding or to ensure learners have planned activities before using devices. This was also acknowledged by the learners.

The HoD does not identify that computing use outside of school is contributing to their learning of computing, therefore favouring a vertical pedagogy.

Figure 5.13: Extract from head of department interview. Purple highlights the influence of computing use outside of school, yellow indicates mention of pedagogic approaches

The HoD is advocating unplugged computing approaches (Figure 5.13). This is a pedagogic approach used by computing teachers where computational thinking and understanding of theory are taught away from devices (Caeli and Yadav, 2020) (also see Chapter 2, section 2.4).

In the same extract, the HoD identifies the use of computers outside of school as not contributing to learning even though parents are identifying the pupils as using them. This shows a view of parents believing that use of devices is building knowledge but the HoD not giving this any value. This, alongside the building of hierarchical knowledge, alludes to a vertical discourse (Bernstein, 2000; Maton, 2009) (also see Chapter 3, section 3.3).

Respondent 1: Yes. I do a leaflet about that, write how do people affect - How does it affect what - Certain things that affect their life. So it's a leaflet that is trying to persuade people to help those animals.
Interviewer: Okay, and were you doing that for a different subject?
Respondent 2: No.
Respondent 1: No.
Interviewer: No, you were doing that in your computing lessons?
Respondent 2: Yes.
Respondent 1: Yes.
Interviewer: In your computer science lessons, okay. So you were creative then, when you were doing your leaflet?
Respondent 2: Yes, because we had to think of ideas to persuade people, and not only did we do computer science. We also did a bit of English because we used persuasive language in it. So computer science is basically like a mix, because you have maths in it, since we have strings. It's alphabetical characters, and persuasive language, doing leaflets. So we have to try to convince someone to do that, and it's just so interesting and it helps.
Extract from: Interview with 2 year 8 pupils (one M and one F) #3 #4
Notes: Whilst talking about a different unit of work, the highlights show the different mentions of subject. Learners view computer science as a mix of subjects including mathematics and English. This indicates a weak classification from the learner perspective.

Figure 5.14: Extract from year 8 pupil interview. Yellow highlights how pupils describe the curriculum.

During this part of the conversation, myself as the interviewer moved between computing and computer science labels for the lessons (Figure 5.14). I had sought clarity at the start of the interview:

> *Interviewer: we've just sneaked out of your computer lesson. So those lessons that you just had, do you call them computing or do you call them ICT or do you call them computer science?*

Respondent 2: Computer science.

Respondent 1: Yes.

Interviewer: Computer science?

Respondent 1: Yes.

The discussion about the creation of leaflets had drawn me back to my own experiences of teaching ICT before the changes to the National Curriculum in 2012. A unit of work on leaflet design was commonplace in schools under the ICT curriculum (Kennewell et al, 2003) (also see Chapter 2, section 2.6). From my own experiences, I would identify such a topic as falling under the IT strand of the National Curriculum rather than being computer science, as the pupil suggests. This exchange demonstrates my own partiality in labelling computing and computer science lessons, already having a view as to what is included in the subject (Thomson and Hall, 2017). Whilst not explicit, the terminology used by the learners will echo that used by their teachers when naming lessons.

Whilst the use of subject labels is part of the pedagogic discourse, it also links to the first research question, exploring the strength of the classification of the subject. Whilst the labels of the subject are very clear for the learners, as computer science, what they are completing is part of the National Curriculum that would fall under the IT strand of the curriculum (create, re-use, revise and re-purpose digital artefacts for a given audience, with attention to trustworthiness, design and usability (DfE, 2013)). The learners also studied e-safety, which is within the strand of Digital Literacy. That said, the National Curriculum does not clearly define the subject content into the specific strands (see Chapter 2, section 2.4).

In terms of building knowledge, I explored the learners' prior experiences in computing, especially as, in the teacher interview, it was identified that pupils had missed experiences at primary level. This continuity for learners is important in understanding how the subject knowledge is built hierarchically (Muller, 2006). What emerged was an interesting discussion with one of the pupils who had spent the last year of their primary education at an international school in Uganda. Prior to that, they had studied in England and returned for the start of year 7 (Figure 5.15).

"I was used to the British curriculum, but I think over the years they've changed it a bit. When I was in primary school, we used to do - I don't think we did computing because I think it was a bit too much. We thought that since we had our SATs and they wanted to prepare us for high school from Year 1, Reception, so we didn't really get to do computer science."
"We normally just fixated on core subjects, so English, maths, science, all day, every day. I just found out the - I never even did PE, but a year ago I did go to Africa, Uganda, so there was PE, we had computer science. It was quite new to me because I'd never even discovered these things. So when I came here, when I came back here, I just thought, "Oh, oh, I saw this in my primary school in Year 6", because I went there to graduate, primary school."
"Yes, I was new to all these different subjects. History, geography, but as I go on, every day, I prepare myself for the day. So I look at Wednesday and I'll be, "Oh, I have DT, I have read, I have maths, so I'm going to study for these and prepare myself." So every time I have computer science I'm quite interested. So since my dad - He's in IT, so we practise a lot in computer science and I think I'm good, but I don't really know."
Extract from: Interview with 2 year 8 pupils (one M and one F) #3 #4
Notes: Highlights show the experiences at primary school in the UK, a focus on SATs, and then returning to the UK and finding subjects quite new, with experience only being in year 6.
Highlights show the discovery of new subjects at school in Uganda.
Highlights show the additional work at home to prepare for the subjects, along with influence of the father at home.

Figure 5.15: Extract from year 8 pupil interview. Yellow highlights pupil experiences in primary school, purple indicates international experience, green highlights engagement outside school.

Interestingly, the other learner in the interview had attended primary school in China, where they had only studied Chinese and mathematics. This demonstrates the transient nature of the school population and the mixed experiences pupils have in primary education. Even whilst at school in England, the learner identifies that they did not follow the National Curriculum in Computing (although it must be noted that they are relying on remembering from their year 5 experiences, at least 3 years prior to this interview). In building hierarchical knowledge, it is an additional challenge to identify what prior knowledge learners already have and can build on if they have not been following the National Curriculum (DfE, 2013; Ofsted 2022). This lack of continuity in the subject for learners means a vertical pedagogy may be short in duration, especially if they then do not opt to continue studying computing at key stage 4 (Daniels, 2006). At key stage 4, learners study different courses depending on their option choices. Some learners do not select any computing related courses; these learners were not included as part of the data collection. Others opt for GCSE Computer Science or an OCR National in iMedia (OCR, 2019). The HoD identified that this will be the last year of the iMedia course and then they will only offer GCSE Computer Science.

#12: iMedia, I really never thought about that. By looking at the work I saw that it was good, but I think it would be too easy for me, if you get what I mean. I want something that will actually challenge me, like computer science. Once I saw the work, for example if there was a poster, they would annotate it and look at all the vibrant colours. That wouldn't really get me anywhere. I can see that it's very eye-catching and all of those things, but I know that would have been too easy for me.

....

#12: [computer science] It's not like speaking language, but there are high level languages, programming languages. One of the main ones we use in programming is Python. That's the programming that we've been using since I was in Year Seven.

....

#11 [computer science] Very different, it's a completely different thing for me. I find ICT easy, it's so simple. Then in computer science you have to think and think and think to find a solution to your problem.

#12: ICT I did in Year Seven and Year Eight. I found it really easy at the end of the day. Some of the things in ICT actually benefited me because if it wasn't for all the information I've learnt in ICT from Year Seven to Year Eight, I wouldn't really have the understanding to be able to do computer science.

Interviewer: What sorts of things?

#12: Just like in algorithms. I didn't know what an algorithm was and I learnt that in Year Eight and pseudocodes, it's not a high level language, there's no syntax. I learnt a lot from ICT and it's benefited me in computer science.

Interviewer: Did you [#11] find your ICT was a bit different? Did you switch schools, is that what happened?

Respondent 1: Yes.

Interviewer: What was your ICT like?

Respondent 1: We did about Excel, Windows and all of this. We didn't do anything about programming or pseudocodes. We just did many tasks on Excel, Windows or Word.

Extract from: Interview with GCSE CS Girls #11, #12

Notes: Highlights although learning programming in Python from year 7, still sees computer science as challenging.

Highlights ICT/iMedia as being easy

Highlights that interviewees had quite different experiences at key stage 3,

Figure 5.16: Extract from GCSE Computer Science pupil interview. Yellow highlights pupil experiences of programming, purple indicates views of level of difficulty of qualifications, blue highlights prior experiences of the curriculum.

In this extract (Figure 5.16), the learners from the GCSE Computer Science class mentioned that computer science was hard and challenging. They repeated this at several points during the interview and identified this as a positive aspect of the subject. This level of difficulty could indicate a vertical knowledge structure with the subject developing in difficulty (Bernstein, 1990), although it could indicate weak framing, where learners do not have the prior knowledge required to build their next layers of learning (Moore, 2006). Both learners had quite different experiences at key stage 3 so it likely that the sequence of learning is different for each of them. Within the extracts there is a jumble of terminology when discussing aspects of Computer Science and ICT. The learners can identify differences within the subject and perceive iMedia as being easy or some ICT topics being ‘just’ using software indicating limited value.

Overall, the pedagogic discourse within the school varies between learners and lessons, especially at key stage 4 where learners follow different qualifications. Key stage 4 covers three of the five years of the education within the school, and not all learners select from the two qualifications on offer, iMedia and Computer Science. The learners discern differences between the qualification routes with iMedia having a weaker classification and subject knowledge. In particular, the iMedia assessment requirements determine the pace and activities within lessons resulting in a strong frame with little control given to teachers or learners.

Subject teachers have more control at key stage 3 determining the topics and pace of learning. However, the mixed prior experiences of the learners and the varied options at key stage 4 result in the building of knowledge in computing being short, potentially just two years for some learners. This does not give the teachers the recommended curriculum time to deliver the full National Curriculum in Computing (DfE, 2013; Ofsted, 2022).

5.4 Case A: Experience of learners

The third research question explores what the perceived impact for learners is as a result of the National Curriculum in Computing. A focus for this is the interviews with the learners themselves, to identify what they are learning and how they view their own experiences.

Codes for this aspect included the influences of the learners (both in and out of school), their own subject-based values, and plans for further study or employment relating to computing (see Figure 5.2).

Both interviewees identify that GCSE Computer Science is harder than their other subjects. They were asked why.

#11: It's hard for programming and all of this. Sometimes I don't know how to program something difficult, but I can work it out after hard work.

………….

#12: Computer science, I find it quite challenging. I think that's a good thing because challenges can impact you and you can actually get a better future with computer science. With my other subjects, they can be quite easy, but the reason I chose computer science is it will challenge me even more because my other subjects are quite easy. The fact that computer science, it's a good subject to learn from.

……………….

#12: Sometimes we do programming. If we're doing subjects that have system architecture… Yes, we do system architecture, but every once in a while, sometimes Miss lets us do a quick programming dash and see if anybody can do this quicker. That's really engaging towards our lessons.

……………….

#11: If we have a source of memory, it's going to be a video that's going to analyse all of the memory information and what it helps with, blah, blah, blah.

#12: Sometimes Miss lets us watch videos on our own. She books the headphones for us, we go onto YouTube and then we have to type in the URL into the internet. We just watch it by ourselves and then we take notes down in our books. Miss sets us off on our own task, so we can do some silent and independent work.

Extract from: Interview with key stage 4 learners studying GCSE Computer Science #9, #10, #11, #12

Notes: The learners find Computer Science more difficult than other subjects. They identify it gets easier over time indicating a vertical pedagogy with knowledge building hierarchically.

The approaches to learning programming, using short, competitive activities, is found to be engaging by the learners. This indicates a strong frame with the teacher identifying appropriate subject specific pedagogies.

Learning facts in Computer Science has a weaker frame with learners selecting their own sources and working independently.

Figure 5.17: Extract from GCSE Computer Science pupil interview. Yellow highlights pupil views of level of difficulty, blue indicates approaches to learning programming, green highlights pupil perception of pedagogic approaches.

Learners identify computer science as a specific subject, insulated from their other subjects (Figure 5.17). This indicates a strong classification (Bernstein, 1990). The learners identify the subject is difficult but appreciate the challenge and that it will lead to improved future opportunities. The pedagogic approaches they have experienced in the classroom vary between the types of subject knowledge being taught. Approaches to learning programming build on subject specific pedagogies and indicate a strong frame, where teachers have drawn on their subject expertise to support learners' understanding (Young, 2011). For topics other than programming, the frame seems to be weaker, with learners having more freedom to dictate the resources and pace of learning (Morais, 2002).

#9: I think sometimes, it can be similar to other subjects in school. Like binary, as you were saying, that links to Maths, but also, like, when we learn about ethics, the ethical topics, the environment, or whatever, that also links back to topics such as RE or, like…[pause]
Computer Science, it's its own thing and obviously, we learn about different things. Well, computers, you don't really learn about them in different subjects, but to some people, it can be seen as difficult. Obviously, once you get it, it's totally understandable.
……………………
#9: We have to apply our Computer Science knowledge to do that [solve problems]. Whatever we've learned or we already know from that topic, we apply that. It can be a real-life subject. Such as, when we're learning about topologies, we link that back to how a business may use that certain network, which obviously helps, then, to help us understand it more.
It was a high expectation. I thought, "Yes, computing's going to be fun. It's going to be" I thought it was going to be quite easy, but we're getting into it. It's actually hard when you think about it, but obviously, when you get used to it, it changes, and it gets easier.
Extract from: Interview with key stage 4 learners studying GCSE Computer Science #9, #10, #11, #12
Notes: The learner makes connections between Computer Science and other subjects yet identifies it as its own subject. The classification is not strong as the subject is positioned in relation to others, however, the learner also identifies that some aspects do have a stronger classification.
As the learners progress and make connections to real life concepts, the subject gets easier. This indicates a vertical pedagogy as the learning builds hierarchically.

Figure 5.18: Extract from GCSE Computer Science pupil interview. Yellow highlights connections between computer science and other subjects, blue highlights pupils connections between computer science and real life concepts. .

#5: I feel as though, because we do the same - well, we used to do the same thing over and over again. So we had, like, a case study. Every time it was the same thing, but it was different words. It was changed. But we had to create the same document again, over and over again. It was just really long, and I don't really like that.

When you first get into a subject, it's like, "Oh, my God, it's so fun." But then, once you get into it halfway through the year, it's not that enjoyable for me anymore. But now that we're going to come up to our exam, we're not doing anything else. We're only revising, so it's just mellow at the moment.

#6: Yes. Basically, you would get a case study, the scenario. And every scenario, there's just a different one, but it's the same thing. So you're creating the same thing over again with just different names of the company, different colours, depending on what they've asked you to do. That's just all that was different.

…………………

Interviewer: and do you think iMedia will help you in future?

#5: Yes, to write out my documents and stuff, and sending emails, and knowing what size I can use, which file types I can use to send them, what I can and cannot send in a file. Stuff like that. I think that could help.

…………………

#7: I think girls are interested [in computer science], but at the same time in iMedia you get a lot of support in a sense. If someone next to you is doing something, Miss will tell you look at their work. But I don’t know in the computer science whether you get support or it’s just one of those things that you have to learn.

Interviewer: Oh, so do you think it could be something about confidence?

#7: Yes, that’s why I think lots of girls didn’t pick it because the barrier was set kind of high. And then as well as that, their confidence didn’t match the barrier.

Extract from: Interview with iMedia learners, #5, #6,#7, #8

Notes:

The learners are repeating similar activities in iMedia indicating the qualification is determining the pace of learning for them and learning is not building vertically.

Software-based skills are viewed as being useful for their futures.

Peer support is available in iMedia but a high barrier for learning in Computer Science means less peer support is available and confidence is reduced. This indicates the learners in iMedia perceive they have a more communal approach to learning.

Figure 5.19: Extract from iMedia pupil interview. Yellow highlights pupil experiences of repetition of learning, purple indicates the development of software skills, green highlights pupil experiences of peer learning.

The GCSE Computer Science learners indicate that they are building knowledge hierarchically indicating a strong frame with specific disciplinary knowledge (Bernstein, 1975; 1990; 2000). In this case (Figure 5.18), the learners do position some of their learning against mathematics, indicating some weaker insulation within the subject.

The learners following the iMedia course have a very different perception and experience of the subject compared to those studying GCSE Computer Science. They found some of the tasks repetitive, which indicates a lack of vertical discourse. There is also an indication that the subject is more skills- than knowledge-based (Young, 2011). The iMedia class has many more female students compared to the Computer Science class. In response, learners discussed their perceptions of support and confidence in Computer Science. The discussion suggests a more collaborative approach in the classroom between learners during iMedia classes whilst Computer Science requires more independence. The Computer Science GCSE is examination-based, whilst iMedia has a high coursework content. It is not clear if learners perceive that the assessment methods generate more of a community or the type of skills and knowledge being learner. Bernstein asserts that a horizontal discourse is primarily community-based, indicated mainly outside the classroom, although this discussion does indicate that, where knowledge is less hierarchical, pupils work more collaboratively and make use of peer-to-peer support (Bernstein, 1995; 2000).

5.5 Case B: Context of the school

School B is an Academy Convertor School in a market town in the South East of England. It is an all-through school, quite an unusual structure, having pupils from age 4 to age 18 years. The teachers and pupils included in the data collection are only involved in the secondary phase of education, for pupils aged 11 to 18 years. The school is in an area with the lowest levels of deprivation, quintile 5 (ONS, 2019). The school has a below national percentage of pupils receiving free school meals, very few pupils from minority ethnic groups and very few who have English as an additional language. The school received an Ofsted grade of 'outstanding' two months after the data collection (Ofsted, 2018).

The school is large in size, with 1,337 pupils. The population is stable, which means very few pupils leave or join the school partway through their education. The overall results for the school are well above national average and slightly above those of the local authority average. Pupils walk to school, travel by bus or get dropped off by parents, all from the local area. It is on a large site with playing fields, playgrounds and a large staff car park. The buildings are approximately 60 years old with various extensions and additional accommodation added at different times. The computing rooms are external to the main school building in more temporary style prefabricated classrooms with their own entrance area and toilets. They are single storey buildings. The classrooms are large and light with a lot of space for both computers around the edge and for tables to allow pupils to work away from the computers. The windows have blinds and most of these remain closed to prevent glare on the computer screens. In addition to the computers in the rooms, every pupil in the school has an iPad to use in all of their lessons; they carry these around with them.

At the time of the data collection, pupils in year 7 did not study computing due to staffing shortages. Their computing curriculum time was given to the art department who delivered digital art. Year 8 and year 9 had one hour per week for computing. Following key stage 3 pupils, one class in year 10 and one class in year 11 were following a course in GCSE Computer Science. An additional class in year 11 were following the OCR National Certificate in iMedia (OCR, 2019), although this was the final year of it being delivered in the school. There was one class in year 12 who followed the A Level Computer Science course whilst a single class in year 13 were following Level 3 Cambridge Nationals in IT. Specific results were not shared by the school, other than that they were good and above national average. The previous cohorts had completed different qualifications with many studying for the European Computer Driving Licence (ECDL), which awarded a pass or fail rather than a grade. All pupils entered for the qualification passed. Results for the cohorts involved in the study are not considered due to the impact of Covid-19 (Crick et al, 2020).

Recruitment of staff was a challenge for this school, and this was discussed with me prior to the data collection. The Head of Department (HoD) was concerned that the limited staffing would limit the contribution the data could make to the study; however, I explained that I wanted to be able to see how the school and the pupils were experiencing computing as a subject even with a shortage of staffing. A shortage of specialist staffing had been identified as a common issue in the national report on computing in education (Royal Society, 2017). The subject leader is a specialist teacher. For the purposes of this study, they are labelled as HoD, although within the structure of the school, technically the Head of Department was the Head of Mathematics and the computing subject leader reported to them. The Head of Mathematics was not involved in the data collection and did not teach or lead specifically on the subject, but had a line manager role. The Head of Department for Computing worked 3 days per week and is a specialist in computing. The other specialist in the department was not a qualified teacher. They had volunteered to do some teaching as they knew the school was short of specialists to support examination classes. The two specialist teachers are both male. The other staff were 8 non-specialist teachers who mainly taught in other subject areas including physical education (PE) and music; they had computing lessons on their timetable although were not formally in the department. The shortage of specialist staffing is a common theme throughout the data in this case. Data collection took place in March 2019 and is summarised in Figure 5.1.

5.6 Case B: Computing as a subject

To explore how computing as a subject is viewed within the computing department, I interviewed both the HoD and the computing teacher about the developments of the computing curriculum within their school. The HoD spoke to me at length prior to the interview about the staffing and time constraints within the school. Some of this is revisited within the interview, with other points captured in the field notes. Whilst this did dominate much of the conversation, the HoD did reflect on the impact of the new curriculum for the learners in the school. The first two extracts were retrieved through collating all HoD comments relating to curriculum (Figures 5.20 and 5.21).

"For some of them, the maths orientated or the ones interested in computers, I think it's [computer science] a lot more engaging for them. Looking at the numbers we get, say we get 30 doing computer science [at GCSE], that's another 130 in a year group who haven't opted to do it, if that makes sense. I think the sorts of activities we're doing now to try and get them prepared for GCSE, which is the whole idea of our Key Stage 3 curriculum, we're trying to show them what's involved and try and build up some of those skills before they enter GCSE so they're a lot more prepared. It doesn't appeal to all of them. It may be the way we're delivering it, I don't know."

"In the past, they were making videos and doing digital graphics and making their own websites, all things which are not really part of the GCSE computer science curriculum now. They've been taken away from us and they've been put over to digital art and things like that. Those were the ones which engaged a lot more people, I think, than the pure computer science which we're trying to put in. We're still trying to do programming in more inventive ways and things, which people can engage with a bit more. I still think the old IT curriculum was probably more engaging for the majority of the cohort than the computer science one is, if that makes sense."

Extract from: HoD interview #13

Notes: Reflections on high numbers not opting for GCSE computer science and why that might be. The pupils not opting will not have any other computing lessons from the end of year 9.

Leadership decisions made by others, not the specialist teachers, therefore indicating a weak level of insulation for the subject specialists.

The belief that previous subject ICT was probably more engaging for learners.

Reflections on the pedagogic processes and whether these can be developed in practice.

Figure 5.20: Extract from HoD interview. Yellow highlights HoD views of ICT curriculum, purple indicates views of pupil numbers, blue highlights HoD reflections on pedagogic approaches.

The HoD identifies that the National Curriculum in Computing has been implemented but is not as engaging as the previous ICT curriculum (Figure 5.20). As a result, the numbers of learners opting for the subject at key stage 4 have reduced and there are a lot of learners at key stage 4 now not studying any computing-specific learning. This indicates an acceptance of the ORF, although identifying it is not engaging for all learners and so reducing the numbers studying the subject. The HoD does not indicate a personal view on the curriculum changes, although identifies that more needs to be done within the department to engage learners (Archer, 1995). However, the HoD says that topics have 'been taken away from us', which indicates the curriculum changes have been imposed (Watling, James and Briggs, 2012).

The HoD does note that computer science is more engaging for mathematics-orientated learners. The theme of mathematics follows in the next extract (Figure 5.21).

Interviewer: Do you ever have time where you can meet with them all [computing teachers]?

Respondent: Not really, no, because the department meetings we do have, I'm actually attached to maths this year, which is logical, I think. It's quite a mathematical subject.

One of the maths teachers who has done quite a bit of programming at home, he says, is quite keen to get involved with the computer science area of it, which I think would be good because obviously the maths has a big crossover with, certainly in the A level, looking at Boolean algebra and simplifying expressions and things like that. He could do that quite easily. That's the way we're looking, or hopefully looking to go now, is trying to get him more involved in the computer science so it builds up another sort of specialist in the subject there.

As I said, because we're not going to deliver the iMedia course next year that will take away some of the curriculum time, which I would have to teach otherwise. It's shrinking a little bit. A lot of IT has been removed, but they're going to try and work it so I can do most of the lessons at Year 9 Key Stage 4 and 5, but with this maths teacher also helping out and becoming more involved in it as well.

Extract from: HoD interview #13

Notes: The computing department is within the mathematics department within the school and a mathematics teacher can become a specialist teacher for A Level.

The curriculum is being reduced as a result of the staffing constraints. It is the IT elements that the HoD notes are to be most reduced, specifically limiting the qualification options at key stage 4 and key stage 5.

Figure 5.21: Extract from HoD interview. Yellow highlights pupil experiences of programming, purple indicates views of level of difficulty of qualifications.

The HoD is unable to meet with the teachers as there are so many non-specialists teaching the subject. This indicates a really weak classification with teachers unable to discuss subject knowledge or pedagogy (Bernstein, 1975; 1977; Maton 2012). The HoD focuses on Computer Science, rather than all three strands of the Computing National Curriculum and identifies close links with mathematics. This is in part due to the structure of the department sitting within mathematics and the close involvement of a mathematics teacher. It is not clear if teachers and leaders in the school already identified a close association with mathematics which determined the structure, or if they brought about a close association with mathematics. The previous ICT curriculum has been closely linked to art within the school and it is not clear from the data whether this was a necessity due to staffing or a decision based on subject knowledge and curriculum design.

The next extract is from an interview with learners. Although this section mainly focuses on the teachers' and leaders' views of the curriculum, the extract captures how the weak insulation against other subjects permeates to the learners' views of the subject.

Interviewer: Do you know why you preferred this qualification [iMedia] to the computer science?
#19: I preferred the more artistic approach obviously because of the industry that I want to go in with. Computer science was more coding and things like that, whereas I more enjoyed like the digital graphics and the animation side.
#20: It was also quite maths based and at the time of options I was definitely struggling with maths. I think I would probably cope with it now but at the time I just didn't want to get into something that was too maths based.
Extract from: iMedia interview #19, #20
Notes: Identifies GCSE Computer Science to be quite mathematics based and so felt they would not be able to cope without having strong mathematics skills. This indicates weak insulation between CS and mathematics.
The iMedia course is viewed by learners as being more artistic.

Figure 5.22: Extract from iMedia pupil interview. Yellow highlights pupil views of iMedia, green indicates pupil views of GCSE Computer Science.

The ongoing discussion on mathematics indicates weak insulation, with mathematics infiltrating into computing. Bernstein talks in more general terms about insulation but in this case it identifies that permeation is from a specific subject area (Bernstein, 1975; 1996; 2000). The insulation is weakened by the school structure, with computing being situated within mathematics. In contrast, although learners study digital art, the permeation from art is not prevalent in the data. The department structure with computing being situated within mathematics is likely to be due to staffing and financial constraints, although this is not explicit in the data.

The next extract is from the only teacher specifically allocated to the computing department. They are a non-qualified teacher but have specific computing subject knowledge. They identify the links with mathematics are not resulting in learners covering all the right topics, such as programming.

Interviewer: Do you think the change to the Computing Curriculum has had an influence on what is happening in school?

#14: I think to a degree it has, but I think you've got to work back to see how you can introduce that into the earlier years, because I suppose with ICT, there's more to computers, and programming and Computer Science. I think somehow you've got to get that engendered into the earlier years. Yes, okay, you can cover e-safety, you can do stuff like that, but I think a lot of the students would like to do, and understand, more in those early years.

To be honest, when you're in Year 8 and Year 7, teaching somebody binary and denary, and stuff like that, that's good but I think it would be better if it was more showing them how to program and do more interactive things like that. It's hard for the school because they can't get the people, that's the trouble. It always comes down to staff and people.

Interviewer: What are some of the topics that you're teaching with the GCSE and the A level students?

#14: We're just going through the AQA syllabus, been through everything with the GCSE people, so we've done programming, done all the algorithms, computational stuff, all the structures and networks, design, how the whole thing fits together, so covering the whole syllabus.

This group, particularly XXXX and XXXX, are incredibly bright mathematically. If it's more on what I call the 'theory side,' they lose a bit of interest, but if it's more on the programming side, they're interested. I was saying to [HoD], I've had a look at some of the stuff they're submitting as their NEA projects, and they need to refocus a bit, because some of them seem quite weak.

Extract from: Interview with computing support teacher

Notes: The teacher identifies that learning in years 7 and 8 is restricted by the staffing. That the mathematics aspect is useful but the learners are not completing interactive programming activities.

Where learners have been strong mathematically, it has not necessarily resulted in a high calibre of programming projects (NEAs are non-examined assessments).

Learners have not built their subject knowledge from younger ages and so it is difficult for teachers to build on their prior knowledge.

Figure 5.23: Extract from computing support teacher interview. Yellow highlights teacher views of links with mathematics, green indicates barriers to the delivery of the curriculum, blue highlights views of prior learning of the curriculum.

"No, I don't think so. It's just tough at the moment, I think, being the only person in here, being part time and trying to juggle all of that around. I think it is having a detrimental effect on the provision or the delivery of computing and ICT in the school, to the extent that we are losing curriculum time from it. I'm not going to go back up to full time in the near future, which means, like you said earlier, they're trying to find ways to, "Oh, how can we deliver the computing curriculum, but how can we adapt the computing curriculum or take away from the computing curriculum so it fits the staffing that we've actually got?" Not the other way round, not, "Let's put the curriculum time in and then find the staff in order to actually deliver it."

That's the way it's going, I feel, in this school. Whether that's the same nationally or not, I'm not sure.

…the idea is to shrink the curriculum rather than try and get other people in. We haven't got the specialists for this.

Extract from: HoD interview #13

Notes: The HoD identifies staffing is having a detrimental effect on curriculum time in the school.

The HoD feels leaders are not identifying the curriculum needs and then securing staffing to provide it. The HoD refers to the leaders as 'they' indicating that the decisions are made by leaders other than themselves.

The curriculum is due to be reduced to match staffing.

Use of the terms computing and ICT. Use of both terms indicates the subject may not have a strong classification.

Figure 5.24: Extract from HoD interview. Yellow highlights views of actions taken by senior leaders, purple indicates barriers to curriculum delivery, blue highlights the impact of barriers to curriculum delivery.

The teacher strongly identifies that the staffing is impacting on the curriculum design and teaching (Figure 5.23). The HoD was keen to point out the links with mathematics and the positive developments in bringing in a mathematics teacher for future teaching; however, this is not viewed as positively by the teacher. Both the HoD and the teacher assert that the staffing restrictions are having a detrimental impact on the computing curriculum and delivery in school.

The staffing restrictions are having more impact on the delivery of the curriculum than the ORF (Figure 5.24). The HoD sees the management within the school are 'shrinking' the curriculum. Whilst the ORF is influencing the teachers and their curriculum design, the Computing National Curriculum has not been prioritised by leaders, suggesting that the ORF is not strong at that level within school. Where the ORF is not strong, this reduces the prominence of instructional discourse and the regulative discourse determines the structure and pace of the curriculum (Bernstein, 1975; Ball, 2011). The data presented in the next section shows this to be the case.

5.7 Case B: Pedagogic discourse

The lack of staffing has had implications for the pedagogic discourse within the school. In the next extract, the Head of Department describes how the experience of the teachers impacts on their teaching. My own fieldnotes describe a year 8 lesson I was present in with one of the non-specialist staff. In the lesson, I helped the learners rather than passively observing. The teaching materials were provided centrally by the Head of Department and accessed by pupils on their iPads. The learners were not applying the HTML code outlined in the lesson materials, but instead were copying and pasting images using simple techniques they had learned previously. The teacher identified that the independent work helped to prepare them for the workplace.

This class are developing their websites using Dreamweaver and HTML code.

PPt 3 is on their iPads and the pupils are sitting at tables.

Quick discussion with the teacher. Explains that, as a non specialist, he encourages a lot of independent learning so that they are prepared for the workplace where they are given a project and told to 'get on with it'

The pupils are doing paired work to develop their websites. They move to the computers to complete some practical work.

spent time helping with putting images in to website.
We spent a long time trying to get the code to work but it kept not displaying the image.

We sought help from another pupil. They then pasted the image in using the design view.
It became clear that very few pupils were actually using the code view in Dreamweaver and they were actually using design view.

Discussed afterwards with [redacted]
- explained this is the reality of having non-specialists.
He explained that he also does not have chance to observe and does not see it as his role to observe the non-specialists.

Figure 5.25: Extract from field notes, labelled year 8, lesson 3

A regulative discourse is dominant in this lesson. The teacher has identified the value of independent activity and very little disciplinary knowledge is being learned (Bernstein, 1990; Young and Muller, 2013). The learners were applying their own prior skills-based knowledge to superficially complete the task. The knowledge they are applying everyday, or mundane knowledge in copying and pasting an image, is found in a horizontal discourse (Bernstein, 1990; 2000). To a non-specialist, it may appear as though the intended curriculum was being taught, as the final outcome could be achieved without any manipulation of code. The learners in this school all have their own iPads to use in each lesson and for homework. Therefore, these learners may have a greater level of digital skills than learners in other schools and so are more confident in by-passing the directed stages to complete a task. This indicates an over-socialised concept of knowledge, with learners able to apply skills across subjects regardless of disciplinary knowledge (Young and Muller, 2010).

A conversation with the HoD following the lesson confirmed that what was seen during the lesson was what they suspected was taking place, being typical of computing lessons in years 8 and 9 (Figure 5.25).

"Frankly, #14 might have told you differently, but I know he certainly feels that [....] in Year 8, they feel that it's almost more babysitting. They're not getting the full level of teaching which a specialist would provide. They can see that. It's more just, "Here's the work. Get on with it," than actual people delivering it, which is just the nature of what we've got to deal with. It's difficult."

"The people I have teaching Year 8 are, well, a teacher of XXXX, who's taught a bit of IT in the past but hasn't got a clue about computer science or binary conversions or anything like that. One of them is a XXXX teacher, who's done, again, a bit of IT in the past and sits in on the lessons, but has no computing background. The other one is a XXXX teacher, who, again, has done a bit of IT and things like that at Year 7 last year, but is now doing the Year 8 computer science work with them. The other non-specialist who's teaching the Year 9 is a XXXX teacher, who struggles (Laughter) to keep up with the work, shall we say."

Extracts from: HoD Interview #13

Notes: The respondent indicates that the views of others is that learners are not getting the full level of specialist teaching, using the word 'babysitting' to indicate that classes are watched rather than taught.

It is not clear if this is their view, or what has been reported. The identification that 'it's difficult' suggests that whether it is the view of what is happening, or whether it is just what is reported, that it creates a difficult situation within the subject.

The second quotation identifies the lack of subject expertise of those teaching the year 8 year group.

The subject areas have been redacted to avoid identification of the teachers mentioned in the interview. They are all teachers of either music, PE, art or cover supervisors (non-specialist staff who supervise lessons as opposed to teach lessons, in the main to cover staff absence).

Figure 5.26: Extract from HoD interview. Blue highlights HoD perception of teacher views, green indicates barriers to curriculum delivery and experience of learners.

The combination of the lesson and the interviews indicate the approach to classroom pedagogy. The curriculum is planned, and materials are prepared for the lessons; however, the classes are encouraged to do this independently and, in the lesson observed, were not able to. Visually they were achieving the same result with the positioning of the image; however, the underpinning HTML code that had been planned for them to apply was not used or understood. This indicates a difference in the intended curriculum and what is actually taking place (Apple and King, 1977). Where pupils are working through independently, this means the pace of the learning is in the control of the acquirers, indicating a weak frame (Bernstein, 1990).

Whilst the work at key stage 3 is all digital, there are some paper-based resources and work produced by key stage 4 learners on display. This included a list of keywords for each of the year groups.

Figure 5.27: Images of classrooms in school B

The classrooms are spacious, with workspace both on computers and desks (Figure 5.27). Subject-specific displays are on the rear wall of each classroom (Figure 5.28).

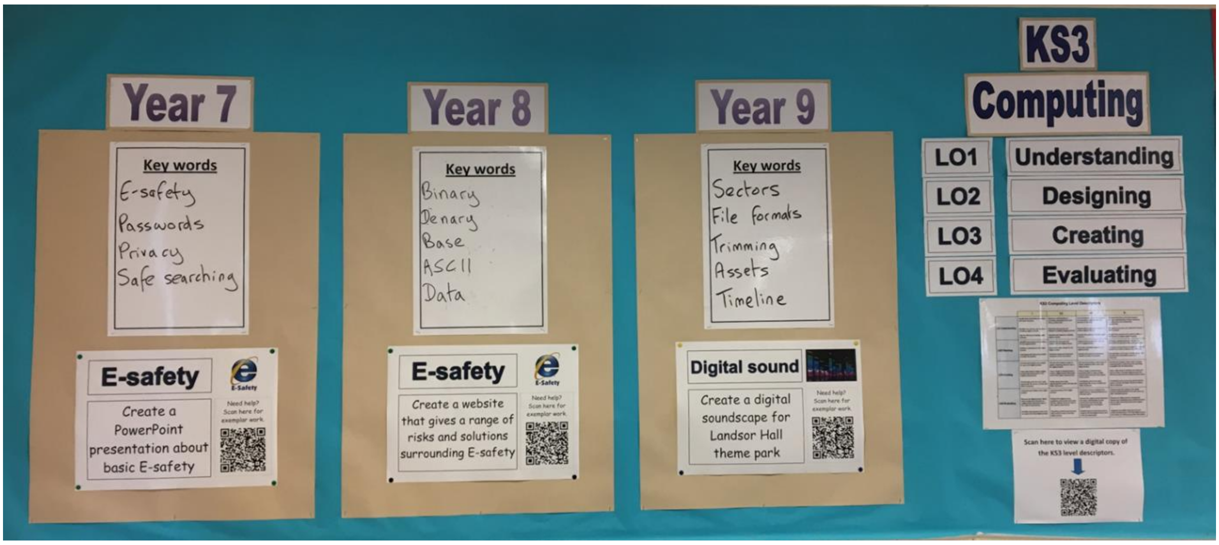
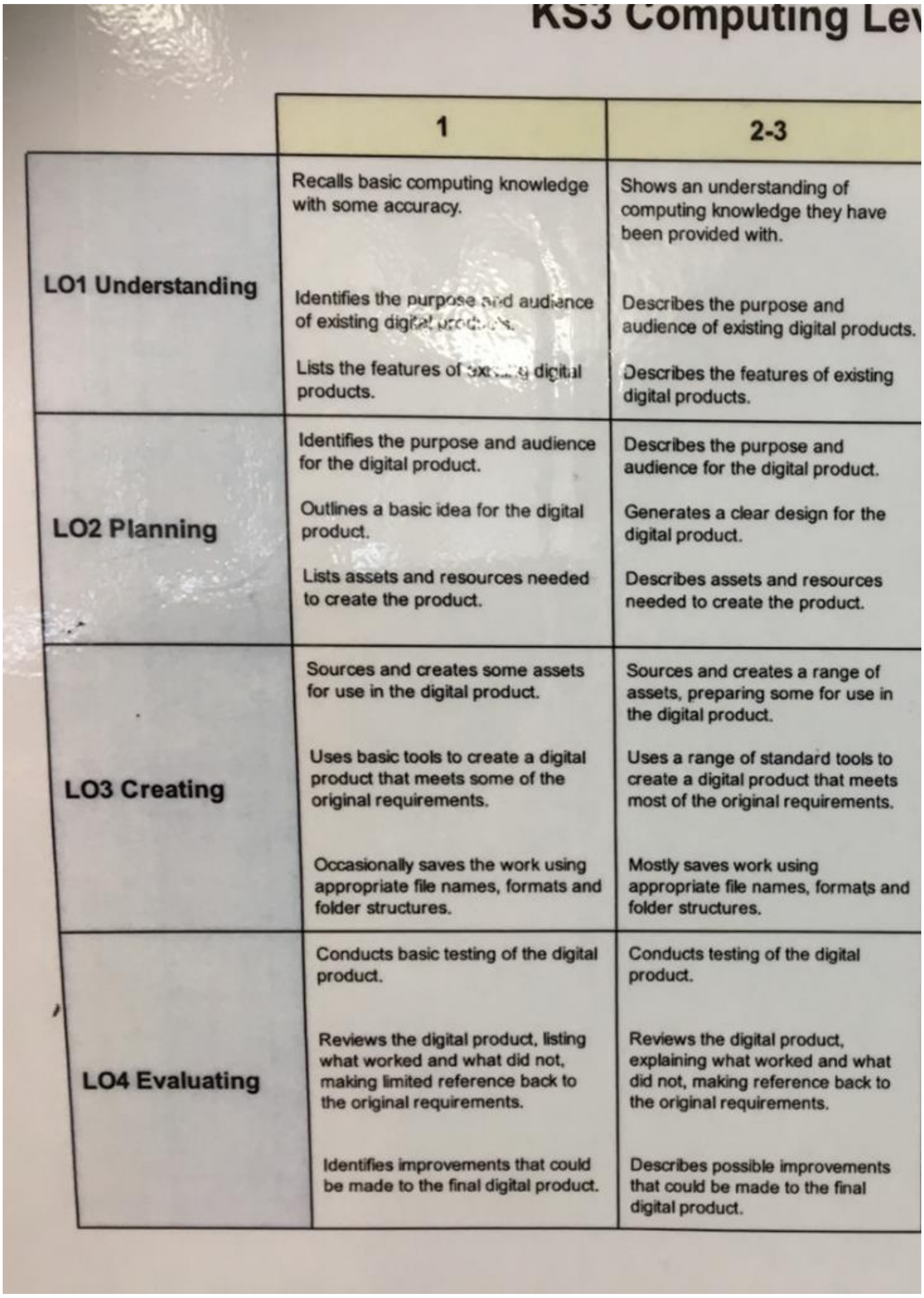


Figure 5.28: Classroom display showing the topics and key words for each year group at Key Stage 3

Key words are displayed for each topic at key stage 3 (Figures 5.27 and 5.28). It is unclear how current the displays were as year 7 were not studying computing within their curriculum and the year 8 words were not based on their current topic. The mismatch between the keywords and the lessons provides conflicting information for learners and weakens their view of the classification of the subject. The QR codes are now not in use, and this will remain the case. At the time, they linked to a digital Google Drive folder of previous pupil work. The folder was not accessed as part of the data collection. The 'LO' refers to learning outcomes and key stage 3 levels (Figure 5.29). These were used regularly by schools in the teaching of key stage 3 ICT as part of the DfE National Strategies (Furlonger and Haywood, 2005). The National Strategies programme ended in 2011 and the use of the resources was gradually phased out by schools moving to the updated requirements of the national curriculum (DfE, 2011). Whilst the learning outcomes are on display, these are not referred to by teachers or pupils and it is not evident they are in use to assess work. Despite the display making use of whiteboards to allow the key words to be updated, they are not current for the pupils and the topics they are studying. Year 8 were completing a unit of work on web design and using HTML. They had previously completed a unit of work on data structures, so it may be that the display had not been updated. The use of outdated displays results in learners being unable to position themselves within the subject environment. It reinforces a message that the subject lacks importance.



KS3 Computing Le

	1	2-3
LO1 Understanding	Recalls basic computing knowledge with some accuracy. Identifies the purpose and audience of existing [illegible] Lists the features of [illegible] digital products.	Shows an understanding of computing knowledge they have been provided with. Describes the purpose and audience of existing digital products. Describes the features of existing digital products.
LO2 Planning	Identifies the purpose and audience for the digital product. Outlines a basic idea for the digital product. Lists assets and resources needed to create the product.	Describes the purpose and audience for the digital product. Generates a clear design for the digital product. Describes assets and resources needed to create the product.
LO3 Creating	Sources and creates some assets for use in the digital product. Uses basic tools to create a digital product that meets some of the original requirements. Occasionally saves the work using appropriate file names, formats and folder structures.	Sources and creates a range of assets, preparing some for use in the digital product. Uses a range of standard tools to create a digital product that meets most of the original requirements. Mostly saves work using appropriate file names, formats and folder structures.
LO4 Evaluating	Conducts basic testing of the digital product. Reviews the digital product, listing what worked and what did not, making limited reference back to the original requirements. Identifies improvements that could be made to the final digital product.	Conducts testing of the digital product. Reviews the digital product, explaining what worked and what did not, making reference back to the original requirements. Describes possible improvements that could be made to the final digital product.

Figure 5.29: An enlarged section of the Key Stage 3 display showing the learning outcomes and assessment levels for creating digital products.

The learning outcomes, as used for the ICT National Curriculum (DfE, 2011), are open in nature and not linked to specific disciplinary knowledge. These are on display in the classroom (Figure 5.29). This indicates a weak frame, leaving the curriculum open to the selection and organisation of learning (Bernstein, 1975; 1996; 2000). There is nothing else on display in the classroom to indicate a strong frame. The generalist nature of the learning outcomes weakens the grammar of the subject and leaves the assessment open to a competence-based model (Bernstein, 2000; Ferreira, Morais and Neves, 2011; Barette, 2017).

The pedagogic discourse, particularly at key stage 3, is dominated by a lack of specialist teachers and pupils determining their own pace and selection of learning. This reinforces an indication of a weak subject frame (Morais and Neves, 2011; Bernstein, 2000).

5.8 Case B: Experience of learners

As in case A, learners in this school have the option of GCSE Computer Science or the iMedia qualification. The iMedia learners also completed the European Computing Driving Licence (ECDL) qualification. As a result, they started their iMedia course later and so have limited curriculum time. This school also has a sixth form with learners in years 12 and 13 (aged 16 to 18 years). The sixth form learners were included in the data collection. Their studies fall outside of the National Curriculum; however, small selections of their data have been included where it is relevant to considering subject community and outside influences.

This section begins with an extract from the interviews with key stage 3 learners. These learners have had a mixed experience of non-specialist staff. Computing is now not taught in year 7 and has been replaced with digital art. This was not in place for these learners, some of whom had their teacher leave part way through their year 7 time.

Interviewer: Have you enjoyed your computing topics?
#18: Yes, binary is quite easy.
#15: It's just like maths, really.
#18: Yes
Interviewer: Generally, do you find maths easier than the programming?
#18: Yes.
#15: Yes.
#16: Yes.
Facilitator: Okay.
#18 : Definitely.
Interviewer: Okay, why do you think that is?
#15: Well, I think with maths, you've been doing it since - Well, forever, you've always done maths, and then when you started computing in primary school you didn't really do much. Nothing actually happened. So we've only really had three years of doing, well, computer science. We've only just started computer science, but with maths we've been doing it since reception.
#16: Yes, and we have three lessons a week of maths and we only have one lesson of computing so it's easier because we know more.
Extract from: Interview with Key Stage 3, year 9 learners
Notes: These learners identify some of their learning in computing as part of mathematics and that this aspect of the subject is easier for them than the programming.
The learners consider themselves to have stronger subject knowledge in mathematics due to the prior experiences and having a greater number of lessons in the subject. This also forms part of the discussion for research question 3, the experience of learners.

Figure 5.30: Extract from year 9 pupil interview. Yellow highlights pupil views of links with mathematics, blue indicates perceptions of their own subject knowledge.

The connections with mathematics have been strongly realised by the learners in their computing experiences (Figure 5.30). The mathematics-based topics are the ones they can most remember and have most enjoyed. The learners identify mathematics is a subject that they have studied for longer and so have built subject knowledge over a much longer period of time. The data suggests they have received limited, if any, learning in computing during their primary education.

[we have not done much computer science before this year]
#15: We used to do Kodo, though, in primary school. Did you do that? We did that in Year 7.
#18: What did you say?
#15: Kodu.
#18: Kodu, it sounds familiar.
Interviewer: Yes, it's where you can make a game, isn't it?
#15: Yes, and then do the game. We made a racing game.
#18: Yes, we did that.
#16: Oh yes.
#17: We did that in Year 6.
Female: We didn't really have an IT teacher in Year 7.
#15: We did it about in Year 7, though, didn't we?
#18: No, because Miss yyyyyy left.
#18: And Miss xxxxxx wasn't actually a proper teacher.
#17: No, she didn't know what she was doing.
#18: No, she's an art teacher.
#17: Year 7 was mainly just e-safety.
Extract from: Interview with year 9 learners, #15, #16, #17, #18
Notes: Learners could not recall details of their learning from year 7.
Pupils state this is the first year they have had computer science lessons (they had the HoD for lessons in year 9) but indicate that in year 7 their teacher who left taught IT.
Learners were aware that their teacher did not have the specialism needed to deliver their curriculum. This knowledge weakens their view of their experience in the subject.

Figure 5.31: Extract from year 9 pupil interview. Yellow highlights pupils' recollections of prior learning, purple indicates pupil views of teachers specialism, green highlights pupils' prior experiences of the curriculum.

In trying to recall their prior learning, the pupils remembered a mixed experience in year 7 (Figure 5.31). They did have some recollection of Kodu, but this was not continued due to the teacher leaving. The HoD confirmed this with me during my time in school. They could not replace the teacher who left and so the pupils in year 7 now study digital art. The pupils themselves identify that their experience was not subject specific. Using the word 'just' could imply they view e-safety to be of low-importance, or that they ‘just’ studied that aspect of the curriculum and not other topic areas (Thomson and Hall, 2017).

Kodu, as identified during case A (Figure 5.12), is a package that forms part of the grammar of learning computing. Whilst these learners are able to recall the name of the package, their recollection of the disciplinary learning it facilitated is limited.

The next extract moves to key stage 4 learners. The first interview was with learners following the iMedia course.

#20: Others had to retake it. People didn't really think that it was a real thing, so we just took months doing that, so it took quite a lot of time out. Then we finally got on to it because people still didn't think it was a real course really, it just took forever. So we had to do three things in Year 11 when we should have only really been doing two.

Interviewer: So it added to the pressure. So have you already got your ECDL?

#19: Yes.

Interviewer: Which do you think is better, your ECDL or the iMedia course?

#20: In a way the ECDL because that was things like Microsoft Word, PowerPoint, Excel, so that's better because you can apply that to more but also I guess creative iMedia, it's kind of equal.

#19: I think the creative iMedia course was more tailored to someone specifically wanting to go into that industry, whereas the ECDL was more tailored for anyone, because most jobs you need some basic knowledge of how to use Microsoft applications.

#20: For me, definitely, more the ECDL because I want to go into law. I took this course because I enjoyed it at the time. It's just something that has a bit of a break between the other subjects.

Extract from: Interview with iMedia learners, #19, #20

Notes:

The learners did not see the importance of the qualification at the time. This dictated a slower pace of learning. This indicates a weak frame with pace in the control of the learners but also weak classification with an importance or priority for the qualification not transmitted.

Learners' views of the ECDL reinforce a weak classification, where the learners see the subject as a 'break' between other subjects and a general competency for most jobs rather than leading to a subject specific career.

The ECDL was mainly software focussed, a criticism of the previous ICT curriculum (Royal Society, 2012).

Figure 5.32: Extract from iMedia pupil interview. Green highlights pupil views of qualifications, purple indicates views of the ECDL qualification, yellow highlights pupils' developments of software skills.

The pace and content of the lessons are dictated by the qualifications the learners are following. The learners identify that their peers did not take the subject seriously, which delayed the time they spent on it (Figure 5.32). This suggests the frame of the subject is dominated by the qualifications rather than the teachers or learners themselves (Young and Muller, 2011).

The qualifications do not align with the Computing National Curriculum, which presents a tension within the ORF. Where the qualifications are not GCSE, it seems the learners do not view them as having the same status. This is more apparent in the next extract. Taking two pages, it is an important selection of data where learners outline that they were not fully informed about what the subject involved. This indicates a weak classification and a deviation from the views of the learners as to what the computing curriculum involves.

#20: I feel like this subject in particular [iMedia], because it's not a GCSE as such, it's Cambridge National, there's a lot of - I don't know how to describe it - but there's a lot of feelings against it. I've been told quite a lot that I'm just doing an easy course, that I'm not doing something that is actually it has worth. Apparently I've been told it's not a subject and that sort of thing.

So there's definitely a view against it that it's for people who are a bit less intelligent or who don't really know what they're doing and they just want an easy subject just to course through.

It is easy in some respects but it's also not because obviously the pressure of doing it...

#19: Coursework aspect.

#20: ... And all the written work and everything. So I feel like because it's not a proper GCSE and it is more creative, it's definitely not viewed - by people at our age anyway, I don't know about older people - but people our age definitely don't see it as a proper qualification.

#19: I do agree in that respect because it's somewhat regarded as a sort of cop out.

Interviewer: When you say that people think that, is it people your age, is it teachers, is it parents?

#19: I think people our age, I think people even who took this course may not have been properly informed of what exactly was in it and that if they were, I think that would have affected their decision on whether to take it or not.

#20: I feel like that is different from computer science because computer science is a GCSE and it is a lot more maths science, sort of, focused work.

Interviewer: Do you think if this course was a GCSE, like GCSE art, do you think it would have more recognition?

This extract (Figure 5.33) continues on the next page.

#19: Yes.

#20: I think so, yes. I personally didn't know and still don't really fully know what a Cambridge National is. We were never really explained what it was by the school. It was sort of it's a Cambridge National, you'll be doing coursework sort of thing.

#19: Yes, and like I said, I think further action should be taken to explain what exactly it does and what career paths it does open up, because I don't think that's really explored in great depth at the moment.

Interviewer: When you did your options, what was the information that you were given that made you choose it?

#19: I was told it was more the graphics and animation side. I wasn't really informed of the more multimedia product side.

#20: We just kind of got told you'll make animation in graphics and that sort of stuff. We hadn't been told much about the coursework. I chose it just because I didn't want to do language because I didn't like the languages that they offered here, so I decided that I enjoyed it in Year 9, I got good levels in Year 9, so I thought I'll take this as a subject that I can enjoy more and be a bit of a difference from my other subjects, be more academic.

#19: I think the reasons why I took creative iMedia I could have implemented those into my art GCSE more. So the bits that I enjoy are also relevant in my art course.

Interviewer: So bit of an overlap?

#19: Yes, the stuff that I don't exactly enjoy I could have avoided, if you know what I mean, so I don't think for me it was necessarily that I needed to take this subject. It's just the lack of information.

Extract from: Interview with iMedia learners, #19, #20

Notes:

Learners view iMedia as being distinct from computer science. The identity of iMedia is both in the coursework and assessment methods of the qualification and with the links to art.

They perceive other learners see the subject as having less value, partly due to it not being a full GCSE.

Learners identify that they were not well informed about the course and 'mis-sold' it. One learner identifies the overlap with their art course means they did not really need to study it. This indicates a weak classification for the subject alongside weak insulation between the course and art (Bernstein, 2000).

Figure 5.33: Extract from iMedia pupil interview. Yellow highlights pupil perceptions of the value of the qualifications, purple indicates pupil perceptions of iMedia and GCSE Computer Science, green pupils perceptions of the views of their peers.

The learners discuss the value of the qualification rather than the subject itself (Figure 5.33). They see the skills as useful for their future work in a range of sectors but do not discuss any disciplinary knowledge they feel was required. The learners said they were not well informed about the subject when they selected it. This suggests that there is little continuity between their learning at key stage 3 with that at key stage 4; therefore their knowledge has not been built hierarchically. It is not apparent in the data why the learners switched from one qualification to another, reducing the time they have to complete them, although the learners having more than one qualification will improve the performance data for the school (Leckie and Goldstein, 2017) (see Chapter 2, section 2.1).

In contrast, learners completing the qualification in GCSE Computer Science are much clearer about their subject and are interested in future work within the computing industry, as the next extract shows.

Interviewer – what made you interested in studying computer science at GCSE?
#23: Well, my dad – and my brother especially – they were… Like, my brother took computer science, and my dad – as part of his job – codes computers; so half of my family already knew a lot about coding, and stuff. Like, they know loads about computers, so I felt that it would be… I don't know, more helpful from them if I took something that they could help me with.
Interviewer: Right. I like your thinking there. What about you?
#24: I just enjoyed doing it in the past years. Yes.
Interviewer: So, do you think there are future careers, or further education things, where you're going to use your computer science? Have you got plans?
#24: I don't really want to be a programmer, but I want to do stuff with computers. So, yes, it will probably help.
#23: Definitely with computers, but maybe not so much like… I mean, yes, coding probably, but I don't want my whole job to be just coding all day.
Extract from: Interview with GCSE computer science girls, #23, #24
They are the only 2 females in the GCSE Computer Science class.
Notes: They felt they would like to study Computer Science as members of their family have expertise and so can help at home.
One learner has enjoyed the subject from previous years. Prior enjoyment does not suggest they see their experience at KS3 as detrimental to their continuing study of the subject.
Both are interested in careers using computers. They associate this most with coding/programming but identify they would not like this to be the only part of their work.

Figure 5.34: Extract from GCSE Computer Science pupil interview. Yellow highlights pupil experiences computing outside of school, green indicates prior experiences of the subject, blue highlights pupils aspirations for working in computing related jobs.

One of the learners identifies that they have family at home who are involved in computing and so could help with subject knowledge if required (Figure 5.34). This provides the learner with security in knowing they can receive help with the subject if needed and this influenced their decision to select the subject. This does not indicate a true horizontal discourse as the family members are not selecting and redistributing knowledge; however, they can support where required (Bernstein 1995; 2000).

Both learners identify that computing may be part of their future careers, indicating a strong affinity with the subject. This suggests the learners view the subject as distinct and well insulated, so having a strong classification (Bernstein, 2000; Moore, 2006). Both learners mention coding and programming as part of future work and would not want to do it full time. This mention could indicate that programming is the most dominant aspect of the subject they see having practical application, or they may not be aware of other computing-based careers.

#21: I think that it's quite likely I'll take it in the sixth form, and maybe, in the future, higher education. At the moment, I'm keeping my options open with different subjects, but I'm sure computer science will be very useful in whatever subject-based job I do.

#22: When we do get set homework, and say, it's coding at home, sometimes, when doing that, I can search new things to do and mess around with them, and have a bit of fun.

Interviewer: Yes. What about you?

#21: I sometimes code on a Raspberry Pi I have at home. That's, sometimes, in different languages and stuff to the ones we use in class. The skills sort of intermingle and they're useful both ways.

#21: I just decided that I was going to get one and give it a go, and try running some things on it, and doing some code.

Extract from: Interview with GCSE computer science boys #21, #22

Notes:

They identify that the subject will be useful in their career and that this will be a subject-based job.

Both learners code at home. This is beyond homework and allows them to try different things. Both identify that they are doing this independently.

Figure 5.35: Extract from GCSE Computer Science pupil interview. Yellow highlights pupil aspirations for working in computing, blue highlights pupil experiences of computing outside of school. .

The learners in Figure 5.35 are in the same GCSE Computer Science class as those in the previous Figure 5.34. The learners explain how they build on their knowledge from their lessons with additional, self-directed, activity at home. The lessons have equipped the learners with the knowledge they need to explore the subject further. Whilst they do this independently, they do have the resources to be able to explore the subject. A Raspberry Pi is a small, programmable computer, that was introduced to support the learning of computer science (Kölling, 2016). With the resources and know-how to build their learning at home, this indicates the use of online or self-directed learning (Czerniewicz, 2010). Although the data suggests that this stems from their interest and learning the subject at school and so is not independent of their formal learning (Perotta and Selwyn, 2020).

The next extract is from an interview with year 13 learners in the sixth form studying the Cambridge Nationals Certificate in ICT (OCR, 2019). They also extended their learning beyond their lessons and homework.

> Interviewer: Great, thank you. Now, you've already said that at home you do some sort of coding yourself to try and teach yourself in preparation for university. Is there other stuff that you do outside of lessons around computing, computer science, either as part of your hobbies or additional work or whatever?
>
> #25: I've built two computers in the last five years or so. So that's where my strongest interests really lie with computers. It's components and how they physically work. I haven't done any coding or anything like that before though.
>
> #26: Outside of school I pretty much just help my dad out at his company, because I've been more introduced to the consumer type hardware and stuff that you can buy in the stores. But then the moment I went into my dad's business I'm seeing all the enterprise hardware and stuff. It's sparked my curiosity, I'm just like, "What can I do with this? How can I work with this?" Even learn about it.
>
> #25: Yes, my dad's very interested in all of that as well. He's a - he runs his own business in his office from home and he has multiple computers at home, so I've helped him with those and replacing different parts and things like that. But he's very interested in the sort of technical side of things as well.
>
> Extract from: Interview with year 13 learners, #25 and #26
>
> The learners carry out considerable subject-based learning outside of school and beyond the bounds of the qualification.
>
> Fathers are influential in their interests in computing and their learning of some technical aspects. This indicates some of their learning is via a horizontal discourse (Bernstein, 2000).

Figure 5.36: Extract from year 13 computing student interview. Green highlights student experiences of computing outside of school, yellow highlights students being influenced by family members.

The learners explained that A level Computer Science was not an option available to them and so they are following a course in ICT. They are a small, all male class taught by a specialist teacher for two out of five of their lessons. These learners describe freedom in their choice of coursework projects and software and identify that the qualification is preparing them well for their next stages of education through a level of self-direction and independence (Figure 5.36). They explained they select their own projects, software and scenarios for their coursework indicating a weak frame (Bernstein, 1975; 1996; 2000). One of the learners is going on to study computer science at university and is learning programming in his own time to prepare for the demands of the university course. This requires access to an online course and is independent of their learning in school (Singh, 2014; 2017). The need for this additional learning is necessary for this learner as the school curriculum is not providing continuity and building of knowledge required for undergraduate studies in computer science. Bernstein identifies that subjects with a strong classification are clearly bounded and build hierarchically to university level studies, directly linked to 'knowers' - those who have studied the subject at the highest levels (Bernstein, 2000; Maton 2012).

Overall, the learners in the case B school have broad experiences based on the level at which they are studying, their access to a specialist teacher and the qualifications they are studying. A mixed experience of non-specialist teachers at Key Stage 3 has resulted in learners not all following the curriculum as intended, and so not securing subject knowledge (Ball, 2011). For iMedia learners, they felt they did not receive the information they needed to make an informed choice about the subject they elected to study. This is further tangled by studying two qualifications, one in reduced curriculum time. These learners experienced an over-socialised curriculum model with weak subject boundaries and an emphasis on skills. In contrast, GCSE Computer Science learners experienced a more traditional model with specific subject knowledge and examinations (Bernstein 1975; 1990; 2000; Young and Muller, 2010). Both the GCSE and Level 3 ICT learners carry out further studies or are reassured by expertise away from their taught lessons. Whilst not an exact fit to a model of horizontal discourse, this does extend beyond the vertical discourse where teachers are solely responsible for the recontextualisation of knowledge (Bernstein, 2000). The limited specialist staffing in the department may have contributed to this situation, and this has been a recurring theme in exploring each of the research questions in this case study.

5.9 From findings to analysis

This chapter has outlined the data from both case study schools. The narratives for each of the cases are quite different, although there are similarities. Both schools offer GCSE Computer Science alongside iMedia. Both schools also have small numbers of female learners selecting to choose GCSE Computer Science, with a greater gender balance in their iMedia classes.

In school A, the specialist teachers are disappointed that learners do not have more experience or knowledge from their primary school learning. The mixed experiences result in the teachers beginning at lower levels, and a shortened key stage 3 results in some learners only having two years of studying computing. A high proportion of learners receive free school meals and so financial support at home is limited. Learners are reliant on the school curriculum for their subject knowledge and learning about future opportunities and careers.

Despite a jumble of terminology and legacy names for the subject, the curriculum is clearly defined and there is a shared understanding between learners and teachers as to what is being taught and when. The HoD would like to develop the curriculum further but is restricted by curriculum time and priority given to other subjects. Regardless of this, most learners interviewed, valued the subject, although they are unsure whether to take it to further study or employment.

School B is dominated by a lack of specialist staffing. This situation impacts all aspects of curriculum design and implementation. The learners themselves recognise a lack of specialist teaching in Key Stage 3 and for some this led to them not being fully informed about the curriculum for the iMedia course. Learners following GCSE Computer Science have more positive views of the subject.

Learners engage in the subject outside of their lessons. Whilst this is not an exacting fit for a horizontal discourse model, community influences and independent learning are contributing to the building of knowledge and confidence. From the data, this is most apparent in learners who have selected Computer Science at GCSE or are planning to continue with the subject at university level.

School B is in a more affluent area and has comparatively few learners in receipt of free school meals. These socio-economic factors may contribute to the opportunities for additional activity and support outside school, although this is not explicit in the data and so cannot simply be assumed. A lack of specialist teaching may also increase the need for the additional support from home. Overall, learners in this area are better resourced, including each learner having their own iPad to use across all subjects. That said, their access to teachers with the required subject knowledge is limited.

Following this final, brief summary of the themes from each of the cases, in the next chapter I bring them together to respond to each of the research questions.

Chapter 6: Analysis and Discussion

This chapter draws on the findings to analyse the case studies in relation to the research questions.

6.1 Bringing the case studies together

Having explored the data as separate cases in the previous chapter, for a deeper analysis and discussion I am bringing the case studies together to explore the themes associated with my research questions (Huberman and Miles, 1998). Whilst having the two cases to compare aids my discussion and consideration of the themes, I am considerate of the differences between the two case studies (Stake, 2006). The schools have very different contexts, and their openness has generated rich and honest data (Thomson and Hall, 2017). There are challenges in each of the schools, including limited staffing or reduced curriculum time. These challenges are important for the context of the schools, and they form part of the story as to how the computing curriculum is being experienced in schools.

Whilst similarities and differences are discussed, I am cautious not to identify false causation or make unfounded generalisations (Flyvbjerg, 2010). In several sections of the chapter, the data are presented in tables. Some of the tables have gaps. This indicates an absence in the data, not that there were no occurrences within the school. I do use the data to outline a model and draw some conclusions from the data that would benefit from further research or analysis. These are discussed in section 6.5 and in the concluding chapter.

6.2 Computing as a subject

Research question 1: how is the National Curriculum in Computing viewed by school leaders and teachers?

The first research question requires an exploration as to the level at which school leaders have embraced the National Curriculum in Computing in the subject departments. Whilst the curriculum has been formally changed through the National Curriculum, the acceptance and will of teachers is critical in evoking change within the classroom (Archer, 1995; Erben and Dickenson, 2004). In both cases there is a mix of subject names used either formally or informally by leaders, teachers and learners (ICT, Computer Science, Computing, iMedia, IT, Digital Art). In my initial coding, this became an initial focus, spending a lot of time exploring the data to identify the interplay between the use of the subject names. Whilst this use of names does indicate a weak classification, with teachers and learners not clear of the distinct bounds of the subject, it became a distraction from the transmissions of subject values within each of the schools (Bernstein, 1996). A broad range of names are used for the subject internationally, but most importantly the subject content and prioritisation of the subjects is of more consequence for the learners (Fluck et al, 2016).

A number of Bernsteinian scholars have made use of a scaled instrument to analyse the strength of classification within their data, as outlined in section 3.2.1 (Bernstein, 1975; 2000; Sadovnik, 1995; Moore, 2006; Morais and Neves, 2011). The application of such a scale is subjective to those analysing the data as there is not a precise measure of what makes a strong frame. However, the scale does allow a useful approach to comparing data and categorising similar themes. It is a functional instrument in being able to compare qualitative data in a structured way. This can also be applied to explore the framing of the subject, and this is utilised in section 6.3. The selection of indicators to compare the frame needs to be relevant to the focus of the study, for example, when exploring classrooms at a micro-level, Morais and Neves compared the structure of students' questions (Morais and Neves, 2011). The indicators I have identified are the implementation of the National Curriculum, drawing together the data from the findings that indicate practical actions that have taken place within the department to deliver the curriculum. The second is the teacher views of the curriculum, which includes the heads of department views, with the third indicator being how well they feel supported by senior management within the school. The final indicator is the organisational structures; practical actions taking place in schools to facilitate the National Curriculum in Computing. These are presented in Figures 6.1 and 6.2.

Figure 6.1: Case A - Strength of Classification

Indicators	C++	C+	C-	C- -
Implementation of the National Curriculum Computing (Case A)	"The curriculum provides opportunities for the students to engage in digital literacy, computing skills, programming, so it identifies the need for programming from an earlier stage or earlier age, but I find that it's a stepping stone or a tool to enable staff to then provide that scheme of work that will enable students to overall reach computer science, rather than computing."	"I've slowly filtered out the ICT and tried to make it computing, which I understand is ICT, digital literacy and the computer science element of it." "I find it is working. I think it still needs a little bit more embedding, which I'm seeing happening over time, but yes."		

Indicators	C++	C+	C-	C- -
Teacher views of National Curriculum (Case A)		"From the government down, is computer science, and STEM, and technology, and maths, and engineering. Which is fantastic. I'm not saying we shouldn't have that. But you need the other side as well." "I think that we need to be careful of not going fully computer science. We need to pull along with also having that mix. ICT functional skills, digital literacy."	"We've gone all computer science and forgot about the ICT. I think it needs to be a healthy balance." "I don't think the profile of CS is where it needs to be, there are not many experts in that field in education." "we need to invest more in in it at Key Stage 2." "I think that's where the ICT element needs to come in a little bit more."	"We're going to have children going into jobs that can't use spreadsheets, that can't write a proper letter, that can't use a database or design a database, because they're not taught it, because it's not seen as computer science."

<table>
<tr><th>Indicators</th><th>C++</th><th>C+</th><th>C-</th><th>C- -</th></tr>
<tr><td>Management support (Case A)</td><td></td><td></td><td>“computing needs to be taken a little bit more seriously by schools and SLT.”</td><td>“that was changed for the school benefit, because of the league tables, rather than what was best for the children.”

“But because I wasn’t, I guess, senior enough they didn’t listen to me.” (HoD)</td></tr>
<tr><td>Organisational structures (Case A)</td><td>“The development of CS has been phenomenal because of HoD as a leader in that department.”</td><td>2-year Key Stage 3 delivered by specialist teachers (years 7 and 8).

GCSE Computer Science or iMedia offered for Key Stage 4 (years 9 to 11).</td><td></td><td>“People deciding, “Okay, they’re going to do maths, English, science intervention,” then taking all the time […] Often I’m then expected to stay after school to make up the time.” (HoD)</td></tr>
</table>

Figure 6.2: Case B - Strength of Classification

Indicators	**C++**	**C+**	**C-**	**C- -**
Implementation of the National Curriculum Computing (Case B)		"the sorts of activities we're doing now to try and get them prepared for GCSE."	"It doesn't appeal to all of them. It may be the way we are delivering it, I don't know."	"[IT skills] They've been taken away from us and they've been put over to digital art and things like that." "they feel that it's almost more babysitting. They're not getting the full level of teaching which a specialist would provide. They can see that. It's more just, "Here's the work. Get on with it.""
Teacher views of National Curriculum (Case B)			"I still think the old IT curriculum was more engaging for the majority of the cohort." "you've got to get that engendered into the early years."	

Indicators	C++	C+	C-	C- -
Management support (Case B)				"the idea is to shrink the curriculum rather than try and get other people in." "being part-time and trying to juggle [...] is having a detrimental effect on the provision or the delivery of the computing and ICT."
Organisational structures (Case B)		GCSE Computer Science or ECDL / iMedia offered for Key Stage 4 (years 10-11). Level 3 ICT National qualification offered for Key Stage 5 (years 12 -13).	"One of the maths teachers who has done quite a bit of programming at home is keen to get involved with the computer science area of it." (HoD) "It's shrinking a little bit [curriculum time]. A lot of IT has been removed." (HoD) 2 Year Key Stage 3 (years 8 and 9) delivered by non-specialist teachers.	"It's hard for the school because they can't get the people, that's the trouble." "...but how can we adapt the computing curriculum or take away from the computing curriculum so it fits the staffing that we've actually got?" Not the other way round, not, "Let's put the curriculum time in and then find the staff in order to actually deliver it."

In both cases, the curriculum is being implemented over two years at Key Stage 3, and there is an offer to continue studies at Key Stage 4. The Key Stage 4 offer is categorised as a C+, having a strong classification, especially considering the context that some schools are not offering the subject at all (Kemp, Berry and Wong, 2018). At Key Stage 3 both cases offer a 2-year curriculum model, against the standard model of three years (Ofsted, 2022). The reasons for this differ. In case A, the Key Stage 3 year is given over to extending Key Stage 4. As a result, those that opt for the subject have more time to study the subject in year 9. Those learners that do not opt therefore stop studying the subject earlier than they would in a three-year Key Stage 3 model. This results in a stronger classification for learners who opt compared to those that do not. This is a standard curriculum model for all option-based subjects such as geography or art, but not for science or mathematics where learners study continuously throughout formal education (Firth, 2011).

In case B, the reduction at Key Stage 3 is not by teacher design. It is a pragmatic solution to the shortage of specialist teachers in the school. The learners spend year 7 following digital art, which is not connected with the computing department. Much of their years 7 and 8 is taught by non-specialists. Their experience of this is discussed in more detail in section 6.4; however, it strongly influences their views of the subject. This structure for Key Stage 3 presents a significantly weaker classification in Case B for Key Stage 3 despite the curriculum time for learners being similar. This is strengthened in part at Key Stage 4, with the same options available;

however, strengthening the learner views of a subject after prior poor experience provides an additional challenge for teachers (Daniels, 2006).

Prior experience of learners is identified as a challenge in both cases. Teachers in both schools believe that further investment and improved subject specific teaching is required at Key Stage 2 (primary school, age 7 to 11 years). This is exacerbated in case A where learners are more transient and so their primary experiences are more varied than in case B. The teacher perception is, therefore, that the National Curriculum has been implemented more fully in secondary education than in primary, mirroring studies in the implementation of computing education (Crick, 2017; Royal Society, 2017). The National Curriculum in Computing was introduced in primary education at the same time as secondary. The organisations that support implementation of computing have targeted primary and secondary teachers; however, the levels of penetration vary. Specialist teachers and those teaching computing for most or all of their teaching timetable are most open to the information and training provided (Sentence and Csizmadia, 2017). This indicates individual specialisms, available time and personal commitment to computing influence how open they are to taking on the messages of the ORF (Bernstein, 2000). In case B, it was notable that the high numbers of non-specialist teachers were a priority for the HoD's curriculum thinking, rather than what they believed should be taught and when.

The teacher views of the National Curriculum also indicate the level of acceptance of the messages of the ORF. In case A, the teachers interviewed had thought considerably about the curriculum and how it benefitted their learners. Both teachers discussed the move to computer science and the need for a balance with ICT. This is where the content of the National Curriculum has been interpreted as dominated by computer science with the IT and digital literacy strands not getting much consideration. This may be linked to the reduced curriculum time at Key Stage 3 not allowing all strands to be covered in full, or a priority in preparing learners for GCSE Computer Science, a focus identified in both cases.

From the data, the messages of the ORF are not aligning with those of the teachers in the study. The teachers have specialisms in the field; Bernstein would class them as ‘knowers’ (Bernstein, 1971; 1975). However, their views of the knowledge and skills that learners need do not align with those they perceive are presented to them by the ORF. There is not a shared agreement of the powerful knowledge in the subject (Bernstein, 1975; 1977; Maton, 2012; Young and Muller, 2013). This is diluted further by the qualifications studied at Key Stages 4 and 5. The qualifications do not align with the National Curriculum at Key Stage 3. Computing is the only subject in the National Curriculum without an exacting, corresponding GCSE. (The only exception to this is design and technology, where qualifications cover the same knowledge in design, making and evaluation; however, the materials and skills vary between the qualifications (DfE, 2013)). GCSE Computer Science aligns with one strand of the National Curriculum, whilst iMedia focuses on IT knowledge and skills, including some knowledge of design (OCR, 2018; 2019). GCSE Computer Science narrows the classification of the subject at Key Stage 4, whilst iMedia has weak insulation from other subject areas and links with only some aspects of the IT and digital literacy strands. Continuity issues are similar as learners progress to courses at Key Stage 5. The misalignment and shift in curriculum focus midway through secondary education weakens the classification of the subject for leaders, teachers and learners.

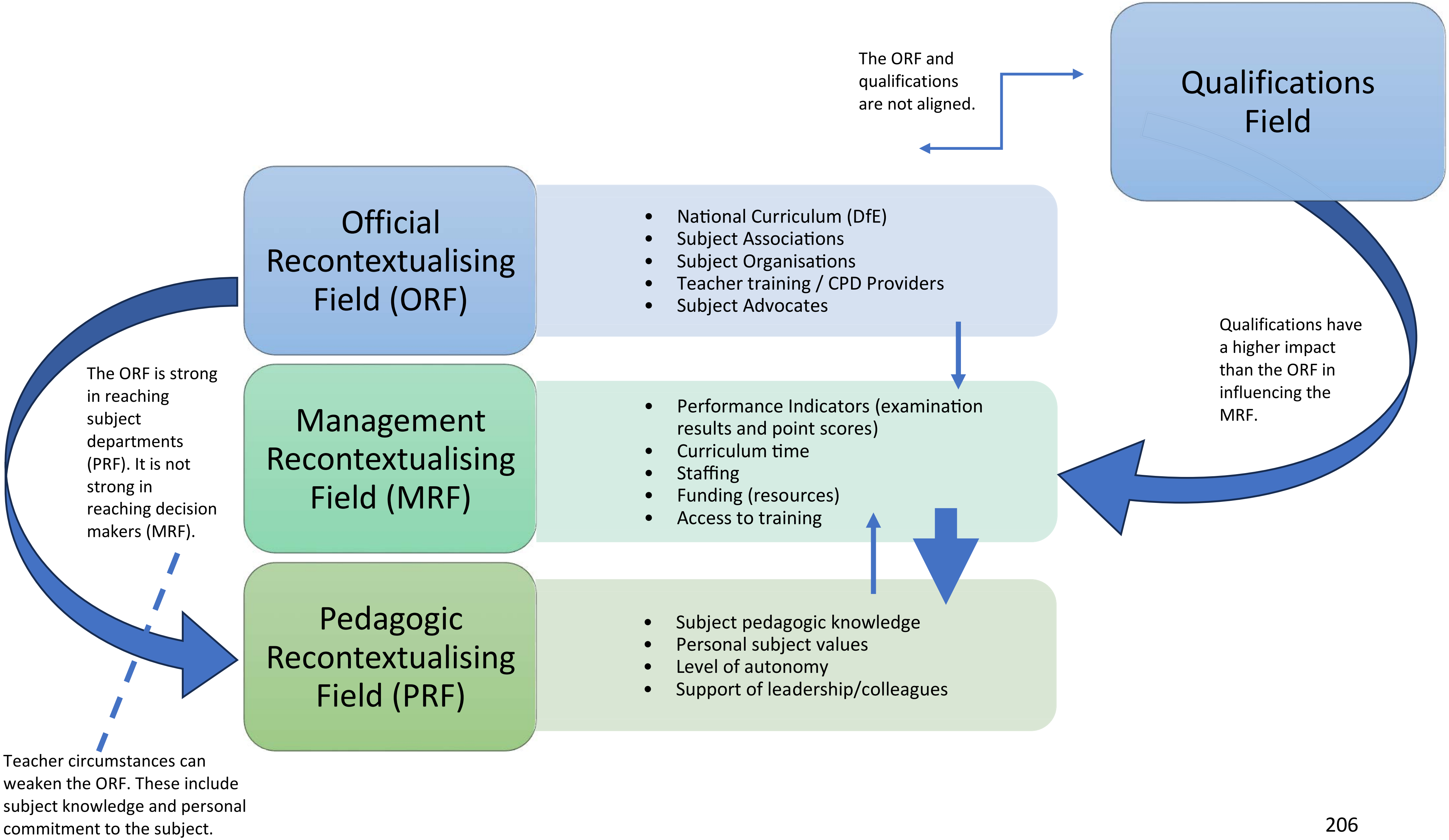
Under Bernstein's definition of the ORF, examination boards would be included in the bounds, as authorities in knowledge (Bernstein, 1975; 2000). In computing, the qualifications provided by examination boards are not bounded by the knowledge identified by the National Curriculum or subject associations, also part of the ORF. The qualification of iMedia has a focus on design and skills, presenting an over-socialised concept of knowledge (Young and Muller, 2010). The qualification weakens the grammar of the subject; for example, the concept and structure of algorithms is not required knowledge (OCR, 2018; Winch, 2023) although this is part of the National Curriculum for learners from age 5 years. The fractures within the ORF weakens the classification of the subject at Key Stage 4, but also at Key Stage 3, as teachers determine how best to prepare learners for their next stages of education. The segregated ORF also gives more credence to teachers' views that they do not view the curriculum as being best for all learners. The lack of unity gives teachers opportunity to question the legitimacy of the ORF bounds of knowledge; for example, a teacher in case A is keen to emphasise the use of databases during their own computer science degree and displeasure that it is not prevalent in the curriculum.

The qualifications have considerable influence over school leaders (Parameshwaran and Thomson, 2015; Leckie and Goldstein, 2017). The HoD in case A identifies curriculum decisions that were made related to performativity of the school rather than what was in the interests of learners. In case B, staffing is a critical issue. Priority for specialist teachers and curriculum time is given to Key Stage 4 qualifications rather than the building of knowledge at Key Stage 3. Whilst senior leaders in school were not involved in the data collection, the heads of department shared their views as to what they saw as the senior leaders priorities for the schools. They indicated senior leaders prioritised securing success in qualifications rather than the disciplinary values presented by the ORF. The teachers identify a lack of investment in staffing as a barrier to successful implementation of the National Curriculum in Computing. The management structures act as a buffer, preventing the full messages of the ORF penetrating through to teachers as they formulate the subject-specific PRF.

Bernstein modelled external influences (e), including qualification authorities, and the influence of internal (i) structures such as teacher values to show the strength of transmission (Bernstein, 1996). The complexity of the model does not fully capture the strength of different external voices, including the political pressure of performativity of schools (Archer, 1995). The openness of the management structures to the ORF is a key feature of the implementation of the curriculum in both case studies. Decisions made at this level, including curriculum time, selection of qualifications and resourcing, produce a level of recontextualisation in themselves. Figure 6.3 outlines a model, based on Bernstein's structures of the ORF and PRF, adding an additional recontextualising field between the two, at the management level of schools (MRF). This outlines the strength of messaging between the fields.

The qualifications sit outside the ORF. The lack of alignment in the bounds of knowledge has resulted in them being separate influences on schools. The strength of the segmented qualifications field is greatest with the MRF, whilst the ORF transmits most directly to the subject leaders and teachers in school. The subject teachers do not make the organisational decisions and their influence on the MRF is limited.

Figure 6.3: A model to show the relationship between the ORF, PRF and MRF



The strength of the classification and the organisational features of the school then impact the way the curriculum is delivered within each of the cases. This takes me on to question 2, exploring the activity within the pedagogic recontextualising field.

6.3 Pedagogic devices and the delivery of computing

My second research question focuses on how teachers are delivering the National Curriculum in Computing in their schools. As already determined, the strength of classification and the influence of qualifications has considerable influence on curriculum time and design, but this section moves beyond that to explore the delivery within the classroom environment.

To explore the interactions within the PRF, Bernstein applies the concept of the 'frame', as outlined in section 3.2.2. Researchers have used this in a similar way to the strength of classification using + and – to compare the strengths and weaknesses within the frame (Singh, 2002; Morais and Neves, 2011; Bosseuk, 2021). The frame explores the precision of and freedom of knowledge and pedagogy within the PRF. I have carried this out for each of the cases, presented in Figures 6.4 and 6.5. As for classification, I have selected my own indicators for exploring the strength of the frame based on the scope of this study (Morais and Neves, 2011).

Figure 6.4: Case A - strength of frame

Indicators	F++	F+	F-	F- -
Vertical knowledge **(Case A)**	“I find Python interesting, they have operators like addition and multiplication I did not know existed in CS.” (year 8) “That’s the programming we’ve been using since I was in year 7.” (GCSE CS) “If it wasn’t for the learning in years 7 and 8 I wouldn’t have the understanding to be able to do CS.” (GCSE CS) When you get used to it (programming) it changes and it gets easier.” (GCSE CS)	“Kodu, I can create my own world.” (year 8) Kodu work (wall display)		“not only did we do CS, we also did a bit of English because we used persuasive language.” (year 8)
Horizontal knowledge **(Case A)**	Instructions for printing follow precise formatting guidance (wall display) Personal learning and thinking skills (wall display)	“binary links to maths […] ethics links to topics such as RE.” (GCSE CS)		

Indicators	F++	F+	F-	F- -
Teacher led learning (instructional discourse) **(Case A)**	"I'm very much a fan of the unplugged theory of them understanding." (HoD) "We might not get onto the computers because we are explaining the work more." (year 8) "Miss lets us do a quick programming dash and see if anybody can do it quicker." (GCSE CS)			

Indicators	F++	F+	F-	F- -
Independent learning **(Case A)**	"We have to apply our CS knowledge to solve problems." (GCSE CS)		"Memory [topic studied]. We go onto YouTube, we type it by ourselves and then we take notes." (GCSE CS)	
Assessment processes **(Case A)**	Learning outcomes and work linked to specific criteria (wall display iMedia) "We had to create the same document over and over again, it was just really long." (iMedia) "now we're coming up to our exam, we're not doing anything else." (iMedia)			

Figure 6.5: Case B - strength of frame

Indicators	**F++**	**F+**	**F-**	**F- -**
Vertical knowledge **(Case B)**	"With the theory side, we have things like pseudo code, which you can be a lot better at if you do the practical coding. So it feels a lot more symbiotic than a lot of subjects." (GCSE CS) "we'll have a theory lesson, and then maybe the next lesson we'll try and use the theory that we've just learnt, and try and use it on actual programming." (GCSE CS)		"We've only just started CS, but with maths we have been doing it since reception." (year 9)	Key words do not align with the curriculum structure or topics being delivered (wall display)
Horizontal knowledge **(Case B)**	"If it's not in a specific lesson, you learn those skills over time in various other lessons." (GCSE CS)		"It was quite maths based. […] I was struggling with maths and didn't want to get into something too maths based." (iMedia)	"I preferred the more artistic approach." (iMedia) "the bits I enjoy are relevant to my art course." (iMedia)

Indicators	F++	F+	F-	F- -
Teacher led learning (instructional discourse) **(Case B)**	"It's taught in a way where if we don't understand something, or any of has struggled with something on a test or a homework, then it's gone back over until we do understand it enough." (GCSE CS)	"There's a lot of going through PowerPoints and noting down what is written, so we can revise for tests and to look back on." (GCSE CS)	"…they need to refocus a bit, because some of them seem quite weak." (teacher)	"they're not getting the full level of teaching which a specialist would provide." (HoD) "she didn't know what she was doing […]. Year 7 was mainly just e-safety." (year 9)
Independent learning **(Case B)**			Learners found alternative solutions to adding images to a website as an alternative to using HTML code (field notes – year8 lesson) "[research using] tech websites, Engadget, BBC News, they do their reporting, the Verge. All these websites. They're reliable and do segments on pretty much all of our topics." (yr 13)	I encourage a lot of independent learning so that they are prepared for the workplace (field notes – year8 teacher comment) "As long as you're getting the work done, it doesn't really matter. You can use whatever you want." (year 13)

Indicators	F++	F+	F-	F- -
Assessment processes **(Case B)**	"It's the only coursework subject I do, so it's more continuous work." (year 13)	"We've got an app that the school has given us which has loads of links to past papers, and it's got all our class PowerPoints on it that we go through in the lessons." (GCSE CS)	KS3 Computing learning outcomes broad without subject knowledge specificity (wall display)	"Others had to retake it. People did not think it was a real thing, so we just took months doing that." (iMedia)

Before discussing the strength of frame within each case, it is important to be reminded that strong and weak frames are not an indicator of success or effective practice, they are an indicator of the level of autonomy within the pedagogic discourse and the balance of power between the transmitters (teachers) and acquirers (learners) (Bernstein, 1971; 1975; Morais and Neves, 2011). For example, in case A, a learner outlines the freedom to use YouTube and make notes to explore one of the topics. Using the indicator of independent learning, this indicates a weak frame (F-), as control has been awarded to the learner, not a reflection of the efficacy of that teaching approach. The activity has not been classed as very weak (F - -) as the teacher has still directed the activity and provided weblinks for the learners to use, so has provided structure. The indicators have been used to compare the data, and as in the strength of classification, it is a subjective process.

In case B, there is a greater level of independent learning, weakening the subject frame as it awards some control of selection of knowledge, resources and pace to the learners. It is commonplace, as learners mature and take on more responsibility for their learning, for teachers to award more freedom and independence (Wolf, 2011). Case A does not have post-16 learners which will be a contributor to a lower presentation of independent learning in the data.

At Key Stage 3, case A presents a much stronger subject frame. Learners can describe building their knowledge and increased familiarity with subject knowledge, especially in programming. The same discourse was reflected in the description of the curriculum from teachers and through the wall displays. In contrast, Key Stage 3 learners in case B were limited in their discussion of learning in the classroom beyond naming topics such as ‘just e-safety’. The term ‘just’ indicates a lack of value placed on their learning. This fits with the narrative of the HoD who identifies the lack of subject specialist staff is hindering the teaching the learners are receiving. The HoD developed a scheme of work and resources for non-specialist teachers to deliver the Key stage 3 curriculum but did not have time to meet with them or provide training to support the delivery of the curriculum.

In case B, during a year 8 lesson visit, an example of a teacher using these materials resulted in learners being directed to an independent learning activity. This could indicate a regulative discourse, where the teacher is placing their own priority, of building learner independence, rather than in instructional discourse with the teacher transmitting subject knowledge (Bernstein, 1971; Edwards 1995). In the classroom activity, the learners were finding their own solutions rather than building the knowledge outlined by the HoD in the intended curriculum. However, the lack of implementation of the intended curriculum may not be a result of the personal values of the teacher, but a lack of confidence from the non-specialist teacher (Ball, Maguire and Braun, 2011). The HoD identifies that non-specialist teachers are not confident in delivering the required subject knowledge. There is no indication in the data that teachers are intentionally not delivering the curriculum as intended, but are hindered by factors beyond their control, including a lack of training.

In case A, learners identify the building of their knowledge vertically in computer science linking from key stage 3 to GCSE. In case B, the data suggest this begins at the GCSE stage. The strands of digital literacy and IT do not feature in the data as building vertical knowledge. This aligns with the model explored in section 6.1, identifying that only the computer science strand of the National Curriculum continues to a matched qualification (DfE, 2013; OCR, 2018). Programming is the particular aspect of the curriculum that dominates a learner's conception of building vertical knowledge. Whilst this is a main element of the curriculum, especially in GCSE Computer Science, authoritative materials targeted at learners from the ORF focus on programming (code.org posters are on display in case A). Learners also describe fun aspects of using memorable tools including Kodu, leading to the text-based programming language of Python (Stolee and Fristoe, 2011). Programming has a strong grammar and this is reflected in the learner's recollections of their learning in the subject (Young and Muller, 2013).

Segmented knowledge has a weaker frame, a weaker grammar and so a weaker instructional discourse (Bernstein, 1975; 2000). The strands of IT and digital literacy do not build hierarchically in the same way as they do in computer science and make up a more segmented body of knowledge (Bernstein, 2000; Moore, 2006). Aspects of these strands progress from Key Stage 3 to Key Stage 4 through the iMedia qualification, for example, the creation of digital artefacts (DfE 2013; OCR, 2018). Neither teachers nor learners identified these increasing with complexity or building knowledge within this aspect of the subject. Totally contrary to increasing complexity, learners in case A described the repetitive nature of creating products as part of their iMedia assessment (OCR, 2018). The Key Stage 3 learning outcomes on display in case B show progression in creating digital products, including building an awareness of audience, the complexity of skills, and planning and evaluating the products. Informally, the HoD identified that these were legacy documents and not relevant to the curriculum the learners were now following. This indicates that the previous ICT curriculum provided a structure by which learners could progress through their understanding, competency and application of skills and knowledge in IT and digital literacy, but this has been detached with the implementation of the National Curriculum in Computing (Juana and Petry, 2016).

Bernstein identifies that subjects with a strong classification have strong levels of communication and collaboration within them (Bernstein, 1971; 1975; 2000). The limited number of specialist staff in case B has limited the internal, subject-specific collaboration. This prevents teachers from working collectively to develop their pedagogic practice, resources and assessment and so has weakened the frame within the school. This is evidenced throughout the case B data, including the legacy wall displays, a lack of time to train staff, and the HoD identifies a lack of monitoring to check the quality of teaching across the subject.

Where the frame is weak across a number of indicators, this results in more variation in the instructional discourse (Creese et al, 2004). This is reflected in case B, with the instructional discourse strongest in GCSE Computer Science where specialist teachers are delivering bounded subject knowledge. It is more varied in other areas, especially at Key Stage 3.

In both cases, the frame is strongest within GCSE Computer Science. It is also strong within the computer science strand of the Key Stage 3 National Curriculum in case A. In these circumstances, the teachers have a strong instructional discourse, the subject is well insulated from other subject areas, and learners identify the knowledge they are building. The frame is weaker in the digital literacy and IT strands of the curriculum. This results in the strands not being viewed equally and connections between the strands are not made. The widest differences in the strength of frame are between the qualification types, with iMedia having a strong structure of assessment requiring learners to create a high number of products, whilst the building of knowledge is not apparent in the data. This links back to the model (Figure 6.3) where the field of qualifications does not align with the ORF. This weakens both the classification and the frame of computing. The next section explores the impact this has on the experience of learners.

6.4 Outcomes for learners

The third research question - what is the perceived impact for learners as a result of the National Curriculum in Computing? - is the final aspect of the discussion. This section least fits to one of Bernstein's models of analysis; however, I draw on themes from his work. This includes an exploration of who influences the learners, both inside and outside school, and how they perceive computing has set them up for future study or employment.

In the absence of a specific tool of analysis to compare the data, I have followed the same structure as the tables used in earlier sections to organise the data. In the tables used in this section (Figures 6.6 and 6.7), the + and – do not indicate a continuum of classification or frame as in previous sections, but they do provide a structure to compare data on the same theme. The selection of the categories (in the first column) is discussed alongside the data. They align with the coding of the data and the themes emerging in the findings (Thomas and Myers, 2015; Saldana, 2016).

Figure 6.6: Case A - student experience

Case A	**++**	**+**	**-**	**- -**
Learner views on computing	"I want something that will actually challenge me." (GCSE CS) "CS is a good subject to learn from." (GCSE CS)		"Lots of girls didn't pick it (CS) as the barrier was set high, their confidence did not match the barrier." (GCSE CS)	"We had to create the same document over and over again. It was really long and I did not like that." (iMedia) "Once I saw work [iMedia], there was a poster, they would annotate it and look at vibrant colours. That wouldn't really get me anywhere […] I know it would have been too easy for me." (GCSE CS)
Learning in the classroom	"When you get used to it, it changes and it gets easier." (GCSE CS) "we practise a lot in CS and I think I'm good." (year 8)	"It's hard for programming, but I can work it out after hard work." (GCSE CS) "If someone is next to you Miss tells you to look at their work." (iMedia)	"I don't know in CS if you get the same support, or it's one of those things you have to learn." (iMedia)	

Case A	++	+	-	- -
Learning outside the classroom				
Computing in their futures	"you can actually get a better future with computers." (GCSE CS) "[it will help my future] to write out my documents, sending emails, knowing what file sizes and types I can send." (iMedia)	When we're learning about topologies, we link that back to how a business may use that network." (GCSE CS)		

Figure 6.7: Case B - student experience

Case B	**++**	**+**	**-**	**- -**
Learner views on computing	"I feel like it's a good difficulty, and that it's often really challenging, but in a way that I feel like I can achieve it. It's taught in a way where if we don't understand something, or any of us has struggled with something on a test or a homework, then it's gone back over until we do understand it enough." (GCSE CS)		"I was struggling with maths [....] I didn't want to get into anything [CS] too maths based." (iMedia)	"there's a lot of feelings against it. I've been told [...] that I'm not doing anything that has worth. I've been told it's not a subject." (iMedia)
Learning in the classroom			"if one of your friends is taking computer science, you're probably more inclined to do it yourself. I have a lot of friends in the computer science class, and if there were a couple more girls in there, there would probably be even more girls in there." (GCSE CS)	

Case B	++	+	-	- -
Learning outside the classroom	"I code on a Raspberry Pi I have at home." (GCSE CS) "I've built two computers in the last five years." (year 13) "I am teaching myself coding at home to prepare for university," (year 13)	"my brother took computer science, and my dad – as part of his job – codes computers; so half of my family already knew a lot about coding, and stuff. Like, they know loads about computers, so I felt that it would be… I don't know, more helpful from them if I took something that they could help me with." (GCSE CS)	"this one is harder; like it requires more work out of school than some of my other subjects, because they're just more difficult to understand on the coding, and stuff." (GCSE CS)	

Case B	**++**	**+**	**-**	**- -**
Computing in their futures	"I preferred the more artistic approach because of the industry I want to go with." (iMedia) "ECDL [will be useful] because I want to go into law." (iMedia) "I don't want to be a programmer but I want to do stuff with computers so yes, it will probably help." (GCSE CS) "I'm sure CS will be very useful in whatever subject-based job I do." (GCSE CS)	"I think the creative iMedia was more tailored to someone specifically wanting to go into that industry, whereas ECDL was more tailored for anyone as most jobs need basic knowledge of how to use Microsoft applications." (iMedia) "I might study it at a further level, or maybe even go on to work at something that includes computer science." (GCSE CS)		"I think people who took this course were not properly informed of what exactly it was." (iMedia) "further action should be taken to explain what exactly it (iMedia] does and what career paths it opens up." (iMedia)

The levels of disadvantage are very different between cases A and B. Case A has a high proportion of learners in receipt of free school meals, whereas the proportion of learners receiving free school meals in case B is well below national average. Whilst this is a measurable indicator of disadvantage, case A also shared additional challenges that some of their learners experienced. These included a high number of transient learners who moved schools several times during their education and a high number of learners where English is not their first language, and in several cases may be their third or fourth. For these learners, English is often not spoken at home so communication with learners' families can be a challenge (stated by the HoD in case A, from field notes). At the time of the data collection, many of their learners they did not have access to digital devices or internet connections at home (Coleman, 2012). In contrast, the HoD in case B reported a stable learner population, attendance at parents' evenings was high and communication between families and school was strong. Most learners spoke English as their first language. Every learner in the school had an iPad. This was through a school-led scheme involving parental contributions and this was supplemented for the most disadvantaged learners, including internet access, removing any digital divide (Eynon, 2009).

These different contexts greatly influenced how teachers directed learners to study outside of lessons. In case A, homework was mainly paper-based, or digital-based homework could be completed at lunchtimes or after school in the computing classrooms. The classrooms were always busy places (from researcher field notes,

Figure 5.25). Case B set homework digitally, and learners at Key Stage 3 did not have any paper-based work. The iPads in lessons allowed them to look at resources, such as detailed help sheets or video guides, alongside carrying out their tasks on the classroom PCs. The learners reported all their revision notes, past papers and resources for their qualification subjects were provided digitally and they could access them at home or anywhere in school. Learners could move between devices and resources with ease (Figure 5.25) (Facer et al, 2001).

In computing, there is a difference in the data indicating that learners from more disadvantaged backgrounds are less likely to select to study the subject beyond Key Stage 3. I did not ask specific details on the numbers of learners in receipt of free school meals selecting different computing qualifications as this involves sensitive information about learner circumstances; however, the proportion of learners overall selecting GCSE Computer Science in case A was higher than in case B. Due to the context of the school, a high number of these will be from lower-socio economic backgrounds. This context is important when applying Bernstein's model of horizontal and vertical discourse.

Bernstein identifies that the reservoir of skills and knowledge is greater in more affluent communities (Bernstein, 1990; 2000). Learners from middle-class backgrounds are also most likely to have experiences beyond the classroom, building their cultural capital (Bourdieu, 2010; Reid, 2020). Learners in case B reported additional activity they were carrying out at home, including one learner who had purchased a Raspberry Pi and was playing with the code. Whilst they said they were not being supported at home to carry out the activity, the educational value must have been understood within the home, and financial support provided. The way the learner described this activity, it was not that it was a formal learning process but more a hobby, akin to creating an artwork, playing a musical instrument or reading novels. This does not align with the Bernsteinian distributive principles within the horizontal discourse' the learners are not being instructed, but are learning through engagement in the process (Bernstein, 2000). However, the community are providing the conditions to facilitate such opportunities for learning, most aligned with cultural capital (Bourdieu, 2010; Paino and Renzulli, 2013; Young and Muller, 2019).

Other learners in case B did present models that would align with a horizontal discourse. One learner was building computers at home, working (and learning) alongside his father within his business (Bernstein, 2000). Another learner described learning programming at home through an online course. Whilst the conditions have been provided within his local community for him to access this, the recontextualisation stems from an online community, potentially an alternative formal institution to his own school, implementing a vertical discourse of building knowledge. In this case, the learner needs both the local community conditions and the online conditions to be in place to facilitate such an opportunity. Bernstein's model does not align with such a process, where both a horizontal and vertical discourse are simultaneously enacted (Czerniewicz, 2010).

The use of online learning presents an insight to the curriculum meeting the needs of learners. The student identified that they needed to learn to program to ensure they were prepared for the start of their university degree. The qualification they were studying did not meet the requirements, so they needed to supplement it with their own studies. This identifies a lag in the ORF, including the qualifications field, responding to developments in the subject. Universities can respond to advancement in the body of knowledge more quickly than the ORF can effect change in schools (Renn, 2000; Bugliarello, 2003). The model (Figure 6.3) identifies that transmission is mainly a top-down process. There is limited opportunity for learners to feedback into the ORF (Apple, 2004). Whilst underpinning concepts remain static in computing, the tools used (such as programming languages) and application of knowledge to new challenges (such as AI) change quite quickly (Fincher and Robins, 2019). Any delays in the transmission from the updated body of knowledge to the ORF to the classroom weakens the frame of the subject (Bernstein, 1975; Sadovnik, 1995). As in the example in case B, learners can find alternative, online sources of learning beyond school, with engagement in online learning growing (Czerniewicz, 2010). Over time, such activity could erode the value learners place on formal qualifications in computing, moving to a model of learners selecting what they learn and when (Singh, 2017; Perotta and Selwyn, 2020).

The data in case A does not present the same experiences of learners carrying out additional activity in the home. This does not mean that it is not taking place, as only a small number of learners took part in each of the studies. The HoD outlined how much additional opportunity they provide in school for learners as they know they do not have opportunities at home. These included after-school lessons and this is where tensions between other subjects appear, with teachers competing for the learners' additional time. Whilst the HoD identifies they have limited opportunities, with so much additionality provided for them in school, it may be that learners do not see a need to learn at home, or that their time is quite limited to do so. The additional opportunities include informal time for all ages to access computers as well as more formal sessions for Key Stage 4 learners. This does provide learners with opportunities to be supported and also have freedom to be discerning in how they spend their time online (within the bounds of the school filtering system). Several learners in case A described computing as fun. What is clear is the HoD acknowledges the needs of disadvantaged learners and works hard to implement them. Due to the school context, that is identified as a priority for all teachers (within school documentation on pupil premium spending) (Maguire, Braun and Ball, 2015; Loughland and Sriprakash, 2016).

A discussion on the use of elaborated and restricted code within the cases is not possible. Researchers who have carried this out have focussed on classroom talk and interactions within the school to explore linguistic codes (Singh, 2002; Ivinson, 2018). I did not formally capture talk at this level; however, I did explore learners' uses of disciplinary language in their descriptions of their learning. Learners in both schools were animated and articulate in describing their computing experiences. The biggest differences were not between the cases, but between the qualifications being studied. Learners studying GCSE Computer Science were able to apply key terms in context and describe the sequencing of their learning. This was most prevalent when they were describing programming, for example, operators, algorithms and pseudocode. Students studying iMedia were most likely to use everyday language to describe their learning although some key terms were used, including file types and sizes. This use of language may be more a result of the demands and content of the qualifications rather than how learners are utilising it;

however, those with most interest and confidence seemed to select GCSE Computer Science, and in both cases this included a higher proportion of male learners (Craig, Lang and Fisher, 2008; Kemp, Wong and Berry, 2019).

Generally, iMedia was regarded less positively than GCSE Computer Science in both cases, for example the repetitive nature of the assessments or it being viewed as having less worth than GCSE. Learners did, however, reflect positively on their future and how the qualification will help them in their work. These learners were all planning to follow non-computing careers such as art or law. Learners following GCSE Computer Science mainly intended to continue study or follow a career related to the subject, although in case A they had limited knowledge as to the range of careers in computing beyond programming. In case B, learners felt they had not received sufficient information to make informed option choices with iMedia. This may be due to their limited access to a specialist teacher in year 9, but this was not explicitly stated. These learners also completed the ECDL contributing to school performance tables (Coe and Sahlgren, 2014; Parameshwaran and Thomson, 2015).

The mixed experiences of qualifications experienced by the learners returns me to the opening discussion in section 6.2. The bounded subject of computing does not continue for learners, which leads to them being misinformed about the content and value of the qualifications or, in the case of GCSE Computer Science, lacking confidence to select it. Learners are keen to dismiss qualifications studied by others based on their levels of confidence, for example, ‘that would be too easy’, or ‘I would struggle with the maths’. The disconnect from Key Stage 3 to 4 weakens the frame of the subject. A subject with a weak frame allows messages from others to permeate, such as parents advocating for a subject or peers saying that a subject is difficult (Bernstein, 2000). In case B, all the learners who described additional activity at home had selected GCSE Computer Science or a Level 3 qualification in IT. Their additional activity may be due to their own personal interest in the subject, or a wider interest from home. If it is the latter, learners without the support at home may be more disinclined to select the subject, especially if their learning in the classroom has a weak frame. This means that where learners are disadvantaged and the subject frame is weak in their computing lessons, they would be far less likely to have the knowledge and confidence to select a subject they perceive to be difficult or beyond their career interests.

6.5 The interconnectedness of research questions

Whilst the structure of the chapter has explored the research questions independently from each other, the links and connections between them have emerged in the discussion. Figure 6.3 is a useful tool to show transmissions between groups within the study.

Specialist teachers have broadly accepted the key messaging from the ORF through the National Curriculum in Computing (Sentence and Caizmadia, 2017). Structural variations within school, including the prior experiences of learners, curriculum time and staffing, vary as to how the National Curriculum is implemented; however, all teachers in the study accepted the messages. Where the messages of the ORF are diluted is through the qualifications field. This has a direct impact on learners. For some learners, they lack confidence to select qualifications, or for others they do not value the qualifications they are studying. This has weakened the strength of frame of the subject experienced by learners in the classroom.

In both cases, the teachers discuss the importance of learners being prepared for their next stages of learning. This involves working from the qualifications backwards in their curriculum design (Coe and Sahlgren, 2014). The qualifications on offer could therefore be having an impact on the curriculum design at Key Stage 3. This presents in the data as a key focus on computer science concepts in readiness for GCSE, with the strands of IT and digital literacy having less prominence. The MRF are focussed on qualifications, so teachers prioritise these in their curriculum thinking and in the allocation of curriculum time and staffing (Apple, 2012). In case A, curriculum time for qualifications was increased and, in case B, specialist staff were placed with examination classes. In case B, this weakened the strength of the frame of the subject at Key Stage 3. For learners with additional challenges, such as special educational needs, English as an additional language or those from disadvantaged backgrounds, they are more susceptible to weaknesses within the curriculum (Arnot and Reay, 2006).

The influence of the ORF and the qualifications field has a direct impact on how learners experience computing within the classroom, not only through the qualifications and curriculum content, but also through structural and pedagogic decisions made as a result of their messages (Bernstein, 1996). The C/F model allows the connectedness to be explored; although this is not a precise model, it allows for the exploration of relationships between transmitters, acquirers and external voices (Bernstein, 1975; 1990; 2000; Illera, 1995). For example, computing in case B has thin insulation and sits within the mathematics department, which weakens the classification. Some teachers are non-specialist which limits the efficacy of their instructional discourse, resulting in a weak frame. In this process, C-F- - is drawn from the data. However, causality cannot be determined. A specialist teacher may also have a limited instructional discourse and it may be a broader reason than the specific subject classification (Morais and Neves, 2006).

The C/F structures allow for an exploration of the variables within the school and the interplay between them. This then provides an insight into the transmission of knowledge and pedagogic processes within the school (Bernstein, 2000).

Chapter 7: Conclusion: Evaluation of the study, reflections and next steps

7.1 Answering the research questions

In exploring the three research questions, it became apparent how the themes interweave and how the data do not sit neatly into separate categories. I will take each question in turn and then explain how strengthened transmissions between the fields of recontextualisation could improve the experience of computing education for learners within the school curriculum.

In the two cases explored, subject specialist teachers are largely receptive to the computing curriculum, they understand why changes were made and are implementing it as best they can with the resources, curriculum time and staffing they have. Teachers did identify that ICT skills are not in the curriculum and that many learners would benefit from these. In the National Curriculum, there is a strand of IT which awards that freedom to teachers to include elements of ICT skills in their curriculum. This identification indicates that teachers have not given equal credence to each of the three strands within the curriculum including computer science, IT and digital literacy. This was also evident in the learners' views of the curriculum. This fracture is linked to qualifications at Key Stages 4 and 5 not aligning to the National Curriculum (DfE, 2013; OCR, 2018).

The ORF presents an unclear picture. Is computing a singular subject in its own right, or a region of knowledge including three subjects of IT, digital literacy and computer science (Bernstein, 2000; Moore, 2006)? Based on the qualifications on offer, curriculum design has tended to give legitimacy to computer science as a singular subject, having higher status than IT and digital literacy. Some teachers feel they need more support for their subject from the ORF to raise the status of the subject amongst leaders.

The second question, how the curriculum is being delivered, is difficult to summarise as curriculum delivery is varied, even within an individual school. Qualifications dominate this aspect of the data, with priority given to examination subjects, including the allocation of specialist staffing and curriculum time. For some learners, this results in them having a weaker experience at Key Stage 3, before qualifications become a main focus. As a consequence, some pupils do not have the underpinning knowledge or confidence to opt for a subject-based qualification, especially GCSE Computer Science, which is perceived by many learners to be more difficult than their other subjects.

The qualifications do not align with the National Curriculum in Computing, resulting in a lack of curriculum continuity for learners. Teachers prioritise readying learners for the start of their qualifications, so this dominates the PRF. The success in qualifications is a main concern for senior leaders within both cases. Teachers deliver qualifications, even if they personally feel they are not best suited or of value for their learners. The focus on qualifications is of greater priority than the messages of the ORF. Figure 6.3 models the current flows and influence between external authorities, school leaders and teachers.

The third research question explores the perceptions of learners in their computing education. Learners have very mixed experiences; however, those who took part in the study were mainly positive about their experiences. Learners studying GCSE

Computer Science were most able to describe the development of their subject knowledge and identify how they might use computing in their futures. However, in both cases, the numbers of pupils opting for GCSE Computer Science was small. In case B, only a very small proportion of learners opted for any type of computing-based qualification. These learners had the most mixed experiences at Key Stage 3, including one year of their computing curriculum being used for ‘digital art’ due to limited availability of specialist staffing. The pedagogic recontextualisation of some non-specialist teachers is weakly classified, leaving learners to use resources to work independently or seek support of peers. Such pedagogic approaches are likely to have greatest negative impact on the most vulnerable learners, where independent learning may be difficult or where they are unable to secure further support from peers or at home.

In both cases, a number of learners followed a course in iMedia. Learners described the qualification in different ways, making connections with art, creativity and digital skills. Some learners explained that they did not know what the subject involved, and others perceived it as having low value. The assessment processes in iMedia dominated the curriculum, with learners identifying frustration with the level of repetitiveness of some of the activities required for assessment. Whilst some learners felt the qualification was useful for their future generalist career ambitions, they did not identify it with a career in computing or the building of specialist knowledge.

What is clear from the study is the interconnectedness of each of the research questions. Any decisions made within the ORF or the qualifications field are being realised within the classroom. Organisational structures including curriculum time, training for staff and selections of qualifications have the greatest influence on how learners experience the curriculum. Organisational decisions are not made by the computing teachers themselves, and, in both cases, there was a sense of frustration at the lack of status given to the subject. To improve the experience of learners, the messages from the ORF need to permeate the senior leaders within school.

7.2 The contributions to knowledge

Making use of Bernsteinian models to explore computing as a subject does not seem to feature in any other studies. Whilst I have found it useful to consider studies in other subject areas such as music and science (Moore, 2006; Morais and Neves, 2010), the application to computing has required a different approach, particularly in identifying the strength of classification. The timing of the study, following the changes in the computing curriculum, has implications for the application of Bernstein's models. Where the models have been applied elsewhere, the curriculum subjects have been more established and present in schools for much longer periods of time (Bernstein, 2000). Due to a range of factors, including a lack of specialist staffing, computing does not have a consistently strong classification within the two case studies. This is despite the national introduction of the computing curriculum designed to strengthen the standing and clarity of the subject compared to the predecessor, ICT.

The process of recontextualisation has significant influence over the strength of the frame of computing. Focus has been placed on training teachers to build their subject knowledge and confidence to try to establish greater commitment to the teaching of computing. The source of such support and information has stemmed from the official recontextualising field (ORF). However, as illustrated in Figure 6.3, there is an additional layer of the recontextualisation process, the management recontextualising field (MRF). This has not been added to the Bernstein model of recontextualisation before; however, the data in this study have identified that this layer has significant influence over how the curriculum is prioritised in schools. The misalignment of the qualifications field (Figure 6.3) with the ORF also has influence over how the subject is taught in schools. Due to the current, performative nature of education in England, the MRF are influenced considerably by the availability and difficulty of qualifications for their learners (Braun et al, 2010). The updated model I have created may be relevant for subjects beyond computing, especially where the decisions made by senior leaders in school are impacted by the relevance and achievability of qualifications and other factors such as budgetary limitations or lack of specialist staffing. This updated model better reflects some of the influences over the pedagogic recontextualising field (PRF), including the autonomy of school leaders to make funding and curriculum decisions, than when the model was first created (Bernstein and Solomon, 1999).

7.3 Implications of the study

7.3.1 Implications for policy makers

The case studies reveal that the computing curriculum has not been consistently implemented as policy makers intend. Partial causes of this have already been identified, such as a lack of specialist staffing (The Royal Society, 2017). However, the influences of, and by, the management recontextualisation field (MRF) may not have been fully realised. The MRF are considerably influenced by the qualifications field. The qualifications field does not align with the curriculum presented by the official recontextualisation field (ORF). Policy makers should ensure that the qualifications field and the ORF align so that the MRF does not have to ‘choose’ between teaching the intended curriculum and securing the best examination outcomes for their learners. Leaders making decisions in school are more influenced by the immediacy of qualifications and attainment than by other curriculum drivers such as future earning potential of learners or skills gaps in industry. Policy makers should also continue to support school leaders in addressing barriers to implementing the computing curriculum well, such as training for teachers and learner access to technology.

7.3.2 Implications for practitioners

In this study, practitioners are the teachers of computing and the heads of department. I do not use the term specialist, as some of the teachers may not have a computing background but are required to teach computing within their schools. With the current specialist staff shortages, non-specialist staff have a crucial role within delivering computing (Royal Society, 2017). All staff, including those labelled as non-specialist, are an integral part of the PRF. Without support, such as time for training, the messages of the ORF are diluted through a lack of staff confidence, expertise or motivation. This weakens the strength of the classification of computing as a subject.

Subject teachers need further support to raise the status of computing within their schools. One teacher identified a lack of authoritative voices in the subject and so leaders, teachers and learners are not hearing about the relevance of computing. The ORF should find a way of listening to the voices of teachers and learners (Bernstein and Solomon, 1999). Teachers want to be able to contribute to the ORF and also hear voices of those they know understand the subject from a school context, not just the subject in industry or higher education. This will provide teachers with some agency and a sense of ownership and legitimacy of their curriculum, rather than being beholden to qualification specifications (Apple, 2002).

For practitioners, an explorative approach to identifying the strength of classification within their own school is useful. How is the subject viewed by staff and learners? This may then identify ways that the subject classification can be strengthened and may result in increased ‘buy-in’ from learners and staff (Brosseuk, 2021). Such actions following an exploration may include minor changes such as updating classroom displays, but may require significant resource such as staff training or increased curriculum time.

A personal reflection for practitioners is also a useful process. What do they personally value within the subject? Have they accepted the messages of the ORF or do their own views and values align with a different curriculum view? Do their own views and values align with those of the MRF within their school? This process of self-reflection may help practitioners in schools to understand where there may be tensions within their subject. They can explore how they recontextualise the subject in their own teaching practice and the resulting experience for learners (Bernstein, 2000).

7.3.3 Implications for senior leaders in schools

Senior leaders in schools are the critical central connection in the updated model of recontextualisation (Figure 6.3). Practitioners in the case study schools perceived the senior leaders to be most influenced by the qualifications field, ensuring that the learners achieved the highest attainment in qualifications as they could. This creates a tension as the qualifications do not fully align with what computing practitioners are being required to do as outlined by the ORF. As a result, some practitioners may be unclear about what is required of them and this weakens the strength of classification and the framing of the subject (Morais and Neves, 2010). Such misalignment may result in mixed experiences for learners, for example, practitioners may not be building well on learners' prior knowledge as they are not clear as to what learners have already studied in the subject. Senior leaders could take the opportunity to discuss with practitioners what their values are and explore how these manifest in the ORF. Senior leaders may be able to support their practitioners to navigate the tensions within the messaging about the curriculum and qualifications and find common ground. Where the MRF and ORF are aligned, the subject will have a stronger classification and leadership decisions will be understood by practitioners (Marsh, 2007).

The MRF model (Figure 6.3) also shows that practitioner voice to carry influence over the ORF is not strong. Senior leaders in school could support their practitioners by providing a voice back to the ORF to indicate where tensions and misalignment cause challenges for practitioners. As a priority, senior leaders may want to highlight the lack of alignment between the Computing National Curriculum and the qualifications field.

Many of the challenges identified within the cases align with those identified in the 'After the reboot' report (Royal Society, 2017). These include training for staff and a review of the qualifications on offer. These recommendations are still relevant and should be prioritised; however, my recommendations focus more on messaging and discourse within the subject.

7.3.4 Implications for policy makers

In the original model developed by Bernstein, policy makers are an integral part of the ORF (Bernstein, 1971; 1975; 2000). The policies are critical in the messaging from the ORF as to what practitioners should be teaching within their classrooms. Within both cases in this study, the messaging from the ORF is not singular. The computing subject curriculum is clear, as outlined in the National Curriculum. However, the qualifications do not align with the curriculum. School leaders are required to focus on the attainment and qualifications of learners in order to meet progress and attainment measures, also being demanded from the ORF. This results in contradictory messaging from the ORF and weakens the strength of classification of computing as a subject.

To further strengthen the ORF, the National Curriculum and qualifications need to align. This will allow teachers, parents and learners to see the progress through the subject and build confidence in the subject over a longer period of time. When the curriculum aligns with qualifications, the subject is more likely to be prioritised by school leaders at all key stages. The management recontextualisation field (Figure 6.3) makes most decisions about staffing and curriculum time. In my experience in working with schools, this can be more evident in Multi-Academy Trusts where they may even have centralised curriculum models. To improve the experience of learners within the subject, it is important that the MRF are presented with clear disciplinary messages from the ORF.

7.4 Recommendations for further research

Within computing education, further research should explore the pedagogic discourse of the subject within different schools, especially from the perspective of under-represented groups. Much noble work is taking place to encourage learners from different backgrounds, including disadvantaged learners and female students, to encourage them to engage with the subject (Hamer et al, 2023). Exploration of the pedagogic processes occurring in school may reveal different approaches are required. For example, where the subject has a weak classification and learners view that they need to be good at mathematics or art to engage in computing, could alternative messaging improve learner attitudes towards the subject? In schools where there is a weak frame at Key Stage 3, requiring learners to undertake high levels of independent study, they may not have the underpinning knowledge or confidence to select the subject for further study. Addressing the pedagogic discourse may prove more impactful than other additional activity that is taking place.

Whilst Bernstein's development on the strength of classification and framing of subjects was highly pertinent to this study, the analysis of data did not fully align with Bernstein's model of ORF and PRF (Singh and Kwok, 2023). The changing nature of education, resulting in increased performativity and pressures on management to allocate resource such as staffing and curriculum time (Ball, Maguire and Braun, 2012), have increased the complexity of the enactment of intentions stemming from the ORF. I have attempted to capture the nature of such new relationships through the addition of the MRF (see Figure 6.3). This model of the ORF, MRF and PRF has not been explored beyond the two cases within this study. Further research using this model would determine the validity of the suggested relationships between the ORF, MRF and PRF. The application of the model could also be used to explore different curriculum subjects, for example, does the MRF have such influence where subjects are longer established and have stronger classification?

The schools in this study are both based in England, where attainment measures and school monitoring are prevalent (Ball, 2016). An international comparison of computing as a subject, using a Bernsteinian lens of classification, may present an alternative approach to comparing the implementation of the subject. For example, does a country with less emphasis on formal qualifications result in teachers having more autonomy in the PRF? As a result of greater autonomy, does this then lead to a stronger classification of the subject with teachers identifying closely with the subject and working collaboratively to develop it? Or, do the messages of the ORF permeate school classrooms more strongly where qualifications and attainment measures are used as a driver for change (Apple, 2012)? Whilst previously not used widely within computing education research, Bernstein's models provide a thought provoking lens by which to build a greater understanding of the subject specific development of computing.

7.5 Reflections on the research process

Application of Bernstein's work has been challenging yet insightful. Other researchers have not used it in the same way to explore the implementation of a full curriculum subject; however, I have learned and borrowed from many different research papers along the way. The journey through the process has been turbulent. In some cases, the discovery of a research paper provided a real insight into the underpinning theory and I was able to return to Bernstein's original writing with a renewed way of approaching it. This created a constant forwards and backwards movement to revisiting his work. I still understand only a fraction of Bernstein's work; however, I enjoy the intellectual challenge of exploring his models and consider how they might be applied in current contexts (Sadovnik, 1995).

My initial scope, to apply the framework of Bernstein to the implementation and outcomes of the whole curriculum was, I now realise, far beyond my capabilities. Instead, as with other researchers, I have been selective in the application with a real focus on the classification and framing of the subject and the implications of such on the pedagogic discourse. The weaknesses of the C/F model outlined by Illera are not unfounded (Illera, 1995). Illera outlines the openness in the selection of the behaviours or interactions, against the subjective nature of allocating +/- values, resulting in an unending range of C/F configurations and so would be highly problematic if used as a real rather than a descriptive strategy (Illera, 1995, p 202). The limitations of the C/F model were exacerbated in my own process of data collection. Prior to the data collection, I had not fully considered how I would explore the relationships between the data using the C/F model. I therefore did not always streamline my data, for example, I might interview one group of learners yet visit the lesson of another. This was partly due to timetable restrictions; however, I was naïve in not having a clear view of how I wanted to analyse the data before collecting it.

As a tool, I have found the C/F lens useful in providing a framework for exploring data. It also provides the promise of being applied to further research to explore relationships within the classification and framing of computing in different school contexts (Morais and Neves, 2010).

The frameworks of Bernstein have not fully aligned with some of my findings, for example, the model of horizontal and vertical discourse. Beyond the scope of the model, the consideration of how and why the data do not fit has been a stimulating process and, out of necessity, has taken my thinking beyond that required if the data aligned with the model (Moore, 1996). Whilst there are limitations to the application of Bernstein's theories to my research, I know I have barely scratched the surface of his body of work and I am open to continuing to build my epistemological thinking through a Bernsteinian lens (Muller, 1995; Sadovnik, 1996).

My visits into schools as a researcher were thoroughly enjoyable, whilst also insightful. It is the first time I have spent considerable time in a school without a professional duty. The participants were open and honest and spoke at length in response to any questions. I built positive relationships and was able to negotiate conversations in a personable yet focussed way (Stake, 1995). The biggest challenge was to switch off from my professional role. Whilst collecting data, I had to resist the urge to share, or advise, or even step in during some lessons. For most of the time, I was able to keep to that role, although my own field notes reveal where I did join in with some lessons (Thomson and Hall, 2017).

Whilst, in the main, I managed to distance myself in the process of the data collection, my professional understanding and values cannot be ignored (Biesta, Priestly and Robinson, 2015). My professional work provides me with the insights, anecdotes and provocation to explore issues further. I will continue to use my professional role to consider and inform the directions for my research, although I need to know when it is appropriate to step back from my day-to-day work into the role of a researcher (Thomson and Hall, 2017).

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Appendix 1: Published paper, From part 1 of EdD.

Using images as a stimulus to explore the identity of student teachers in computing

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Abstract. The computing curriculum in English secondary education is now officially in its second year of implementation. A new, specialist group of student teachers are being trained to be able to deliver the new, rigorous computing curriculum. In this emerging curriculum area, it is essential teachers explore their own identity, beliefs and values in order to deliver effectively and ensure enjoyment for both themselves and the pupils they teach. In this study, the student teachers engage with images and place them in a hierarchy to stimulate honest discussion and exploration of computing teacher identity. Whilst the student teachers resonate with approaches in the classroom, such as group work, engagement with the computing curriculum topics themselves are limited and show an area which may require more attention and challenge in the computing teacher training programme**.**

Keywords: Computing education, ICT education, student teachers, ITE, images, diamond 9, teacher identity.

1 Introduction

The National Curriculum in England has undergone a significant shift; from September 2014 ICT education was withdrawn and replaced with computing [6]. As a result, Initial Teacher Education (ITE) courses have been updated to reflect the requirement for new, specialist teachers to enter the profession. Secondary trainee teachers in England now follow courses in ‘Computing’ or ‘Computing with [Information and Communication Technologies] ICT’. The courses attract a range of graduate applicants, some direct from computing-related degree courses and others from industry and computer-related employment. For some applicants their computing subject knowledge is broad and in sufficient depth to teach to the highest levels, others may have more specialist backgrounds and so need to follow a computing subject knowledge enhancement course prior to teacher training. The opportunity to teach the ‘new’ subject attracted 878 students in England between 2013 and 2015 [5]. The availability of bursaries to support career change and the availability of subject knowledge enhancement courses has brought in a wide range of students, differing in age, background and expectations. Added to the eclectic mix of students are a range of school-based mentors, many of whom are not computing specialists themselves but may have been teaching an ICT-based curriculum for considerable time. Those that are computing specialists may have found themselves teaching mathematics or more science-based subjects so the opportunity to engage with their specialism is also a new experience. Although a rapidly developing area, finding trainee teachers an experienced school-based mentor who is a computing specialist is a challenge.

The context of change and curriculum reform adds an additional layer of complexity for trainee computing teachers. Developing an identity as a teacher, whilst a changeable and evolving process, is crucial as part of any ITE where students are given the opportunity to explore their values and beliefs, how they are learning and the context in which they will work; a process of becoming [1]. The computing trainees may well receive mixed messages from mentors, university tutors, the media and pupils themselves. All those involved in the curriculum change will also be identifying their own role and position within it so therefore, whilst thinking primarily of their own position, the trainees are also subject to mixed rhetoric from those around them. Exploring identity within this context is therefore more crucial yet more challenging than for many other subject areas at this time.

2 Exploring identity

2.1 The importance of identity construction

Studies have found supporting teachers in the exploration of their identity has allowed teachers to 'grow in service to students', develop better teaching, renew practice and ultimately enjoy the role [8, 10]. Leuhmann prioritised 'recognition work' with student science teachers in order to provide opportunities for the student teachers to explore their identity through personal reflection and exploratory processes such as keeping journals and engaging in discussion. The methods of exploring teacher identity vary in nature but are similar in aim, in order to identify external influences (including prior experience and own education), professional factors, personal factors and uncovering a set of values, beliefs and goals held by the teacher [12].

Ni and Guzdial [12] carried out a study exclusively with teachers of computer science in the United States of America (USA). They found varied identities, with particular differences in motivation and confidence with the subject of computer science. Respondents in the survey very much attached themselves to labels such as programming, computer science and the complexities of the subject. With the current government rhetoric in England there is a danger of current student teachers in computing finding themselves attached to the lexicon rather than the underlying values and priorities they have as computing teachers. There is a drive for computing to portray itself as having far more academic rigour and challenge than its predecessor, ICT, and current student teachers are very much part of this emerging landscape [14].

Assessment practices are also developing. The national qualifications in England taken by school pupils at age 16 years now require 80% of assessment to be completed through written examinations. This results in very little of the two-year course being practical requiring 'project based' computing solutions. For student teachers this may be at odds with their own experience in industry before training to be teachers or in their own personal experience of being engaged in the 'maker movement' or 'hackerthon' type events. In these, constructivism is very much favoured with participants 'playing' and exploring to discover new learning [9].

Support during the teacher training course and in negotiating a path through the range of conflicting influences, terminology and rhetoric is provided by school-based mentors. School-based mentors help shape the teacher the student becomes through the communication of classroom practice-based values that the student may then receive or reject. At the same time, the students will need to feel valued by their mentors in order to feel self-worth in their development as teachers [17]. Where the student teachers may have greater subject knowledge than their mentors this may add complexity to how mentors support the development of student teacher identity. Subject knowledge may become less of a priority for the students or could even lead to them devaluing the beliefs and advice of the mentors and so seek values from alternative sources.

2.2 Image as a provocation

In an attempt to break away from the lexicon of the emerging computing curriculum, a visual approach to exploring identity is being taken. The theoretical frameworks for this study are varied yet interwoven. The study draws on identity theory and on semiology; how is identity portrayed or interpreted? The study also 'borrows' from art theorists. This section outlines the frameworks that are drawn upon in this study but also explores the overlaps within the fields.

Foucault considers a painting of a pipe, which features a blackboard stating 'this is not a pipe' within the image, depicting yet another pipe. The reading of this image by Foucault outlines a number of ambiguities [7]. The discussion extends for some time and raises a number of questions about the painting. What is clearly illustrated is the non-relation, or the very complex relation between the painting and its title. The intention of the artist, Magritte, is to challenge the viewer of the image and focus their attention on the very act of naming. The tension between the naming of the painting and the objects portrayed, resemblance and affirmation, is where the viewers (or 'reader' of the image) are forced to think, to devise meaning and consider their own view. Without the text, the painting would be accepted by most as a representation of a pipe.

The tension that can be created through visual representation and opposing text can also be initiated through contradictory images. In an attempt to move away from lexicon, the same tensions can be developed and so similar commitment from the 'reader' is required. Two images are presented, using the anchorage 'pupils at work'; firstly an image of children sitting in rows, working on paper without evident speech or movement; secondly, a small group of children clearly talking and focussed on a central resource. A choice needs to be made, which one is most representative of 'pupils at work'. For this to happen, as a reader of the images, you would need to draw on your own experiences, your understanding of 'work' and which image most resonates. The comparative process aids the reader, not only to view the image, but consider their own position and so new understanding of it.

There is a concern that this process of comparing and selecting images is simplistic and limited in scope. The images may be isotopic in nature so the comparison becomes superficial, a tangle of words and images with little contradiction to sustain a purposeful discourse [7, 11]. However, within this process of comparing images, the multiplicity of layers and 'readings' on an image adds further value and legitimacy to the method. Even the most naive of images (produced without intention or message, if this is indeed possible) will convey characteristics of a message; even if not substantial these will be relational in some way to the 'reader' [2]. Without applying their own experience and prior understanding to the reading, signs would not be understood and the image would be unintelligible to the reader. Each reading of an image is therefore individual, based on experience and understanding, so in exploring one's own readings of signs, a consideration of one's own experience, beliefs and identity will be required.

3 Methodology

The study involved 40 trainee computing teachers from two different cohorts between September 2014 and December 2015. The students worked in pairs to discuss, respond and reflect on the process.

3.1 The images

Participants were given 18 images and requested to select only 9 to feature in their completed diagram. This first part of the process required the trainee teachers to act as 'readers' of the images. They discussed what each of the images meant to them and agreed half of the images to be discarded. They were instructed to keep the 9 that most resonated with them as teachers of computing. By working in pairs, the students were required to articulate their view of each image and come to a consensus as to which images are given priority.

The images selected for the process were varied in nature and included a selection of photographs from classroom situations, topics delivered within ICT or computing classrooms, and pupil work. Each image was numbered for purposes of analysis but these were allocated randomly. The students were given the images as a shuffled pile of cards. The students were given no further information on what the images depicted, although they were much larger than the examples presented below. Students were asked to annotate, wherever appropriate, to provide an insight into their reading or positioning of the image. A copy of all images is available online [18].

	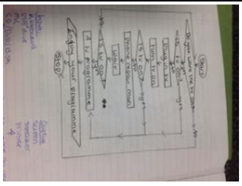	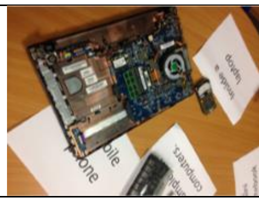
Image 4	Image 2	Image 3
		
Image 9	Image 6	Image 10

Figure 1: Examples of images from the study

Depicting pupil activity within learning settings (Figure 1):

- **Image 4** is a view of a typical examination setting. All English national computing qualifications will require 80% assessment through a written examination.

- **Image 9** is a pupil connecting a MakeyMakey with Scratch running on screen.

Depicting pupil work in computing or ICT lessons:

- **Image 2** shows a hand-drawn flow chart.

- **Image 6** shows a pupil working on a tablet, in this case using the Beebot application.

Depicting classroom display or on-screen presentation of pupil work from computing and ICT lessons:

- **Image 3** shows two separate pieces of hardware along with moveable printed labels.

- **Image 10** is a hand-drawn poster depicting 'Internet Safety Girl'.

Following the discussion and selection of an agreed 9 images, the students were given a 'Diamond 9' shape as shown in Figure 2. They were requested to place their images within the hierarchical structure, the most important being at the top of the diamond and the least at the base. This time, rather than just being 'readers' of images, the students were required to draw on their beliefs, values and classroom practice to prioritise images. This process has been used successfully to develop discussion and identify tacit thoughts of abstract concepts, particularly with school age children [3, 13].

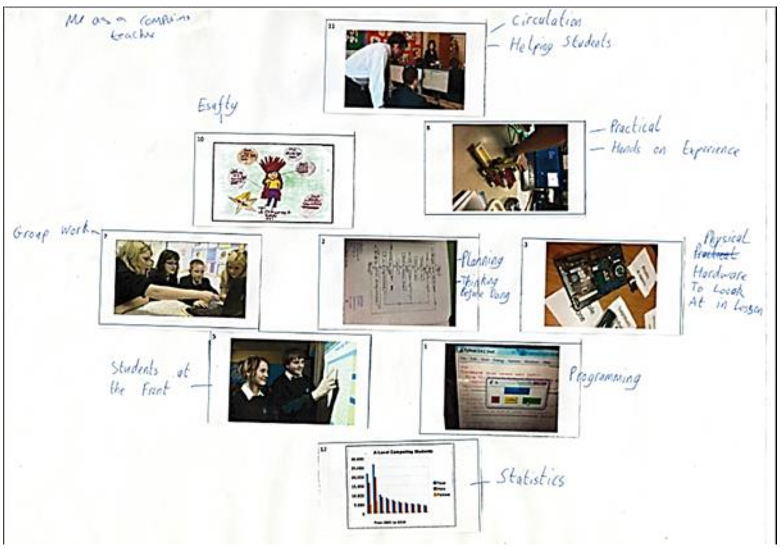

Figure 2: An example of a completed Diamond 9

4 Results and findings

Approaches to analysis of the data are three-fold. The first two make use of a basic statistical analysis to identify patterns and trends in the selection and placement of the data. The first looks at the overall usage of each image using a weighted score dependent on the position anywhere within the Diamond (Figure 3).

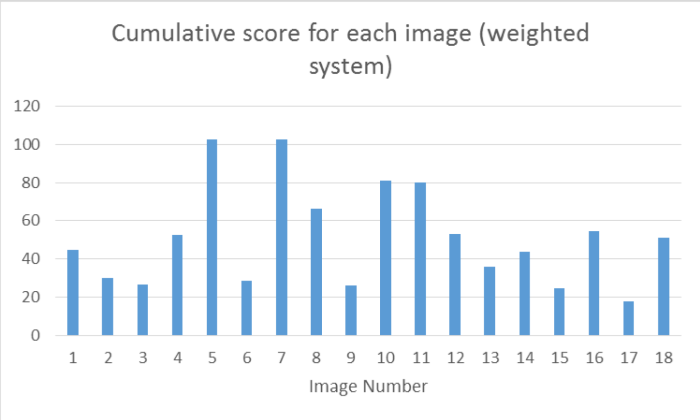

Figure 3: Summary data showing weighted scores for each image based on overall use within the Diamond 9

The second simply identifies the images most commonly used in the top 3 rows of the diamond formation (Figure 4). Thirdly the Diamond 9 responses are compared to consider the annotation added by the participants.

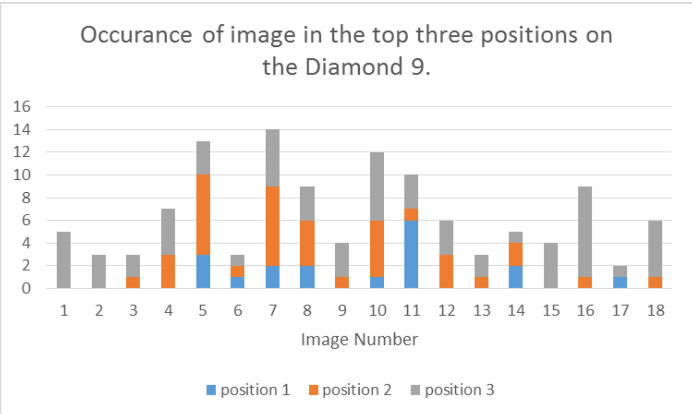

Figure 4: Summary data showing frequency of images used in the top three positions within the Diamond 9

Images 5 and 7 are most prevalent in their use within the diamonds. One depicts pupils clearly conversing and working together around a laptop. It is labelled throughout the responses with appropriate ‘buzz words’ (for example, Figure 5). These are terms that currently feature prominently across much teacher training and development across all curriculum areas. These descriptors include ‘peer learning’, ‘group work’, ‘interactive learning’, ‘learning by doing’, ‘active learning’ and ‘experimental learning’. Also featuring highly are practical work, pupil-led learning and teacher support.

Figure 5: Annotated image 7 labelled as group work, peer teaching and active learning

Image 10 also featured strongly throughout many of the diamonds. Interestingly, it is one of the few images that does not depict a computer or some aspect of specific computing subject knowledge. The image portrays a hand-drawn 'super hero girl' who knows how to stay safe online. The annotations (Figure 6) mainly feature an 'e-safety' label, never alluding to a reading of the image other than the safety message. The trainees are reading this image as the pupil illustrator intended and have held fast to the message. They have identified safeguarding as being one of their top-most priorities as a teacher, the need to protect and even nurture the pupils in their use of the internet. This notion of the caring nature of the role resonates strongly with some of the findings Walkerdine identified from her own exploration of teacher identity [16].

Figure 6: Annotated Internet Safety Girl

Interestingly, code, assessment and curriculum seldom featured or were placed in low positions on the Diamond. Where they were included the annotation was very basic, often including straightforward terms such as 'programming' and 'coding'. Very few of the wider terms and content featured in the National Curriculum Computing document were included in any of the annotation and images that may have suggested these were placed very low in the hierarchy or not featured. These omissions are the terms most associated with current 'measures' of the English computing education through Ofsted and government-led computing curriculum rhetoric. What was clearly apparent, however, was the rejection of 'ICT' both as a curriculum subject and in the wider context. Only one image displayed use of a mobile device and there is a clear dislike for traditional ICT-type tasks such as the annotated database shown in Figure 7.

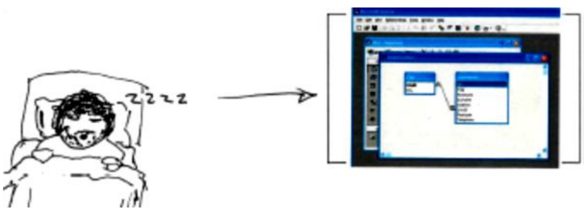

Figure 7: Database structure with student annotation

The student teachers were also asked to note any omissions they felt they were unable to represent from the images with which they were provided. Not all felt the need to take this opportunity; however, some were listed: cross curricular, inclusion, marking, differentiation, behaviour, class discussions and the internet. It is interesting how this list features some of the more challenging aspects of teaching and yet none of the images have been annotated in a way to suggest they have been 'read' as a negative feature of teaching as a profession. This is due to the nature of the study with student teachers being asked to prioritise and look at importance. This suggests the process may lend itself to being used in different ways, for example, specifically addressing curriculum design or teacher challenges.

One of the most revealing aspects of this research process was the participant response. The trainee teachers fully engaged with the process and were fascinated by the outcome, both their own and those of others. Following the task they requested to look at each other's work and discussed and justified their own decision making process. It also allowed university-based teacher educators to have a greater understanding of the student teacher identity and support areas they felt may be worth further discussion and exploration.

By only recording the final annotated diamonds for this study, much rich data was lost. Recording the discussions the trainees were having during the process would have provided additional insight into the process and the actual awakening of teacher identity occurring within the group. With the second cohort the student teachers were asked to volunteer to record their discussions. Only one pair did and after a short while asked if they could stop the recording. They felt their discussions were less honest and free flowing as they were conscious that university staff may listen to what they said. It may be more appropriate for student teachers to develop their own personal reflections following the discussion to contribute towards the understanding of the process. Also revisiting this activity at a later date would add another insight into identity development amongst the student teachers. What is most important is that student teachers have the opportunity to construct and re-construct their identity as part of their teacher training programme [15].

5 Conclusion

A main finding from the Diamond 9s is the lack of priority given to subject specific topics or classroom activity. Student teachers are clearly more engaged in the 'how' of their teaching rather than the 'what'. Maybe this is where student teachers feel they have the most freedom and ability to develop their own practice, whereas the computing curriculum is a given. Conflicts between personal identity and the mandated curriculum can really hamper teacher development, a sense of achievement and so job satisfaction [4]. In the new field of computing education in English high schools, it is important any conflicts are explored, particularly to ensure the growing number of specialist teachers are able to contribute their ideas and beliefs to the development of the curriculum and to ensure retention of this new group of teachers. It is essential time is given to this within computing teacher training programmes and student teachers are able to explore where they may have ownership and influence in curriculum development in schools.

What is clear is the images have been a valuable stimulus for discussion. A move to images has ensured the student teachers have been able to have jargon-free, open discussions and really explore the aspects of teaching they most resonate with rather than paying lip service to computing curriculum rhetoric or the assessed requirements of the course. In this study the images have been collected and issued to the students. Expanding the process to encourage student teachers to take their own images, through a photo journal, may encourage them to 'look' at their teaching practice from a different perspective. This way the process would develop to be more personally reflective and explore identity over a period of time.

The process embraced within this paper, whilst at an early stage of development, is already appreciated by student teachers and student teacher educators. The process of engaging with the images has allowed a space for discussion and exploration which may otherwise be missed. It is important, particularly in the developing area of training computing teachers, that identity continues to be explored.

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Appendix 2: Gatekeeper Letter.

Dear Headteacher

I am currently researching the impact of the ICT and computing curriculum on classroom learning as part of my doctoral studies at Manchester Metropolitan University. The main aims of the research are to develop an understanding of how the new curriculum is realised in practice and to examine how teachers and pupils experience the new computing curriculum.

Some regional variation may be developing and I am really interested in working with schools in different parts of the country to try and gain a balanced view of how the curriculum is currently being realised. I would like two schools to be included to act as case studies to inform the research. It would be ideal if your school was willing to be involved as a participant.

Involvement would require allowing me access to the ICT / Computing department during the spring and summer terms of 2018 to carry out unobtrusive, non-judgemental research processes. These would involve short interviews with the Head of Department and teachers and focus groups with small groups of learners, both from key stage three and key stage four. I would also like to be able to look at documentation such as schemes of work to see what topics are being covered, time spent on the curriculum, assessment processes etc. The research would also involve a visual study, which would involve taking photographs within classrooms. The photographs would be of classroom display and computer screens during lessons, not of pupils or staff. Any images that may unintentionally feature pupils or staff would only include the backs of heads and individuals would not be identifiable from the images with any names, identifying features of uniforms etc being blurred using photo editing software prior to any images being used as part of the study.

Participation would be entirely voluntary and informed consent to participate would be obtained from the teachers and pupils who volunteer to take part. All volunteers would be free to withdraw from the research at any time without any personal detriment.

The interview questions, consent forms (for staff, pupils and parents) have already been prepared for the study and are available for you to view before agreeing to participate. All Manchester Metropolitan University ethical guidelines have been followed and again, this documentation is available. I have full DBS and am attuned to the high standards of safeguarding required in schools, ensuring that your school safeguarding policy is followed at all times.

If you have any questions or wish to discuss this further then please do not hesitate to contact me by email or telephone. In addition, please feel free to contact my Director of Studies, Professor Cathy Lewin c.lewin@mmu.ac.uk should you have any further questions.

Yours sincerely

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Appendix 3: Pupil Letter.

Manchester Metropolitan University

Dear Pupil

I am currently researching the impact of the ICT and Computing curriculum in learning. I am trying to find out if there have been changes in the type of things pupils are learning in ICT and computing and how pupils like you feel about the curriculum. You are invited to take part in a small group discussion so we I can hear your views.

Before you decide if you would like to take part in this discussion, it is important for you to understand why the research is being done and what it will involve. Please take time to read the attached information sheet carefully and discuss it with others if you wish. This information covers the most commonly asked questions, but please ask if there is anything that is not clear or if you would like more information. Please take time to decide whether or not you wish to take part.

There is a consent form for you to complete if you wish to take part. There is also an information sheet and a form for a parent / guardian to sign to agree to you taking part in the study.

Thank you for your time and co-operation.

Yours sincerely

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Appendix 4: Pupil information sheet.

Pupil Information Sheet

Manchester Metropolitan University

Study title:

How have schools embraced the National Curriculum in Computing and what has been the impact on teachers and learners: A case study of two schools.

The purpose of the study is to:

- To develop an understanding of how the computing / ICT curriculum is carried out in schools.
- To find out how teachers and pupils experience the computing / ICT curriculum.
- To look at visual images in computing / ICT classrooms (such as wall displays and computer screens) to see what it tells us about the curriculum and the learning.
- To produce an account of the computing / ICT curriculum in two different schools.

Why have I been asked to take part?

You have been invited to take part as I would like to gain an understanding of what pupils think about computing and ICT at school. I would like to hear a range of views and experiences as to how you learn about ICT and computing, whether it links to what you do with technology outside school and whether you think it may be important to you in the future, in studies or in work.

Do I have to take part?

It is up to you to decide whether or not you take part. If you do decide to take part, we would like you to sign the attached consent form. If you do decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time or a decision not to take part, will not affect you in any way.

What will I have to do?

If you agree to take part in the study you will be invited to take part in a small group discussion (called a focus group). You will have opportunity to answer questions about computing and ICT and have a chat with others in the group. It will last no more than 30 minutes.

Will photographs be collected?

As part of the research, photographs will be taken in the classroom. These will not feature you or your teachers, but be of visual features such as wall displays and computer screens. No faces, identifying features or names will feature in photographs. Should these be accidentally included, any identifying features will be blurred using photo editing software.

Will my name appear in any written reports of this study?

All information that is collected about you during the course of the study will be kept strictly confidential. Any information about you that leaves the Manchester Metropolitan University will have your name removed so that you cannot be identified. When the results of the research are published direct quotes from the focus groups may be used. These will all be anonymised but you can choose not to have your direct comments included on the consent form.

What will happen to the data generated?

All digital data will be kept in a secure online space, to which only the researchers on this project will have access. Paper documents will also be digitised and paper copies destroyed. All data reported as part of the project will be anonymised. It will be kept for three years after the study has been written and then will all be permanently deleted.

What are the benefits of taking part?

The results of the study will not directly affect you but the information we get will really help to increase the understanding of the ICT and computing curriculum. Your views and experience will make a valuable contribution.

What if you have questions or complaints?

If you would like to contact someone other than the researcher about anything relating to the study you may contact my supervisor.

Prof Cathy Lewin c.lewin@mmu.ac.uk (0161) 247 5191

If you would like to take part in the research please read and complete the attached consent form. Thank you for taking the time to read this information.

Yours sincerely

Eleanor Overland

Doctor of Education Student

Faculty of Education

Manchester Metropolitan University.

e.overland@mmu.ac.uk

Appendix 5: Pupil consent form.

Student Consent Form

Manchester Metropolitan University

Title of project: To what extent have schools embraced the National Curriculum in Computing and what has been the impact on teachers and learners: A case study of two schools.
Researcher: Eleanor Overland, Faculty of Education, Manchester Metropolitan University.

I have read the information sheet and I am aware of the purpose of this research study. I would like to take part in this study and have been given the researchers contact details if I need any further information.

My signature says that I have decided to take part having read and understood the information given and had a chance to ask questions.

I ……………………………………………………………give my permission for my data to be used as part of this study and understand that I can withdraw at any time and my data will be destroyed.

Signature……………………………………………… Date………………………..

Direct quotes

I …………………………………………………………give my permission for direct quotes from my interview to be used as part of this study.

Signature……………………………………………   Date………………………..

I have explained the nature of the study to the subject and in my opinion the subject is voluntarily and knowingly giving informed consent to participate.

Researcher …………………………………………… Date………………………..

Appendix 6: Parent information sheet.

Manchester Metropolitan University

Dear Parent / Guardian

I am currently researching the impact of the ICT and Computing curriculum in learning. I am trying to find out if there have been changes in the type of things pupils are learning in ICT and computing and how pupils feel about the curriculum. Your child has been invited to take part in a small group discussion so I can hear his/her views. The discussions will take part during ICT / computing lessons so no other lessons or pupil time will be affected.

Before you decide if you would like your child to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the attached information sheet carefully and discuss it with your child. S/he will also receive a copy of this information. This information covers the most commonly asked questions, but please ask if there is anything that is not clear, or if you would like more information. Please take time to decide whether or not you wish your child to take part.

There is a consent form for you to complete if you agree to your child taking part. There is also a pupil consent form for your child to complete to agree to participate.

Thank you for your time and co-operation.

Yours sincerely

Eleanor Overland

Doctor of Education Student

Faculty of Education

Manchester Metropolitan University.

e.overland@mmu.ac.uk (0161) 2472341

Parent / Guardian Information Sheet

Study title:

How have schools embraced the National Curriculum in Computing and what has been the impact on teachers and learners: A case study of two schools.

The purpose of the study is to:

- To develop an understanding of how the computing / ICT curriculum is carried out in schools.
- To find out how teachers and pupils experience the computing / ICT curriculum.
- To look at visual images in computing / ICT classrooms (such as wall displays and computer screens) to see what it tells us about the curriculum and the learning.
- To produce an account of the computing / ICT curriculum in two different schools.

Why has your child been asked to take part?

Your child has been invited to take part as I would like to gain an understanding of what pupils think about computing and ICT at school. I would like to hear a range of views and experiences as to how different pupils learn about ICT and computing, whether it links to what technology they use outside school and whether they think it may be important to them in the future, in studies or in work.

Do they have to take part?

It is up to the pupils and yourselves to decide whether or not to take part. If your child decides to take part, I would like you to sign the attached consent form to show you are happy for her/him to participate. If s/he decides to take part, s/he is still free to withdraw at any time and without giving a reason. A decision to withdraw at any time or a decision not to take part, will have no negative consequences.

What will my child have to do?

If s/he agrees to take part in the study, s/he will be invited to take part in a small group discussion (called a focus group). S/he will have opportunity to answer questions about computing and ICT and have a chat with others in the group. It will last no more than 30 minutes.

Will photographs be collected?

As part of the research, photographs will be taken in the classroom. These will not feature pupils or staff but be of visual features such as wall displays and computer screens. No faces, identifying features or names will feature in photographs. Should these be inadvertently included, any identifying features will be blurred using photo editing software.

Will my child's name or image appear in any written reports of this study?

All information that is collected about your child during the course of the study will be kept strictly confidential. Photographs will not include faces or identifying features. Any information about them that leaves Manchester Metropolitan University will have names removed so no one involved can be identified. When the results of the research are published direct quotes from the focus groups may be used. These will all be anonymised but your child can choose not to have direct comments included by indicated on their consent form.

What will happen to the data generated?

All digital data will be kept in a secure online space, to which only the researchers on this project will have access. Paper documents will also be digitised and paper copies destroyed. All data reported as part of the project will be anonymised. It will be kept for three years after the study has been written and then will all be permanently deleted.

What are the benefits of taking part?

The results of the study will not directly affect your child but the information we get will really help to increase the understanding of the ICT and computing curriculum. Their views and experience will make a valuable contribution.

What if you have questions or complaints?

If you would like to contact someone other than the researcher about anything relating to the study you may contact my supervisor.

Prof Cathy Lewin c.lewin@mmu.ac.uk (0161) 247 5191

If you would like your child to take part in the research please read and complete the attached consent form. Thank you for taking the time to read this information.

Yours sincerely

Eleanor Overland

Doctor of Education Student

Faculty of Education

Manchester Metropolitan University.

e.overland@mmu.ac.uk (0161) 247 2341

Manchester Metropolitan University

Appendix 7: Parent consent form.

Parent / Guardian Consent Form

Title of project: To what extent have schools embraced the National Curriculum in Computing and what has been the impact on teachers and learners: A case study of two schools.
Researcher: Eleanor Overland, Faculty of Education, Manchester Metropolitan University.

I have read the information sheet and I am aware of the purpose of this research study. I would like my child take part in this study and have been given the researchers contact details should I need any further information.

My signature says that I am happy for my child to take part having read and have understood the information given.

I ………………………………………………………give my permission for my child's data to be used as part of this study and understand that they can withdraw at any time and their data will be destroyed.

Signature……………………………………………   Date………………………..

Appendix 8: Teacher information sheet

Dear Teacher

We are currently researching the impact of the ICT and computing curriculum on classroom learning. We are trying to find out if there have been changes in the type of things pupils are learning in ICT and computing and how staff like yourself feel about the curriculum. We would like to invite you to take part in an interview so we can hear your views.

Before you decide if you would like to take part in this study, it is important for you to understand why the research is being done and what it will involve. Please take time to read the attached information sheet carefully and discuss it with others if you wish. This information covers the most commonly asked questions, but please ask if there is anything that is not clear or if you would like more information. Please take time to decide whether or not you wish to take part.

There is also consent form to sign if you would like to take part.

Thank you for your time and co-operation.

Yours sincerely

Eleanor Overland

Doctor of Education Student

Faculty of Education

Manchester Metropolitan University.

e.overland@mmu.ac.uk

Teacher Information Sheet

Study title:

To what extent have schools embraced the National Curriculum in Computing and what has been the impact on teachers and learners: A case study of two schools.

The purpose of the study is to:

- To develop an understanding of how the computing / ICT curriculum is carried out in schools.
- To find out how teachers and pupils experience the computing / ICT curriculum.
- To look at visual images in computing / ICT classrooms (such as wall displays and computer screens) to see what it tells us about the curriculum and the learning.
- To produce an account of the computing / ICT curriculum in two different schools.

Why have I been asked to take part?

You have been invited to take part as we would like to gain an understanding of how teachers perceive computing and ICT at school. We would like to hear a range of views and experiences as to how you deliver ICT and computing, whether you feel it prepares pupils for future education or employment and whether you have had to adapt and develop in order to deliver the curriculum.

Do I have to take part?

It is up to you to decide whether or not you take part. If you do decide to take part, we would like you to sign the attached consent form. If you do decide to take part, you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time or a decision not to take part, will not affect you in any way.

What will I have to do?

If you agree to take part in the study you will be invited to take part in an interview with the researcher. You will have opportunity to answer questions about computing and ICT and have an opportunity to make points you feel the questions do not allow. It will last no more than 45 minutes.

Will my name appear in any written reports of this study?

All information that is collected about you during the course of the study will be kept strictly confidential. Any information about you which leaves the Manchester Metropolitan University will have your name removed so that you cannot be recognised. When the results of the research are published, direct quotes from the interviews may be used. These will all be anonymised but you can choose not to have your direct comments included by ticking this section of the consent form.

What will happen to the data generated?

All digital data will be kept in a secure online space, to which only the researchers on this project will have access. Paper documents will also be digitised and paper copies destroyed. All data reported as part of the project will be anonymised. It will be kept for three years after the study has been written and then will all be permanently deleted.

What are the benefits of taking part?

The results of the study will not directly affect you but the information we get will really help to increase the understanding of the ICT and computing curriculum. Your views and experience will make a valuable contribution. A summary of the report will be made available to you once the study is complete.

What if you have questions or complaints?

If you would like to contact someone other than the researcher about anything relating to the study there are two people you may contact.

Prof Cathy Lewin c.lewin@mmu.ac.uk (0161) 247 5191

Dr Sue Pope s.pope@mmu.ac.uk (0161) 247 2373

If you would like to take part in the research please read and complete the attached consent form. Thank you for taking the time to read this information.

Yours sincerely

Eleanor Overland

Doctor of Education Student

Faculty of Education

Manchester Metropolitan University.

e.overland@mmu.ac.uk

Appendix 9: Teacher consent form.

Teacher Consent Form

Title of project: To what extent have schools embraced the National Curriculum in Computing and what has been the impact on teachers and learners: A case study of two schools.
Researcher: Eleanor Overland, Faculty of Education, Manchester Metropolitan University.

I have read the information sheet and I am aware of the purpose of this research study. I would like to take part in this study and have been given the researchers contact details if I need any further information.

My signature says that I have decided to take part having read and understood the information given and had a chance to ask questions.

I ………………………………………………………give my permission for my data to be used as part of this study and understand that I can withdraw at any time and my data will be destroyed.

Signature…………………………………………… Date………………………..

Direct quotes

I ………………………………………………………give my permission for direct quotes from my interview to be used as part of this study.

Signature…………………………………………… Date………………………..

I have explained the nature of the study to the subject and in my opinion the subject is voluntarily and knowingly giving informed consent to participate.

Researcher …………………………………………… Date………………………..

Appendix 10: Head of department interview questions.

Head of Department Interview Questions

1. *How would you describe the current Computing or ICT curriculum within the school?*

2. *Can you explain as to how it has developed over the last three years?*

3. *Do you feel you and your staff have the right skills and knowledge to deliver the curriculum in its current format?*

4. *Do you plan to make any changes to the curriculum within the next two years?*

5. *Do you feel there are any barriers to developing the curriculum? (expand)*

6. *How do the pupils respond to the current curriculum provision?*

7. *How do parents respond to the current curriculum provision?*

8. *Do you feel pupils are suitably skilled in computing / ICT for the next stages of their education or entry into work?*

9. *Have you personally sought support from SLT, colleagues or the wider profession in relation to leading the curriculum?*

   What about for delivery with your own classes?

10. *Is there anything additional you would like to add about any of the points raised or other comments about the computing / ICT curriculum?*

Appendix 11: Key Stage 3 focus group questions.

Focus Groups with Pupils – Key Stage Three

1. On your timetable do you have computing lessons, ICT, computer science or something else? How often do you have these lessons?

2. How do you find these lessons compare with your other subjects (Could use prompt words such as harder, easier etc)

3. What type of tasks do you do in the lessons (suggest topics they have studies as prompts)?

4. What resources do you use? Which do you find most useful?

5. Do you think you experiences of ICT or Computing at primary school prepared you for your computing lessons here at this school?

6. Do you think you will choose to continue with the subject at Key Stage 4. Why?

7. How do you imagine studying this subject will impact your future studies / career?

8. Do you think there are differences in the way girls and boys relate to the subject?

9. Do you do any activities outside school that link to the subject? How do these compare with your studies inside school?

10. Is there anything else you would like to say about the subject or using computers / technology in general?

Appendix 12: List of categories used for coding data.

Stage	Coding Term	Rationale
Computing as a subject	Curriculum change / development	Any changes from the previous curriculum or ongoing developments
	Computer science curriculum	As outlined in the National Curriculum (ORF)
	IT or ICT curriculum	As outlined in the National Curriculum (ORF)
	Digital literacy curriculum	As outlined in the National Curriculum (ORF)
	Computing curriculum	As outlined in the National Curriculum (ORF)
	Qualifications / exam boards	Mention of curriculum, specifications and other formal requirements determined by external examinations (ORF)
	Government influence	Including National Curriculum, DfE and other bodies that could be considered part of the ORF
	Industry influence	Mention of business or professionals in computing industry who

		have influenced curriculum decisions (ORF)
	Collaboration, partnership and/or networks	Work with other schools, trusts, subject associations or other networks
	Funding	Mention of funding, either at a national or local level.
	Leadership and Management	Mention of views or values from leadership / management within the school that impact the computing curriculum.
	Management related decisions: Staffing Timetabling Training Pupil numbers	Specific management decisions impacting the computing curriculum.
	Computing as a subject - uncategorised	Any other aspects that relate to the first stage of the research questions ‘computing as a subject’.
Pedagogic Discourse	Subject based values (teacher view)	Teachers’ personal views on the value of learning the subject (PRF)
	Economic values (teacher view)	Teachers’ personal views on the economic value of the subject (PRF)

	Continuation of learning (teacher view)	Teachers' personal views on studying computing beyond the curriculum within the school (PRF)
	Formal subject related language (teacher use)	Teacher's formal use of disciplinary language (Elaborated code)
	Informal subject related language (teacher use)	Teacher's use of informal language when discussing the subject (Restricted Code)
	Subject knowledge / Classroom activities – computer science	Teacher's own subject knowledge and choice of lesson activities specifically relating to computer science
	Subject Knowledge / Classroom activities – IT or ICT	Teacher's own subject knowledge and choice of lesson activities specifically relating to IT or ICT
	Subject Knowledge / Classroom activities – digital literacy	Teacher's own subject knowledge and choice of lesson activities specifically relating to digital literacy
	Hierarchical knowledge	Knowledge or skills that build on prior learning or link to next stages of learning
	Segmented knowledge	Knowledge or skills that

		are standalone
	Level of difficulty (teacher)	Teacher comments on how easy or difficult the learning is
	Department level planning	Planning collaboratively within the school
	Teacher level planning	Individual teachers' planning
	Selection of resources	Teacher's choices resources (including digital)
	Cross-curricular links	Links to other subject areas
	Pedagogic discourse - uncategorised	Any other aspects that relate to the second stage of the research questions 'pedagogic discourse'.
Experience of Learners	Influence of teachers	Learners' views on how teachers influence their attitudes towards the subject
	Influence of family and friends	Learners' views on how their family or friends influence their attitudes towards the subject
	Knowledge in computer science	Learner's own knowledge specifically in computer science
	Knowledge in IT or ICT	Learner's own knowledge specifically in IT or ICT

	Knowledge in digital literacy	Learner's own knowledge specifically in digital literacy
	Learning online	Learning pupils do online (either in or outside school)
	Learning in the community	Learning taking place from others away from the classroom e.g. tutors, online forums, from family
	Technology use outside school	Learners' use of computers and other devices outside of school
	Career intentions	Learners' intentions for future work, further study and/or careers
	Formal subject related language (learner use)	Learners' formal use of disciplinary language (Elaborated code)
	Informal subject related language (learner use)	Learners' informal use of disciplinary language (Elaborated code)
	Level of difficulty (learner)	Learner views on the level of difficulty of aspects of their learning computing
	Relating to learner outcomes: Attainment Progress	Mention of results, exams, grades etc (graded performance)

	results	
	Relating to learner outcomes: Skills Readiness for next stages of education / employment	Mention of achievements not measured by formal assessment (competence-based performance)
	Gender differences	Mention of different experiences or outcomes by gender groups
	Socio-economic differences	Mention of different experiences or outcomes by socio-economic groups
	Subject based values (learner view)	Learners' personal views on the value of learning the subject
	Economic values (learner view)	Learners' personal views on the economic value of the subject
	Continuation of learning (learner view)	Learners' personal views on studying computing beyond the curriculum within the school
	Experience of learners - uncategorised	Any other aspects that relate to the third stage of the research questions 'experience of learners'.

Appendix 13: Example of coded data taken form NVivo.