Stakeholder Perceptions Regarding Level 3 'Digital Skills' Teaching: A Qualitative Case Study of Colleges in South West England

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Abstract

This case study of colleges (n=13) in the South West of England explores the experiences and perceptions of senior leadership (n=8), heads of computing departments (n=10), and lecturers (n=14) in relation to the teaching of digital skills related courses at level 3. Existing literature reveals that there is a 'digital skills gap', with colleges identified as key in addressing this issue. However, they are suffering from a multitude of challenges and have historically been neglected politically and in research. Furthermore, the breadth of level 3 'digital skills' qualifications available only exacerbates the issue of identifying what is good practice in this complex and ever-changing environment. Through conducting semi-structured interviews, this thesis presents the voices from those on the 'front line' of digital skills delivery and provides key contributions to knowledge and implications for practice. First, this thesis addresses a key knowledge gap in how curriculum decisions are made, both regarding who makes this decision, and what curricula decisions are based upon. From these findings, a model of curriculum choice has been established which educational institutions can use to ensure curriculum decisions are made more systematically. Second, this thesis augments current literature which has typically focused on schools with regards to the challenges that influence the teaching of digital skills courses, but within a college setting. Thirdly, this thesis outlines what practices are being employed to overcome the challenges identified, which include the three main areas of working together, pedagogical approaches, and knowledge development, with the latter culminating in the creation of a continuing professional development framework. These findings should serve useful for practitioners in learning what practices are effective so they can adopt them into their own practice, while policy makers could utilise these findings to aid the formulation of

future policy initiatives regarding the further education sector. Additionally, these findings are of particular significance to organisations involved in the advancement of college education or computing education such as the Association of Colleges, the National Centre for Computing Education, the Institute of Coding, and the British Computer Society.

Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by a specific reference in the text. No part of this thesis has been submitted as part of any other academic award. The thesis has not been presented to any other educational institution in the United Kingdom or overseas.

Any views expressed in this thesis are those of the author and in no way represent those of the University of Gloucestershire.

Signed:

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Terms and Abbreviations

Abbreviation	Definition
A-Level	Advanced Level
AELP	Association of Employment and Learning Providers
AoC	Association of Colleges
AQA	The Assessment and Qualifications Alliance
AGQ	Applied General Qualification
BCS	British Computer Society
BTEC	Business and Technology Education Council
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CCEA	Council for the Curriculum, Examinations and Assessment
CISO	Chief Information Security Officer
CK	Content Knowledge
CPD	Continuing Professional Development
DS	Digital Skills
EFA	Education Funding Agency
EPQ	Extended Project Qualification
ESFA	Education and Skills Funding Agency
FE	Further Education
FEFC	Further Education Funding Council for England
GCSE	General Certificate of Secondary Education
HE	Higher Education
HEFCE	Higher Education Funding Council for England
HESA	Higher Education Statistics Agency
ICT	Information and Communications Technology
IfL	Institute for Learning
IFS	Institute of Fiscal Studies
IoC	Institute of Coding

Abbreviation	Definition
ITT	Initial Teacher Training (England)
LSC	Learning and Skills Council
NVQ	National Vocational Qualification
OCR	Oxford, Cambridge and RSA Examinations
OECD	Organisation for Economic Co-operation and Development
Ofqual	The Office for Qualifications and Examinations Regulations
OfS	Office for Students
PG	Postgraduate
PGCE	Postgraduate Certificate of Education
PK	Pedagogical Knowledge
PCK	Pedagogical Content Knowledge
QCDA	Qualifications and Curriculum Development Agency
QTS	Qualified Teacher Status
QTLS	Qualified Teacher Learning and Skills
SET	Society for Education and Training
SFA	Skills Funding Agency
STA	Standards and Testing Agency
STEM	Science, technology, engineering, and mathematics
T-Level	Technical Level
UCAS	Universities and Colleges Admissions Service
UG	Undergraduate
UKRI	United Kingdom Research and Innovation
UTC	University Technical Colleges
WJEC	Welsh Joint Education Committee
YPLA	Young Peoples Learning Agency

Part I

Introduction, Context and Literature Review

Part I introduces the study and discusses the background context as well as the theoretical foundations that shape the research. It locates the study in the English college education sector, focusing on digital skills and the related qualifications that are taught at level 3.

This part also conducts an analysis of the macro environment of the college sector and literature regarding the challenges of teaching digital skills. This culminates in the formulation of a conceptual framework which argues the need for further depth with regards to the challenges colleges face and how they decide what they teach.

This section continues by investigating potential ways these challenges could be overcome and discusses how additional research is required to better understand the best practices in how to overcome the challenges in teaching digital skills within colleges. All the factors combined within this part delineate the research questions and objectives for the thesis.

Part I contains the following chapters:

1) Introduction
2) Understanding the Context
3) Challenges of Teaching Digital Skills
4) Potential Best Practices to Overcome the Challenges in Teaching Digital Skills

Chapter 1

Introduction

The aim of this chapter is to provide an overview of the thesis and set out the rationale and objectives for the study. This will be achieved through a presentation of the research setting and rationale that provide the background context for the research, before presenting the associated research aim, questions and objectives. Following this, justification of the research questions will be provided, and then an overview of the research methodology used will be conveyed. After this, the delimitations of the thesis will be detailed, and finally a brief overview of the thesis structure will be outlined.

1.1 The Research Setting and Rationale

According to Störmer *et al.* (2014), ICT hardware, software and connectivity will experience massive growth in their complexity and, within 20 years, 90% of jobs will require digital skills (Skills Funding Agency, 2016). However, employers are struggling to find employees with the right digital skills (Störmer *et al.*, 2014). In fact, an Employers Skills Survey revealed that 35% of all skills gaps involved a deficiency in digital skills (Winterbotham *et al.*, 2018), while the Digital Skills for the UK Economy report found that 72% of large companies and 49% of small and medium sized enterprises (SMEs) are suffering tech skills gaps (ECORYS UK, 2016). Regardless of the demand for these skills, employment outcomes for computer science graduates have been found to be particularly poor (Wakeham, 2016), as they are the most likely to be unemployed six months after graduation according to HESA statistics (HESA, 2017). The Shadbolt Review suggests the issues affecting graduate employability originate earlier than in HE (Shadbolt, 2016), with Medhat (2014) stating that the structure and content of courses are often outdated and not in sync with industry needs.

The Wolf report which reviewed vocational education states that England is different to most countries regarding qualifications as there are a large number of separate qualifications and non-governmental 'awarding bodies' (Wolf, 2011), resulting in a variety of educational routes (Lucas, Spencer, and Claxton, 2012). At level 3, these qualifications include A-Levels, BTECs, Cambridge Technicals, Tech Levels, Apprenticeships, and T-Levels. Many of these qualifications have a variety of study units to choose from but there is little research investigating why certain qualifications and units of study are taught over others.

Colleges offer a wide variety of qualifications and therefore have a significant influence regarding the teaching and future of digital skills, as they can bring forward the next generation of industry-ready employees (Medhat, 2014; House of Lords, 2015). However, while colleges are multi-faceted (O'Leary and Brooks, 2014), and cater to learners with a wide variety of educational needs (Lucas, Spencer, and Claxton, 2012), initial teacher training for college teachers has been criticised as being weak (Orr, Hanley, Hepworth, and Thompson, 2019), with teacher training applications decreasing in recent years (Zaidi, Howat, and Caisl, 2017), resulting in colleges suffering from recruitment difficulties (Association of Colleges, 2018b). There are also issues regarding funding, with one survey of 90 colleges revealing that the top three college concerns are all monetary related (Association of Colleges, 2018d). There are potential ways to overcome these issues but existing literature tends to view these challenges and ways to overcome them in a broad sense. Colleges have their own idiosyncrasies, educational offer and unique contexts, which has rarely been explored in existing literature. The education inspection framework by Ofsted (2019a) explains how there has been a relative paucity on research in the college sector, while pedagogy has received less attention in technical subjects in comparison to more academic subjects (Orr *et al.*, 2019). Consequently, how a college's specific context affects both the challenges that influences the teaching of digital skills, and how to overcome them, is something that should be investigated, predominantly as the lessons learnt can then be used to help inform practitioners and policy makers regarding improving level 3 digital skills teaching within colleges.

1.2 Research Aims, Questions and Objectives

Based on the research project setting, the aim of this research project is:

'To explore stakeholder perceptions regarding how colleges can overcome the challenges that influence the teaching of 'digital skills' to students studying post-16 Level 3 education'

1.2.1 Research Questions

Based on the research project setting and aim, four research questions (RQ) have been developed to guide the research:

1. How do colleges decide what 'digital skills' qualifications and units of study to teach their post-16 level 3 students?

2. How does a college's specific context relate to the perceived challenges that influence the teaching of 'digital skills' at level 3?

3. What practices do colleges currently employ to overcome the perceived challenges that influence the teaching of 'digital skills' at level 3 and why?

4. How do college stakeholders differ regarding their perceptions on the challenges that influence the teaching of 'digital skills', and the practices used to overcome those challenges?

1.2.2 Research Objectives

1. To investigate the decision-making processes that inform which digital skills qualifications and units of study are taught within colleges at level 3.

2. To investigate the perceived challenges that influence the teaching of digital skills within colleges at level 3 study and the practices employed to overcome them, in relation to a college's specific context.

3. To carry out an analysis of how internal college stakeholders differ regarding their perceptions on the challenges that influence the teaching of digital skills and the practices employed to overcome them.

1.3 Justification of the Research Questions

The Importance of Investigating the Decision Making Processes of Curriculum Choice

Education should support students in engaging in curricula that are most effective at supporting the needs of the future economy by providing students with the necessary skills (Aničić, Divjak, and Arbanas, 2017; Passey, 2017). One of the key areas required by the workforce in the future and now is digital skills, and this need has only been heightened with the UK leaving the European Union (Shury *et al.*, 2017), and COVID-19 leading to an increased emphasis on remote working. However, there is a 'digital skills gap' (Crick, 2017), where these skills needs are not being met effectively. Colleges, which form part of the further education sector, have been identified as being pivotal in addressing these skills gaps (House of Lords, 2015; Augar *et al.*, 2019; HM Treasury, 2020), but they have been plagued by continuous change over the last thirty years (Norris and Adam, 2017), resulting in a lack of policy and qualification coherency. Furthermore, curriculum transition takes many years (Sentance and Waite, 2018), and there are a wide variation of qualifications which exist. Therefore, when these factors are combined with the fact that colleges will have their own idiosyncrasies, local context, history, strategic agendas and challenges, this results in an unclear situation regarding curriculum in colleges. However, curriculum plays a large part in a student's education, and ultimately in the skills pipeline of the future workforce, and so it is important to understand how curriculum decisions are made within colleges.

The Importance of Investigating College Context in Relation to Perceived Challenges of Digital Skills Teaching

There are several challenges that lead to digital skills gaps from a college point of view which ultimately fall under two categories. Skills gaps due to ineffective teaching, or skills gaps due to it not being covered in current curricula or because colleges are not teaching it. The first research question helps to identify factors influencing the latter, but research question 2 aims to focus on identifying what leads to ineffective teaching of digital skills through perceived challenges and college context. It has been identified in literature that there are a multitude of challenges influencing colleges such as a lack of funding, a limited supply of suitable educators, and dealing with a wide variety of student needs and complex curriculum offer (Greatbatch and Tate, 2018), resulting in a sector that has become demoralised (Bathmaker and Avis, 2005; Augar *et al.*, 2019). Typically, these challenges are viewed as general sector issues, but there is limited research which investigates how these challenges influence individual institutions and the implications that result because of them. By framing these wider challenges in individual college context, and through the consideration of stakeholder perceptions, research question 2 aims to obtain a much deeper understanding of the current situation within colleges than what already exists. Besides, understanding how challenges influence college teaching in more detail allows for more aligned solutions to be devised and implemented.

The Importance of Investigating the Practices Used to Overcome the Challenges which Influence Digital Skills Teaching

Good design of teaching practice has been described as evolving from a variety of practical examples without being formally articulated and documented (Beetham and Sharpe, 2013). Existing literature which does identify 'best practice' or ways to overcome the challenges of teaching digital skills, are typically related to that of schools or higher education institutions, so they may not be relevant in the context of colleges. Given the challenges that influence digital skills teaching, and the challenges that exist in the further education sector, it is important to investigate the practices used to overcome these challenges for colleges from the perspective of those who are affected: college stakeholders. Furthermore, it has been recommended how research should investigate the value of the different approaches used in the teaching of digital skills (Garneli, Giannakos, and Chorianopoulos, 2015; Crick, 2017; Webb *et al.*, 2017), and by understanding which practices work (or not) in a college context, this allows for a more accurate and representative creation of 'best practices' which can be disseminated to colleges so they can improve their practice. Besides, with the rapid rate of change in technology, which ultimately influences curriculum design and teaching practice, it is important to share best practice with others (Beetham and Sharpe, 2013; Derrick, Laurillard, and Doel, 2016).

The Importance of Investigating how Stakeholder Perceptions Differ

There are several stakeholders who influence digital skills teaching within colleges, which go beyond those directly involved in the teaching itself. Biggs (1993) contends, in his model of 'systems of tertiary education', that there are multiple layers within and outside of educational institutions which influence the teaching context, while it has also been highlighted elsewhere that in research, it is important to consider those adjacent to a phenomenon, not just those directly involved (Miles, Huberman, and Saldana, 2014). Hence, in addition to lecturers, heads of departments and members of senior leadership teams are just two examples of stakeholders who influence the teaching and learning environment within colleges, whether that is directly or indirectly. It has been claimed that different groups within an organisation experience a different workplace reality (Saunders, Lewis, and Thornhill, 2019), and the aforementioned stakeholders will likely have different perspectives due to their roles and different levels of focus on pedagogy, management, and strategy. Therefore, investigating exactly how stakeholder perceptions differ can deepen the analysis of digital skills teaching within colleges, as it allows the possibility to gain a more comprehensive understanding of the reality of the situation, while also helping to counter any threats to validity (Robson and McCartan, 2016).

1.4 Research Methodology

The philosophical underpinnings of this thesis is based on ontological critical realism (i.e. there is one reality but this is blocked by a 'subjective lens'), epistemological constructionism (i.e. meaning is constructed, not discovered), and an overall research philosophy of interpretivism (i.e. assumes social reality is subjective). The purpose of interpretivist research is to map the variety of perceptions and views people take on a given research topic (Robson and McCartan, 2016) in order to create rich understandings of social worlds and their contexts (Saunders, Lewis, and Thornhill, 2019), which the research questions necessitate. Furthermore, this research follows a qualitative approach as qualitative research has a strong potential for revealing complexity (Miles, Huberman, and Saldana, 2014), and values people and their perceptions of the world (Saunders, Lewis, and Thornhill, 2019), which is what the research questions and objectives require.

The research strategy used is a multiple case study design, where each case could be considered as an individual college, yet overall, the colleges together represent the one case study of colleges in South West England. Case studies are particularly relevant for studies where the research requires an extensive and in-depth description of a phenomena (Yin, 2009), and they recognise that context is a strong determinant for causes and effects (Cohen, Manion, and Morrison, 2018). Hence, case studies are particularly useful for answering the research questions due to their relation to contextual college factors. Besides, case studies can make unique and distinctive contributions for educational research (Cohen, Manion, and Morrison, 2018), with Merriam (1998) contending that case studies have proven particularly useful for educational innovations, for evaluating programmes, and informing policy. For example, Lahiff (2015) used in-depth qualitative case studies to focus on initial teacher training within further education colleges, concluding that the case studies resulted in clear implications for practice.

Regarding sampling, much like O'Leary and Brooks (2014), whose case selection of colleges was based on having colleges with differing profiles in terms of size, location and curriculum offered, this thesis does the same, with 13 colleges from the South West of England being represented from 32 interviewees. These interviewees consist of three different stakeholder groups: teachers/lecturers (n=14), heads of departments (n=10) and members of senior leadership teams (n=8). Multiple internal college stakeholders were chosen as they were likely to have different perspectives of digital skills teaching. Besides, it is important to speak to those who are neighbours to a phenomenon, not just those central to it (Miles, Huberman, and Saldana, 2014).

Semi-structured interviews were the predominant data collection method and were particularly useful for investigating a case in depth (Bryman and Bell, 2011). Using semi-structured interviews with different internal college stakeholders has been successfully used in studies before (Broad, 2015; Edgington, 2013; Lahiff, 2015; O'Leary and Brooks, 2014; Orr and Simmons, 2010), and was therefore deemed as an effective data collection method. Interviews focused on three key themes regarding digital skills teaching: reasons for course selection, challenges faced, and methods to overcome challenges. Document analysis, such as of college websites and Ofsted reports were also used prior to interviews to ensure that the questions asked were both relevant and thorough enough to ensure sufficient detail was covered during the interview process.

Interviews were conducted virtually with most being conducted using Microsoft Teams. These interviews were recorded and transcribed before being added to the document management software of NVivo to help organise the analysis and coding of interview data. Interview data was analysed by coding and categorising transcripts in line with Braun and Clarke (2013) thematic analysis framework to construct key themes. This involved a five-phased iterative coding process which led to the creation of six overarching themes, which together contained nineteen themes. These themes formed the basis for analysis and discussion in answering the research questions.

1.5 Delimitations of the Study

There are some delimitations of this thesis which intentionally limit the boundaries or scope of the research. First, it was decided to exclude the focus on any qualifications other than at level 3, as level 3 itself provides such a broad variety in curricula regarding digital skills, proving problematic for higher education providers and employers in knowing which qualifications are useful or relevant. To focus on higher education qualifications or level 2 qualifications would have broadened the scope too much. Besides, even with a distinct focus on level 3, interviewee participants had an awareness of, and cited other levels of qualifications during the interview process. The second delimitation was the colleges chosen for the sample. When the research began in 2019, there were 257 colleges in England. This was deemed too broad a population considering the emphasis of the research was on in-depth college studies and using qualitative methods such as semi-structured interviews. Hence, due to the South West having interesting characteristics worthy of targeted research (later discussed in Part II), a focus on only the South West reduced the college population to just 24 (Department for Education, 2020a). This allowed the research findings to be contextualised in the context of the South West. Furthermore, due to land-based colleges not offering courses related to digital skills, this college type was also excluded from this study. This study is also limited to internal college stakeholders, with students and external stakeholders such as curriculum providers and employers excluded from this study. While it is acknowledged that these groups could provide a great detail of interesting insight into digital skills teaching at level 3 within colleges, the research questions focus on how colleges make decisions around curriculum, and college employee perceptions of challenges and practices used in the teaching of digital skills courses. Other groups may have distracted from the focus of this research, and instead, these stakeholder perceptions should be incorporated into future research of digital skills teaching at level 3 within colleges.

1.6 Main Contributions

The main contribution of this thesis is presenting stakeholder perceptions regarding the teaching of digital skills related courses at level 3 within colleges in the South West of England. Furthermore:

- Creation of a conceptual framework which identifies the challenges influencing the teaching of digital skills, and how these challenges lead to ‘digital skills gaps’.

- A comparative analysis of what digital skills qualifications are offered within colleges in the South West, who makes these decisions, and what these decisions are based upon.
- A model of curriculum choice that details the key factors which should be considered when making curriculum decisions.
- The identification of what practices are used by colleges to support the teaching and learning of digital skills related courses.
- The creation of a continuing professional development framework identifying the key factors that must be present for continuing professional development to be effective in a college setting for teachers of digital skills.
- The dissemination of five peer-reviewed publications relating to the findings of this research (see next section).

1.7 Related Publications

The following list includes all peer-reviewed publications by the author which are related to this thesis.

- Allison (2020a). 'A Framework for Effective Continuing Professional Development: The Case of Computer Science Teachers within Further Education Colleges'. *2020 International Conference on Computational Science and Computational Intelligence (CSCI)*. IEEE, pp. 898–903. doi: 10.1109/csci51800.2020.00168.
- Allison (2020b). 'The System's Holding Me Back: Challenges of Teaching Computing in Further Education'. *2020 International Conference on Computational Science and Computational Intelligence (CSCI)*. IEEE, pp. 929–933. doi: 10.1109/csci51800.2020.00173.
- Allison (2021a). 'Hopes and Concerns for Digital T-Levels: A Preliminary Study'. *The 16th Workshop in Primary and Secondary Computing Education*. ACM, pp. 1–2. doi: 10.1145/3481312.3481326.

- Allison (2021b). 'The Importance of Context: Assessing the Challenges of K-12 Computing Education Through the Lens of Biggs 3P Model'. *21st Koli Calling International Conference on Computing Education Research*. ACM, pp. 1–10. doi: 10.1145/3488042.3488043.

- Allison (2022).'The who, how and why of choosing post-16 computing curricula: a case study of English further education colleges'. *Journal of Further and Higher Education*. pp. 1-18. doi: 10.1080/0309877X.2022.2088269.

1.8 Thesis Structure

This section outlines the structure of the remaining chapters of the thesis:

Chapter 2 provides an overview of digital skills, level 3 qualifications, colleges, and presents an educational systems theory. Together these areas present the context of the study and conclude with the justification for research question 1.

Chapter 3 presents existing literature regarding the challenges that influence digital skills teaching. This literature review leads to the creation of a conceptual framework of the challenges that lead to 'digital skills gaps' and presents the rationalisation of research question 2.

Chapter 4 is the final chapter in Part I and presents three main areas of potential best practice that can overcome the more specific challenges related to digital skills teaching. This chapter culminates in the justification of research questions 3 and 4.

Part II contains chapters 5-7, and all are related to research methodology and processes. Chapter 5 highlights the philosophical and theoretical foundations of the research.

Chapter 6 discusses the research design and processes which includes how the research was conducted and why, and outlines the thematic coding process used in analysing interview data.

Chapter 7 outlines the research considerations and includes topics such as ethics, reliability and validity, and reflexivity.

Part III contains chapter 8-11, which outline the research findings, analysis, and discussion. Chapter 8 presents the 19 themes which were created from the analysis of interview data with associated interviewee quotes, before presenting how stakeholder perceptions differed.

Chapter 9 considers curriculum choice, and this is the chapter which discusses and answers research question 1. Curriculum choice is presented as a framework consisting of four main areas, and these areas are discussed in relation to interview data and existing literature.

Chapter 10 discusses the challenges that influence digital skills teaching in relation to college context, interview data, and existing literature. Findings are discussed in relation to Biggs 3P Model, and this chapter focuses on answering research question 2.

Chapter 11 focuses on answering research question 3, through providing a discussion on the best practices identified by interviewees on how to overcome the challenges that influence digital skills teaching in relation to literature. Three main areas are presented; working together, approaches to teaching, and knowledge development (professional development). For the latter, a framework for effective CPD is created which may prove useful for CPD providers and colleges alike.

The final part, Part IV, contains a singular final chapter (Chapter 12) that concludes the research. It revisits the research questions and provides the contributions to both practice and research, before addressing what future research should investigate next.

Chapter 2

Understanding the Context

This chapter will set the scene regarding four main areas: what is meant by digital skills and their importance in society; the range of level 3 qualifications regarding digital skills that are available to learners aged 16-18 years old; an overview of colleges, including what is meant by a college, some key facts about colleges and why they are worth investigating; a discussion of educational systems theory and its implications for educational research.

2.1 Digital Skills

2.1.1 Definition of Digital Skills

There is not a simple and obvious definition of ‘digital skills’ (hereafter referred to as DS). It is a highly debated and contested concept, often with similar yet overlapping names, such as digital literacy (Hinrichsen and Coombs, 2014), digital competence (Janssen *et al.*, 2013), and digital fluency (Garneli, Giannakos, and Chorianopoulos, 2015; Madsen, Archard, and Thorvaldsen, 2019). By way of illustration, the Digital Skills for the UK Economy report (2016), offers a review of DS definitions from fifteen papers and explains how over time there has been a range of partially overlapping definitions with many being too broad or not considering different user groups. However, the report does define DS in accordance to three proficiency levels; basic digital literacy skills, digital skills for the general workforce, and digital skills for ICT professions (ECORYS UK, 2016). The latter being described as encompassing the two previous areas, and includes the skills linked to the development of new digital products, services, and technologies. The emphasis on different proficiency levels for DS has been highlighted in other reports too. The report 'Building digital skills in the Further Education Sector' (2016) explains how DS are needed for all types of jobs, not just ICT professionals, and the report highlights the notion of how there are both generic, and specific DS. Meanwhile, some authors have attempted to characterise exactly what these skills are.

One study conducted a systematic literature review of seventy-five peer reviewed journals regarding DS in the context of workforce preparation, and concluded with a DS framework that consisted of seven core skills and five contextual skills (Van-Laar, Van-Deursen, Van-Dijk, and De-Haan, 2017). The core skills included: technical, information management, communication, collaboration, creativity, critical thinking and problem solving. Meanwhile, the contextual skills included: ethical awareness, cultural awareness, flexibility, self-direction and lifelong learning (Van-Laar *et al.*, 2017). Additionally, one study which asked ninety-five experts to contribute their opinion on the definition of digital competence, resulted in several issues of debate, yet concluded that digital competence pertains to twelve different areas (Janssen *et al.*, 2013). This study, alongside an analysis of fifteen existing frameworks and experts' workshops, were used to create a digital competence framework consisting of twenty-one competences where each competence area had three proficiency levels; foundation, intermediate, and advanced (Ferrari, Punie, and Brečko, 2013). This framework has since been used more widely, with the European Commission providing the translations of digital competencies for twenty-five countries under the DigComp 2.0 framework that contains twenty-one competencies under five overall competence headers including: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving (European Commision, 2022).

The variation in what is meant by DS can provide issues for those who are responsible for its development in others such as teachers (Janssen *et al.*, 2013). Therefore, it is important to define what is meant by DS for this thesis. Besides, the British Computer Society in their landscape review of computing qualifications, highlights how any discussion of computing skills should take care and be as precise as possible with what is meant by the terminology employed (British Computer Society, 2022). Hence, this thesis will first outline DS in a similar manner to that of ECORYS UK (2016), Nania, Bonella, Restuccia, and Taska (2019), and Ferrari, Punie, and Brečko (2013), by defining DS in accordance to three different types of user or proficiency level as below:

- Basic: the skills needed for general day-to-day to use of technology such as for communication, email, browsing and use of basic software such as Word, Excel (basic knowledge), and PowerPoint.

- Intermediate: all of those in 'Basic' but also knowledge of some specific IT skills and software required as part of a person's job. This could be more advanced Excel skills, or knowledge of how to use some specific software.

- Advanced: all of those in 'Basic' and 'Intermediate' but also higher levels skills which are a fundamental requirement of a person's job and where IT skills and knowledge make up the majority of their job. This is the category for the IT professional who may have knowledge in areas such as networking, cyber security, programming, software development etc.

The above categorisations of DS can be applied to all areas of the workforce. However, for the purpose of this thesis, DS will take a narrower approach in what is meant by DS. Much like the article 'Bridging the digital skills gap: Are computing degree apprenticeships the answer?' (2019), this thesis recognises how DS can encompass employees at all levels but will focus on the DS required for a career that is explicitly focused on computing and related subjects. Hence, this includes the skills outlined in the 'Advanced' proficiency level outlined above and relates to the skills that computing graduates may require for a successful career as indicated in the Shadbolt Review of Computer Sciences Degree Accreditation and Graduate Employability (Shadbolt, 2016). This includes the subject areas as outlined by the Higher Education Statistics Agency (HESA), which provides a subject category for degrees within their Joint Academic Coding System (JACS) denoted as Computer Sciences (HESA, 2019). This category includes those with the following subject codes:

- (I1) Computer science
- (I2) Information systems
- (I3) Software engineering
- (I4) Artificial intelligence
- (I5) Health informatics
- (I6) Games
- (I7) Computer generated visual and audio effects
- (I9) Others in Computer sciences

Hence, for the purpose of this thesis, DS will refer to those skills required for having a successful career in the above subject areas as defined by HESA which come under the category Computer Sciences. Therefore, DS in the context of this thesis includes subject areas and qualifications that may commonly be referred to as 'Computing', 'Computer Science', or 'ICT'. While this definition may still seem too broad and not explicitly refined, due to the nature of technology evolving at such a rapid rate, DS (and related terminology) should be seen as a "pluralistic concept" (Janssen *et al.*, 2013, p. 480), with even the latest reviews of computing qualifications highlighting the difficulty of defining the subject area (British Computer Society, 2022).

2.1.2 Why Investigate Digital Skills

Demand for Digital Skills

In February 2015, the Department of Business, Innovation and Skills commissioned two independent reviews on STEM degree provision, accreditation and graduate employability, the Wakeham review (2016), and the Shadbolt Review (2016), with the latter focusing on Computer Sciences. Both of these reviews reported that there is a growing demand in a variety of DS areas as evidenced in existing literature. These areas include, but are not limited to: cloud computing, big data analytics, cyber security and digital forensics, mobile computing, FinTech, HealthTech, biotechnology, agricultural technologies, energy storage, robotics, and the automation of routine tasks (Medhat, 2014; Störmer *et al.*, 2014; Dass, Goodwin, Wood, and Luanaigh, 2015; Vogel, 2016; Shadbolt, 2016; Wakeham, 2016; Elliott, 2017; Nania *et al.*, 2019; Industrial Strategy Council, 2019). These advances have resulted in much of everyday life being dependent upon computing (House of Lords, 2015; Webb *et al.*, 2017) with jobs being created which did not exist 10 years ago (Voogt, Erstad, Dede, and Mishra, 2013a; Nania *et al.*, 2019; Scepanović, 2019). This trend is likely to continue into the future with an end-point seeming unlikely (Passey, 2017; Van-Laar, Van-Deursen, Van-Dijk, and De-Haan, 2020).

Due to the plethora of advances in technology, DS are increasingly being considered as crucial English and Maths skills (Derrick, Laurillard, and Doel, 2016), with the Skills Funding Agency (2016) estimating that within 20 years, 90% of jobs will require DS. As a result, employees need to develop DS to cope in this changing environment (Van-Laar *et al.*, 2017; Van-Laar *et al.*, 2020). Digital literacy will undoubtedly become more structured in a wider range of roles (Department for Digital Culture Media and Sport, 2019), in both STEM and non-STEM specific jobs (ECORYS UK, 2016; HM Government, 2017), while in 2018, there were 601,000 job openings in the UK digital sector (Association of Colleges, 2019b). Due to the high demand expected for individuals with DS, it is crucial for the population to acquire the DS required for employment and participation in an ever-growing technological society (Van-Laar *et al.*, 2017; Webb *et al.*, 2017; Industrial Strategy Council, 2019). Consequently, there will need to be a plentiful supply of labour with the right DS. Acquiring this plentiful supply of labour with the right skill set requires appropriate education infrastructure and therefore there is a clear argument that education should be integrated with the future societal needs forecasted regarding DS (Passey, 2017; Scepanović, 2019). However, the supply of labour with the right DS is currently scarce.

The Mismatch Between Supply and Demand of Digital Skills

Skills supply refers to the skills available in the workforce and society, as a result of acquired qualifications, or significant exposure/experience (Campbell, 2016). While there is a plentiful supply of labour for many sectors, employers are facing increasing challenges to find employees with the right skills for ICT related job vacancies (Aničić, Divjak, and Arbanas, 2017). For example the 2018 Employers Skills Survey (2018) revealed that 35% of all skills gaps involved a deficiency in DS, while the Digital Skills for the UK Economy report (2016) found that 72% of large companies and 49% of SMEs are suffering tech skills gaps. The Wakeham review (2016), and the more recent Augar review (2019), found that skills gaps have been highlighted for specific sectors such as Engineering and Computer Science where the skills are not meeting employer's needs. One survey found that just 16% of STEM based companies feel their skills needs are being met while 32% reported finding people with the right skills as a serious struggle (Medhat, 2014). Similarly, an e-skills survey of chief information security officers (CISOs) from 40 employers found that 85% experience recruitment difficulties due to candidates lacking the right cyber security skills (Caldwell, 2013). Due to difficulties such as this, it has been found that employers have had to inflate salaries to try and attract employees with the required DS (Manchester Digital, 2019), which over a 12 month period, is estimated to cost at least £527 million (Nania *et al.*, 2019). Overall, there is a mismatch between supply and demand with demand exceeding supply for DS which long term could hold back growth for UK businesses (ECORYS UK, 2016). Therefore, addressing this issue is of the utmost importance, with the governments Post-16 Skills Plan explaining that reforming the skills system is one of the country's most important challenges (Department for Education and Department for Business Innovation and Skills, 2016).

Where Does the Issue Lie?

Employees with the right DS are in high demand, not just for England, but also worldwide (Störmer *et al.*, 2014), and due to the rapid changes in technology, many employees who have already been through education may not have learnt what is now required. It could be expected that new job openings would be filled with those recent graduates who have most recently learned the up to date skills and knowledge required as part of their education. However, employment outcomes for computer science graduates have been found to be particularly poor (Wakeham, 2016; Aničić, Divjak, and Arbanas, 2017), as they are the most likely to be unemployed six months after graduation according to HESA statistics (HESA, 2017). It is suggested that sector work is needed to help students with their career and job search (Department for Business Innovation and Skills, 2016) while awareness of careers and the skills required would likely help students plan more effectively for their futures. For example, there are concerns many graduates are leaving university without up to date technical and softer skills required for the workforce (Dass *et al.*, 2015; Scepanović, 2019) with complaints that "students aren't industry-ready" (Davenport, Crick, Hayes, and Hourizi, 2019, p. 3), and that the content taught does not connect with occupational requirements (Lucas, Spencer, and Claxton, 2012; Elliott, 2017). A qualitative study involving 64 computer science graduates revealed that the graduates thought they lacked the transferable skills and soft skills required in industry, but many believed that due to the high demand of DS jobs available, that they would easily secure employment (Department for Business Innovation and Skills, 2016). Hence, one issue is that computing graduates are lacking the necessary skills to meet this increased demand for DS.

It could be argued that computing graduates lacking the right skills is an outcome of earlier issues present in the educational system, not just in HE. The Shadbolt Review (2016) suggests the issues affecting graduate employability originate earlier than in HE, with reports stating that the structure and content of courses are often outdated and not in sync with industry needs (Medhat, 2014; Elliott, 2017). This is echoed by Voogt *et al.* (2013a) who explains how there is a gap between the elaboration of the importance of DS in society and what actually happens in practice within education. For example, one paper mapped international secondary computer science curricula to the Cybersecurity Body of Knowledge, with the authors finding that topics such as newer technologies, internet-of-things security, and human factors were rarely included (Riel and Romeike, 2020). Furthermore, DS related courses are generally an optional subject for students and when this is the case, there has been a limited uptake of learners, and historically, this has resulted in declining numbers at GCSE level and also in A-Levels (Passey, 2017). However, in September 2014, there was the introduction of the new computing curriculum (Sentance and Csizmadia, 2017a), which established computer science as a foundational subject alongside Maths, English, and the Sciences (Crick, 2017). However, despite an increase in A-Level student numbers for computer science from 2016-2021 (British Computer Society, 2022), in 2020 it was ranked the 18th most popular A-Level with just 6% of the cohort undertaking the exam, and was the least popular of the four main science subjects (British Computer Society, 2022). Therefore, there is still only a limited proportion of level 3 students developing the skills which are developed on a DS related course. Hence, it is not a surprise that there have been calls for students to develop the key skills, understanding and cognitive approaches that stem from DS qualifications prior to HE (Webb *et al.*, 2017). Level 3 study should be investigated to understand the reasons behind this mismatch between supply and demand. Besides, firms need to engage with students earlier than in HE to help them understand what skills are required for the careers they are interested in (Dass *et al.*, 2015). For example, industry employers such as ABB Robotics explain that training should be available for all levels, not just "the immediate workplace, but also to the grassroots level in schools and colleges" (Medhat, 2014, p. 29). However, schools and colleges suffer from a variety of challenges, which influences the effectiveness of computer science teaching (Sentance and Csizmadia, 2015; The Royal Society, 2017) and so this could later influence the DS students have for HE and beyond. Therefore level 3 qualifications will now be explored.

2.2 Level 3 Qualifications

This section will discuss the level 3 qualifications that are currently on offer within England. The Wolf report (2011) which reviewed vocational education, states that England is different to most countries regarding qualifications as there are many separate qualifications, and non-governmental 'awarding bodies'. Consequently, vocational education is incredibly varied with learners able to take an incomprehensible range of routes for their education (Lucas, Spencer, and Claxton, 2012). There are a variety of post-16[1] level 3 qualifications that include academic qualifications, applied general qualifications (AGQs), Tech Levels, Occupational qualifications (e.g. apprenticeships), and

[1]'Post-16' refers to the types of courses available for students immediately after their level 2 study (e.g. GCSE's aimed at 15-16 year olds) that are aimed for 16-18 year olds. For this thesis, post-16 does not refer to qualifications for mature learners that are equivalent to level 3 such as access to higher education courses which are only available for those aged 19+.

T-Levels.

2.2.1 Academic Qualifications

There are a variety of academic qualifications available but this section will focus on A-Levels as they are the most common level 3 qualification with nearly half (47%) of all 16-18 year olds studying A-Levels (Department for Education, 2019b). They are subject based qualifications that can lead to further study, university, work or training and students can normally study three or more A-Levels over a period of two years. There used to be two main options for DS related A-Level qualifications (ICT and Computing) but a government reform resulted in A-Levels being streamlined.

A-Levels that prospective level 3 students can now study regarding DS include computer science which is offered by a variety of awarding bodies such as OCR, AQA, and Eduqas (English brand of WJEC) (British Computer Society, 2022). Meanwhile, CCEA offer A-Levels in Digital Technology, Software Systems Development and Applied Information and Communication Technology. All of the major examination boards offer some form of A-Level in a DS area, and each one of these qualifications will have different units of study within them. Hence, depending on which option students choose (or what is available) there may be areas of DS which are 'missed'.

2.2.2 Applied General Qualifications (AGQs)

AGQs are another level 3 study option mostly delivered by colleges and they allow entry into a range of HE courses in their own right or through a combination with other qualifications such as A-Levels (Department for Education, 2019b). Within this section, two main types of AGQs will be described; BTEC Nationals and Cambridge Technicals. Both are vocational qualifications which over recent decades have been subject to various changes from government intervention(Lahiff, 2015).

BTEC Nationals

BTEC (Business and Technology Education Council) Nationals are specialist work-related qualifications that combine subject and theory content with practical learning. For DS there are two main schemes of work; BTEC Computing and BTEC Information Technology. Both can be studied as a certificate (0.5 A-Level equivalent), extended certificate (1 A-Level equivalent), foundation diploma (1.5 A-Level equivalent), diploma (2 A-Level equivalent) and extended diploma (3 A-Level equivalent). Based on which option is studded will determine how many units of study a student will take. For BTEC Computing there are 23 units (Pearson Education Limited, 2020a), while the full specification can be found in Figure 2.1.

Key

	Unit assessed externally	M	Mandatory units	O	Optional units

Unit (number and title)	Unit size (GLH)	Certificate (180 GLH)	Extended Certificate (360 GLH)	Foundation Diploma (510 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
1 Principles of Computer Science	120		M	M	M	M
2 Fundamentals of Computer Systems	90	M	M	M	M	M
3 Planning and Management of Computing Projects	120				M	M
4 Software Design and Development Project	120					M
5 Building Computer Systems	60					
6 IT Systems Security	60					
7 IT Systems Security and Encryption	90	M	M	M	M	M
8 Business Applications of Social Media	90			M	M	M
9 The Impact of Computing	90				M	M
10 Human-computer Interaction	60		O	O	O	O
11 Digital Graphics and Animation	60		O	O	O	O
12 Digital Audio	60				O	O
13 Digital Video	60				O	O
14 Computer Games Development	60		O	O	O	O
15 Website Development	60		O	O	O	O
16 Object-oriented Programming	60				O	O
17 Mobile Apps Development	60		O	O	O	O
18 Relational Database Development	60				O	O
19 Computer Networking	60				O	O
20 Managing and Supporting Systems	60		O	O	O	O
21 Virtualisation	60				O	O
22 Systems Analysis and Design	60		O	O	O	O
23 Systems Methodology	60				O	O

Figure 2.1: BTEC Computing 2020 Specification. Source: (Pearson Education Limited, 2020a).

In comparison to A-Levels there is more freedom in the curriculum design as there are many optional units to choose from. For the extended diploma, there are 7 mandatory units (with combined guided learning hours totalling 720), and 14 optional units (where they must offer 6). This can mean that students with the same qualification may have studied different units if they are coming from different educational institutions. Hence, this can potentially cause difficulties for employers and HE establishments in understanding the skills and capabilities of students based on this qualification alone as certain areas of DS may be missed.

For BTEC Information Technology, there are 21 units to choose from (Pearson Education Limited, 2021), and for the extended diploma, the situation is almost identical to that of the BTEC Computing. There are 7 mandatory units (with combined guided learning hours totalling 720) and 14 optional units (where they must offer 6) and therefore this course is likely to provide the same challenges.

Cambridge Technicals

Cambridge Technicals are vocational qualifications that are designed through consultation with HE and employers and allow learners the opportunity to develop the knowledge and skills required for both the workplace and education. The Cambridge Technical in Information Technology (IT) has 4 main pathways of study (OCR, 2016):

- IT Infrastructure Technician.
- Emerging Digital Technology Practitioner.
- Application Developer.
- Data Analyst.

Similar to the BTEC courses, there are different types of study available for these courses such as a foundation diploma and extended diploma and they also offer a variety of units that are both mandatory and optional. Again, for the extended diploma options, there are 7 mandatory units. However, the combined guided learning hours is fewer than that of the BTEC courses at 510 as opposed to 720. Therefore, optional units must contribute 570 guided learning hours. For this Cambridge Technical there are 12 optional units and due to the hours required for the qualification of an extended diploma, learners must study 10 units. Hence, the Cambridge Technical still offers choice but not as much choice as BTECs meaning that learners with this qualification are more likely to share the same skills and knowledge.

2.2.3 Tech Levels

Tech Levels are technical vocational qualifications for post-16 students that wish to specialise in a specific occupation, role or industry, and provide students with the specialist skills and knowledge for employment or HE (Department for Education, 2019b).

AQA offer a Tech-level in Computer Science and IT where there are 4 main pathways of study (AQA, 2019); Cyber Security, Networking, Programming and User Support. The qualifications are either foundation diplomas, or diplomas (equivalent to 2 A-Levels) and cover various units of study. As opposed to a broad curriculum on offer with various units such as with the AGQs, these tech levels are more specific to a particular area of DS instead of DS generally. As they are only worth up to a maximum of 2 A-Levels, there is much less course content, and due to the specificity, less optional choices. For instance, the diploma in Cyber Security and Security Administration has 7 mandatory units and two optional units where students must complete one of them.

2.2.4 Occupational

In this section occupational refers to on the job training qualifications taken as part of apprenticeships. Apprenticeships range from levels 2-7 and are jobs that have practical training as part of the job which should contribute at least 20% of the time spent in work hours (Education and Skills Funding Agency, 2019a). Apprentices earn a wage and are an alternate route to the aforementioned level 3 study options discussed.

Apprenticeships are a key aspect of government policy as they help to increase skills levels, increase workforce productivity and support employability (Shury *et al.*, 2017). Apprenticeships have recently been reformed where apprenticeship frameworks were to be phased out by 2020/2021 and new apprenticeship standards introduced (Education and Skills Funding Agency, 2019b). With regards to DS, level 3 apprenticeships on offer from 2020/2021 include those such as:

- Infrastructure Technician.
- Software Development Technician.
- Unified Communications Technician.

The training part of apprenticeships are typically delivered by colleges and HE institutions but as apprenticeships require a job (something other level 3 qualifications do not require), this can mean there are difficulties in offering many of them with one survey of colleges reporting that 68% of colleges state that a main barrier in offering more apprenticeships is a lack of employers prepared to offer them (Association of Colleges, 2018d). For example, the Employer's Perspectives Survey of 18000 employers in 2016 revealed that just 18% of employers offered apprenticeships (Shury *et al.*, 2017). The report went on to explain that the main reasons employers did not offer them were due to 'perceived structural barriers' such as the company being an unsuitable size for apprenticeships. Furthermore, when asked for views on the apprenticeship reform, out of 85 colleges, 52 viewed the reform as having a negative impact, 11 as having no impact and 22 as it having a positive impact (Association of Colleges, 2018d). Therefore, colleges across the sector generally view the new apprenticeship reform as having a negative impact.

2.2.5 T-Levels

T-Levels are a two-year level three qualification that was initially proposed in the UK Post-16 skills plan in 2016 (Department for Education and Department for Business Innovation and Skills, 2016). Equivalent to three A-Levels (Department for Education, 2020b), T-Levels are an alternate route of education for students post GCSE, and have been described as the new 'gold standard' of technical education (Straw and Sims, 2019). They have been designed to support the UK industrial strategy and to enhance productivity as it has been identified that there are currently costly and growing skills gaps in key sectors (Association of Colleges, 2019b). A unique feature of T-Levels is their inclusion of a 45 day workplace component which occupies approximately 20% of the overall qualification (Department for Education, 2020b). This occupationally specific industry placement will ensure that the learner develops the technical and practical skills required to succeed in industry and finding employment (Association of Colleges, 2019b). T-Levels are based on the same model as apprenticeships, and have been developed in collaboration with employers so that the content meets the need of industry and are approved by the Institute for Apprenticeships and Technical Education (Department for Education, 2019c). September 2020 marked the

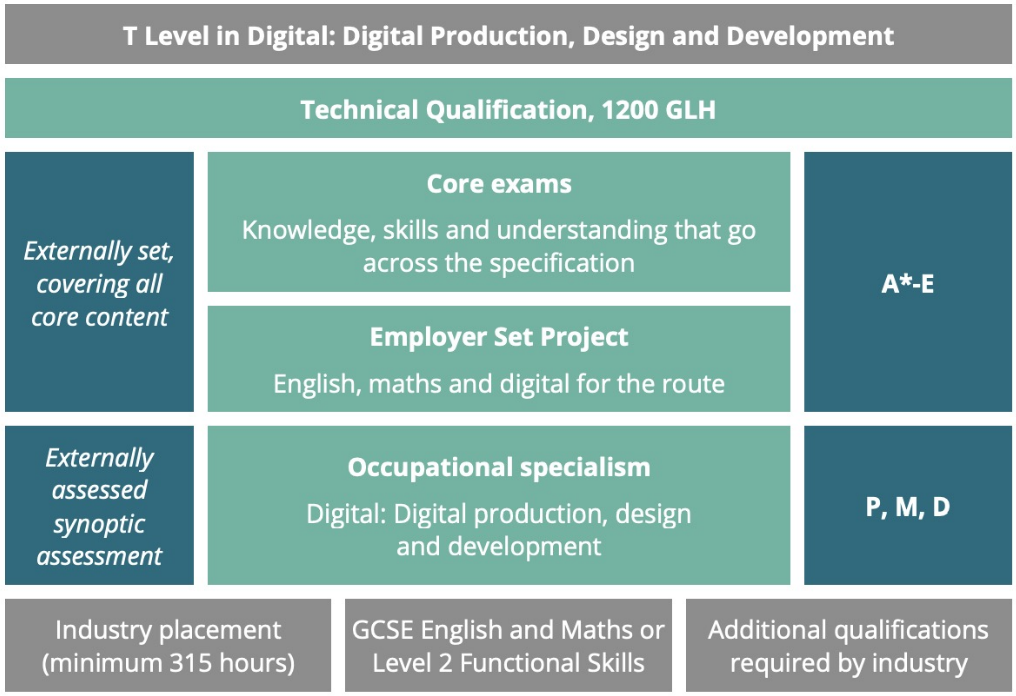

Figure 2.2: Pearson Technical Qualification in Digital: Digital Production, Design and Development. Source: (Pearson Education Limited, 2020b).

delivery of the first three T-Levels (Department for Education, 2019c):

- Design, Surveying and Planning for Construction
- Digital Production, Design and Development
- Education and Childcare

The digital T-Level is intended for students who want to progress into a career within the digital sector, but with a particular focus on software design and development (Pearson Education Limited, 2020b). In addition to the industry placement of approximately 315 hours (45 days), the digital T-Level has a core component which consists of knowledge and skills, an employer set project, and an occupational specialism component, as shown in Figure 2.2. These three areas will now be explored in further detail.

Core Component: Knowledge and Skills

The core component of knowledge and skills contains eight main areas which students must learn. Students are assessed on these content areas through two externally-assessed written examinations which are set and marked by Pearson. Both examinations are 2 hours 30 minutes, and have equal weighting. Examination paper 1 (Digital Analysis, Legislation and Emerging Issues) covers the first four content areas, while Examination paper 2 (The Business Environment) covers the second four content areas. Together these papers contribute 66% of the total mark for the core component, and are graded A*-E.

Core Component: Employer Set Project

The employer set project accounts for the final 33% of the core component. This is also graded A*-E and set by Pearson but it is an externally assessed project that takes place over multiple sessions totalling 14.5 hours. The project involves students being tasked with responding to a brief in a vocational context, where they need to plan a project, identify and fix defects in an existing code, design a solution, develop a solution and then conduct a reflective evaluation. The project is validated by an employer panel, which takes into account the client's requirements and the user experience (Pearson Education Limited, 2020b). Therefore, providing students with an assessment very relevant to what they may have to do in the workplace.

Occupational Specialism

The occupational specialism component consists of an extended design, development and implementation project, where students must respond to a scenario to design and develop a software-based solution. This is a single synoptic assessment to ensure students can demonstrate threshold competence in eight taught content areas. This project requires the submission of a portfolio of evidence which is externally assessed and takes place over multiple supervised and unsupervised sessions up to a combined total of 67 hours. This project is graded either Fail, Pass, Merit or Distinction and involves the four main tasks of analysing a problem and designing a solution, developing the solution, gathering feedback to inform future development, and evaluating feedback to inform further development.

Relevance of the Specification

The digital T-Level specification is comprehensive and covers a wide range of core technical areas such as cyber security, networking, cloud environments and managing data which are all increasingly needed in industry. Further, it has some practical assessments linked to the workplace, and this combined with the workplace component itself should help increase the employability of the students that study on a T-Level course. Therefore, the digital T-Level could be seen as a very relevant qualification in the contemporary landscape and it is understandable why it has been described as the 'gold standard' of technical education. However, the T-Level does not appear to address occupational competencies such as teamwork, communication skills, and leadership, other than simply having the industry placement. This industry experience may differ for each student and depending on the employer and job roles, students may not have the opportunity to develop these occupational competencies effectively. Additionally the two written exams are not particularly relevant and applicable to industry, as they do not go into any substantial depth or include any practical element (Association of Colleges, 2018c).

It is currently unclear how the introduction of T-levels will affect existing AGQs or Tech Levels and how popular they will be, but a survey of 90 colleges revealed that 58% applied to be early adopters of T-Levels (Association of Colleges, 2018d). However, this same survey also revealed that just 30% of colleges view T-Levels as offering better opportunities for the college and students compared to the current level 3 offer.

2.2.6 Qualification Summary

While this short overview of qualifications does not include every level 3 course available regarding DS, it can still be seen that there are a wide range of level 3 qualifications available for students, which all have different options and units of study. Due to vast array of qualifications that students can take, this can lead to qualifications having different values in the labour market (Norris and Adam, 2017). Subsequently, Ingleby and Tummons (2017) declares this will hinder young people in finding employment or progressing into HE. This is an ongoing concern with it being mentioned over a decade before both of these papers were published (Department for Education and Skills, 2006). Therefore, it is not surprising that white paper after white paper continually explain how FE is the neglected or poor relation of the education sector with qualification options continually being referred to as confusing (for example see Department for Education and Skills (2006), Department for Education and Department for Business Innovation and Skills (2016), Augar *et al.* (2019), Department for Education (2021d)).

The uncertainty regarding qualifications has encouraged employers to have a greater focus on other attributes such as work experience and ability above formal qualifications (Shury *et al.*, 2017). This is echoed by Aničić, Divjak, and Arbanas (2017) in their systematic literature review on employability for ICT graduates which found that non-technical skills such as business knowledge and project management are agreed upon areas which require improvement. Further, in the context of programming, the Shadbolt Review (2016), found that some employers are not looking for graduates with knowledge of specific programming languages, but instead, an ability to learn, recognise and select relevant languages for a given task. This hints that the conceptual underpinnings of computer science are deemed more important. Students must be taught how to learn and adapt with traditional education generally being ill-prepared in this regard (Scepanović, 2019). Consequently, advances in technology necessitate updates in curricula (Webb *et al.*, 2017). However, it is only in the last few years that changing these qualifications has started coming to fruition. A-Levels have now been reformed, but apprenticeships are still in transition with T-Levels only being introduced in 2020. There are plans to stop funding qualifications that do not provide the high-quality education that the new A-Levels, apprenticeships and T-Levels provide (Hinds, 2019), with the Department for Education (2021d) stating that they want to align the majority of post-16 education and training to employer-led standards by 2030.

Although qualifications can be reformed, this does not mean they will be successful. While the past does not predict the future, it is noteworthy that over the last 40 years, educational reforms have been plagued by qualification reforms, with the Wolf Report (2011) suggesting that prior to its publication, only two qualification reforms were genuinely successful, and it was not due to their internal design, but instead because of changes in aspirations. Therefore, given that the Department for Education has now recognised that it is important to build “an agile and adaptable workforce” (Department for Education, 2021d, p. 4) in response to increases in technological change, this suggests that there is now a clearer focus on the importance of DS. Still, the delivery of DS qualifications is still overwhelmed with challenges such as an insufficient number of appropriately trained and qualified teachers (Brown, Sentance, Crick, and Humphreys, 2014; Webb *et al.*, 2017), predominantly as changes in curriculum design often suggests a need for a change in delivery methods (Aničić, Divjak, and Arbanas, 2017). Moreover, due to the nature of focusing on student results and meeting the needs of the Office for Standards in Education (Ofsted), exams can become ‘high-stakes’ which can corrupt effective learning and teaching as the exams are not used as an indicator of learning, but instead become the goals themselves (O’Leary and Brooks, 2014). Therefore, getting students to pass tests can sometimes become a greater focus than the learning of the subject itself.

Even though certain content may be on a qualification specification, this is just a small component that contributes to what is actually taught to students (Wolf, 2011) as there are other influential factors. The most notable being that a curriculum indicates what should be taught to students, but does not indicate how to address issues that students may have (Passey, 2017), whether that be any individual learning needs or pastoral issues. With many of these reforms, teachers and further education lecturers need to go through a learning process of how to deliver the course content successfully and how to overcome student issues. The government is providing little guidance on how to implement these curriculum changes, leaving employers and educational establishments to play the leading role (Crick, 2017). Hence, addressing curriculum change is a significant challenge, which is particularly relevant for teacher training and pedagogic research (Sentance and Waite, 2018). Besides, research regarding computing education is a relatively young field (Hubbard, 2018), with pedagogy receiving less attention in technical subjects in comparison to more academic subjects with those students on technical courses often losing out as a result (Orr *et al.*, 2019). Consequently, understanding the issues which educators face in teaching these reformed qualifications effectively is something that should be further explored, as there are likely to be best practices emerging from different educators and institutions.

2.3 Colleges

This section will focus on colleges, and that includes defining what is meant by a college, presenting an overview of the college sector, and policy and legislation that has impacted the sector. Thereafter, the teaching and recruitment of teachers within colleges will be explored, before finally justifying why colleges should be investigated in their own right.

2.3.1 Definition of a College

Further Education (FE) refers to a wide variety of institutions and training providers. FE takes place after the age of 16 but before higher education (HE). Consequently FE institutions primarily offer post-16 level 3 education or skills training. Colleges make up the bulk of FE, and their breadth of provision is far greater than other providers (Snelson and Deyes, 2016), while they have the unique ability to connect learners to employers (Department for Education, 2021d). There are many different types of colleges including general FE colleges which offer a range of education and training opportunities for those aged 14 upwards, as they can also offer level 2 and HE courses (Ofsted, 2019b). Sixth-form colleges typically only offer education for those aged 16-18 (level 3 courses), and specialise in A-Level provision (Snelson and Deyes, 2016), while there are also specialist colleges that typically specialise in areas such as agriculture, and the arts (Ofsted, 2019b). For this thesis, when the term college is used, it will refer to all these types of colleges collectively, unless specified otherwise [2]. The variety of institutions in the FE sector means that FE is multi-faceted (O'Leary and Brooks, 2014) with colleges catering to learners with a wide variety of backgrounds and educational needs (Ingleby and Tummons, 2017), and becoming providers of everything to everyone (Hill and James, 2017; Augar *et al.*, 2019). Hence, teaching in

[2]The term 'college' does not include University Technical Colleges (UTCs), or secondary schools and universities that happen to have 'college' in their name. For example, Imperial College London is a university offering undergraduate (UG) and postgraduate (PG) courses but happens to have 'college' in its name.

colleges is important and complex work (Chowen, 2014; McCrone, O'Beirne, Sims, and Taylor, 2015), while colleges themselves have been subject to continuous change.

2.3.2 Policy and Legislation

Over the past few decades, there have been numerous changes in policy and legislation that has impacted on colleges, and this is important context to consider when conducting research into colleges. The number of colleges in England decreased from 325 in 2016-17 to 244 in 2019-20 (Association of Colleges, 2017; Association of Colleges, 2020c) a reduction of 81 (25%). As discussed by the Augar Review (2019), the government's FE 'area review' programme from 2015 to 2019 is likely to be partly responsible as this led to a number of mergers and closures. Between 1 September 2018 and 31 August 2019, there were 11 mergers involving general FE colleges (Ofsted, 2019b). The reduction in the number of colleges indicates the sector may be suffering from some challenges, while college mergers have historically been driven by financial issues (Snelson and Deyes, 2016; Popov and Cattoretti, 2019). However, financial issues are just one issue affecting colleges, while there have been many other influencing factors. Consequently, a timeline of events has been created (see Figure 2.3) which details legislation, major reviews, key governmental changes, and changes in organisations that would have, in some capacity, influenced colleges, and hence, the teaching of DS.

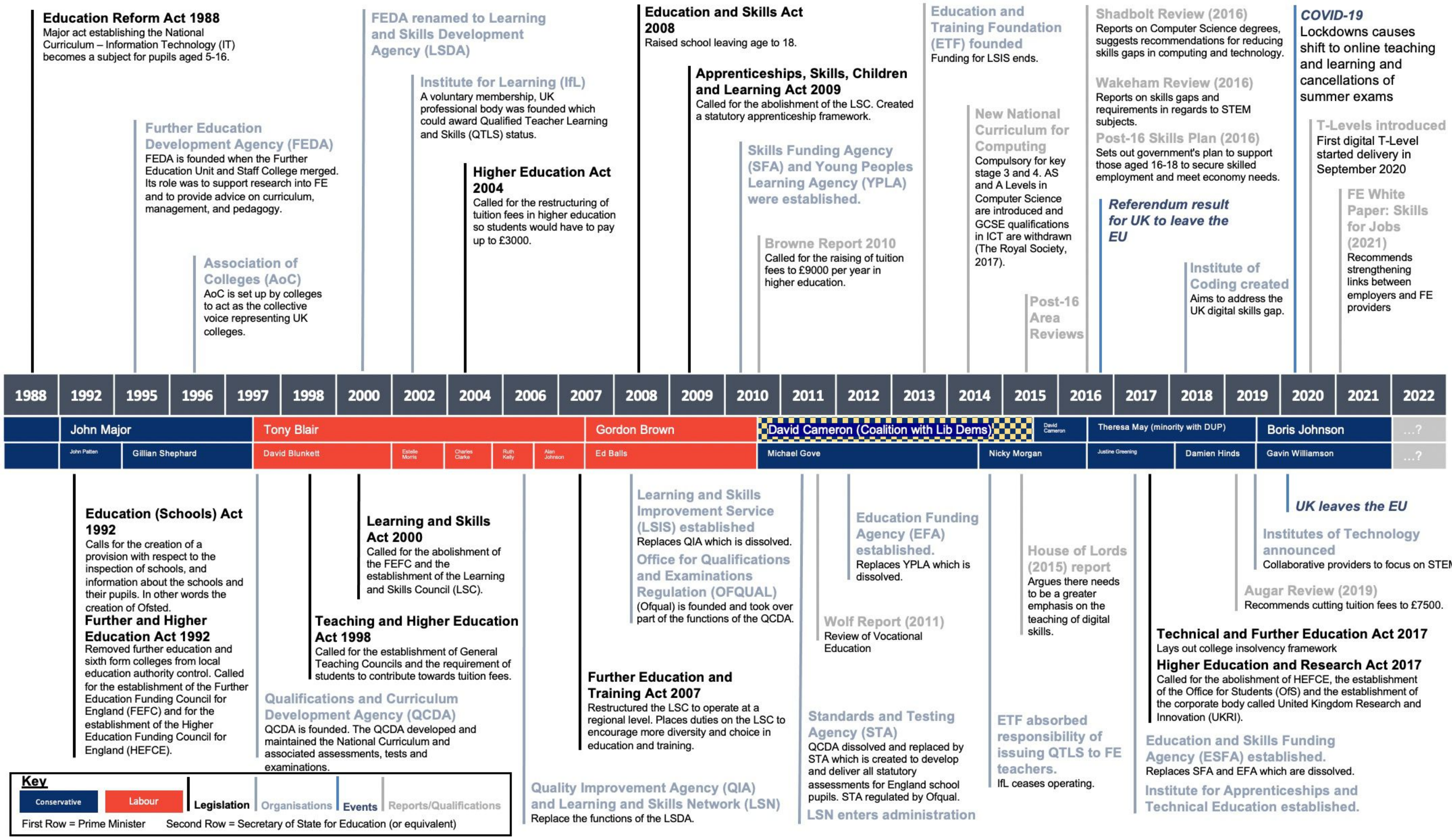

Figure 2.3: Timeline of Events Influencing the College Education Sector within England.

From this timeline of events, it is clear that there are numerous changes which will have influenced how colleges operate and what they teach. Hence, this is important context to consider when investigating the challenges college face in teaching DS and how to overcome them. The first major change occurred in 1992, with the Further and Higher Education Act. As stated by Hill and James (2017) this allowed the Secretary of State to create FE corporations, where to enact the corporation, a governing body had to be formed. This meant colleges were removed from local authority control, allowing them more autonomy in how they run and what they teach. To be successful, this requires good leadership and a good governing body overseeing how colleges operate. However, as explained by Hill and James (2017), the governance of colleges has not been a highly researched area, and so understanding the perceptions of individuals on the board of governors of colleges may prove insightful.

The Further and Higher Education Act 1992, also allowed a number of polytechnics to become universities and it called for the establishment of the Higher Education Funding Council for England (HEFCE), and the Further Education Funding Council (FEFC), who's remit was to distribute funding to colleges now that they were no longer under local authority control. The FEFC was abolished by the Learning and Skills Act 2000, being replaced by the Learning and Skills Council (LSC). Meanwhile, this was closed shortly before the coalition government on 31 March 2010, and was replaced by the Skills Funding Agency (SFA) and the Young Peoples Learning Agency (YPLA), where both were later abolished and replaced by other similar organisations.

It can be seen that from 1992 on-wards, a variety of organisations and agencies have been developed and later abolished, only to be replaced by a similar organisation. Norris and Adam (2017) substantiates this nonsensical change in organisations by what they refer to as 'policy churn'. Their review on policy changes and its impact on FE is claimed to be influenced by the fact that ministers and policymakers are unlikely to 'make their mark' if they do not suggest change. The authors further contend that due to further education receiving less attention than schools and HE, a perception held by many other authors (Thompson, 2014; Burnell, 2017; Ingleby and

Tummons, 2017; Augar *et al.*, 2019), this gives government much greater freedom, and incentive to make changes in that sector (Norris and Adam, 2017), and clearly, these changes are both frequent and large in impact. The governments Post-16 Skills Plan (Department for Education and Department for Business Innovation and Skills, 2016), acknowledges these changes and states that past reforms over the decades have often failed because they lacked commitment, with government changing plans before they could have any meaningful impact. A prime example of this is the ephemeral existence of the Quality Improvement Agency (QIA), which itself was formed with the guise of fulfilling previous organisations responsibilities such as that of the Learning and Skills Development Agency (LSDA) amongst others. The QIA was created in March 2006, and according to a 2006 white paper, it would be fully operational by April 2007 (Department for Education and Skills, 2006). However, as time elapsed, the QIA would only be operational for two and half years, being dissolved in October 2008 and its functions transferred to that of the Learning and Skills Improvement Service (LSIS), which itself only lasted until July 2013. These changes come at a cost, with a new department being estimated as costing £15 million in the first year alone (Norris and Adam, 2017), which has clear economic implications as this money could be better spent elsewhere.

Some change in legislation has been for the better. Prior to the Education and Skills Act 2008, which raised the education leaving age to 18, the Department for Education and Skills (2006) reported that the proportion of young people staying on in education post-16 was extremely low, with the UK ranking 24 out of 29 developed nations on this matter. Due to this legislative change in 2008, this meant that more people would have to continue studying than before, resulting in more students likely to enrol on to level 3 programmes of study at colleges across the country. Nevertheless, as discussed in the previous section of this chapter, level 3 qualifications are numerous with qualification reforms ongoing. For this reason, the author agrees with both Ingleby and Tummons (2017), who assert that the FE sector appears to be lacking in a coherent education philosophy, and Wolf (2011), who argues that England does not have a good educational system. Still, throughout all of these reforms, there is an imperative to provide the high-quality service to upskill existing and new teachers in delivering these qualifications (Crick, 2017), with the FE 2021 white paper 'Skills for Jobs: Lifelong Learning for Opportunity and Growth' stating how the government plans on launching a national recruitment campaign for teachers in FE settings, to base teacher training on employer-led standards, and to improve the provision of professional development for teachers (Department for Education, 2021d). However, whether this actually happens remains to be seen, and based on the multitude of changes that has occurred in the past, what has been said has not always come to fruition. Therefore, the next section will explore teaching and recruitment within colleges in further detail.

2.3.3 Teaching and Recruitment Within Colleges

> *'Preparing students to become literate in computing activities requires the training of tens of thousands of teachers in computer science'*
>
> (Yadav and Berges, 2019)

Training computer science or DS teachers poses many questions regarding what the best practices are for preparing them effectively (Yadav, Gretter, Hambrusch, and Sands, 2016). Armoni (2011) discusses computer science teacher preparation programmes, and explains that computer science includes elements of mathematics, science, and engineering, and that at the time of publication, there was little literature available on computer science teacher education. Meanwhile, the professional status of FE teaching has been documented as being precarious in policy, academic and professional literature (Hanley, Hepworth, Orr, and Thompson, 2018). At the same time, initial teacher training (ITT) for the FE sector in England has been reported as being just as complex as the variety of learners and qualifications they provide (Thompson, 2014). The following are the core qualifications people can take to teach in FE (Greatbatch and Tate, 2018):

- Level 3 Award in Education and Training (AET) – a broad overview of teaching in FE, covering topics such as lesson planning and teaching practice. They are course delivered for 1-2 weeks at level 3 or 4.

- Level 4 Certificate in Education and Training (CET) – typically 6-

month courses, targeted at those delivering training but do not design qualifications.

- Level 5 Diploma in Education and Training (DET) – the primary entry route for teaching in FE, courses are delivered at level 5 and are typically a yearlong studying full time

- Level 5 Diplomas in Education and Training with a subject specialism in either Numeracy, Literacy, and/or English for Speakers of Other Languages (ESOL).

- There are also courses such as Cert ED, ProfGCE (level 6) and PGCE (level 7) courses offered by HE institutions for trainee teachers who wish to enter the FE sector.

If someone has completed a level 5 or above teaching qualification, they can apply to the Society for Education and Training (SET) for qualified teacher learning and skills (QTLS) status. This is similar to that of what school teachers hold as qualified teacher status (QTS), and having QTLS shows that the individual has the skills and knowledge at a certain professional level.

A major problem with gaining FE teaching qualifications is that compared to secondary teacher training courses where most trainees are grouped by subject, for FE it is often catered to a wide diversity of trainees and subject areas (Lucas, Nasta, and Rogers, 2013; Orr *et al.*, 2019; Thompson, 2014). While this reflects the college environment, it means the majority of advice is on generic pedagogy (Hanley *et al.*, 2018). Hence, subject specific teaching skills is lacking as it is often up to the trainee to apply generic pedagogy knowledge to their own subject of teaching (Lucas, Nasta, and Rogers, 2013). Similarly, due to advancements in technology, these advancements should be factored into ITT curricula but keeping up with these changes is problematic (Voogt *et al.*, 2013a), and therefore a key issue is identifying the knowledge that prospective teachers are expected to have (Armoni, 2011). The subject specialist element of ITT in FE has been consistently criticised for being too weak (Orr *et al.*, 2019), with providers explaining how they are not always confident that trained staff will be of a consistent standard after their ITT

(Department for Education, 2021d). Hence, many recently graduated FE teachers may still not have the suitable requirements to teach their subject effectively, whether this be for DS or other subjects.

There are a variety of factors which are likely to influence the recruitment of college teaching staff, with a key issue being the lack of funding (Chowen, 2014; Augar *et al.*, 2019), or requiring teachers with strong subject specialisms, (Greatbatch and Tate, 2018), particularly in English and STEM subjects (Chowen, 2014). Even in 2020, the Department for Education and the Association of Colleges both report how colleges struggle to recruit English and Maths staff (Consulting, 2020; Association of Colleges, 2020a). Over the past few years, colleges have been suffering from recruitment difficulties (Association of Colleges, 2018b; Consulting, 2020; Department for Education, 2021d). However, this is not unexpected given there are not enough skilled staff available in the education industry overall (Department for Digital Culture Media and Sport, 2019), that teacher training applications have been decreasing in recent years (Zaidi, Howat, and Caisl, 2017), and that average FE teacher pay has been reported to be £7000 less than that of within schools (Association of Colleges, 2018a). This culmination of issues has resulted in FE teaching being less appealing for prospective teachers.

2.3.4 Why Investigate Colleges?

The FE sector has undergone some dramatic changes in recent years (Burnell, 2017) while increased levels of digital skills and the ability to adapt and learn new competencies are progressively becoming a requirement for the general population (Störmer *et al.*, 2014). University courses will be essential for developing employees with the right DS for the future, but the valuable contribution made by colleges should not be ignored (Medhat, 2014; Department for Education, 2021d). Colleges can help meet the DS demand and bring forward industry ready employees in a much shorter space of time (Medhat, 2014), and so FE will play a pivotal role in developing the next generation of employees with the high level of DS required (House of Lords, 2015). However, the subject specialist elements of ITT for FE has been criticised as being weak (Orr *et al.*, 2019), there are recruitment difficulties (Chowen, 2014; Department for Education, 2021d), and reforms to post-16 education qualifications are providing considerable challenges (Greatbatch and Tate, 2018). Still, the education inspection framework by Ofsted (2019a) explains how there has been a relative paucity on research in the FE sector, with the Augar Review (2019) stating that they were 'struck' by the modicum of data and research available in the college sector, relative to that of schools and HE. Therefore, the challenges colleges face and what could be implemented to address them should be investigated, so suggestions can be made regarding what is needed to help those teaching DS within colleges.

2.4 Educational Systems Theory

Now that DS, level 3 qualifications, and colleges have been discussed and the appropriate contextual foundations have been laid for this thesis, it is important to understand how these factors interact and to present an underpinning theory. Given that this thesis concerns education, a systems model of teaching and learning was deemed the most appropriate. Biggs (1993) presage-process-product (3P) model of student learning (Figure 2.4) has been considered for understanding what the important factors are to consider when conducting educational research.

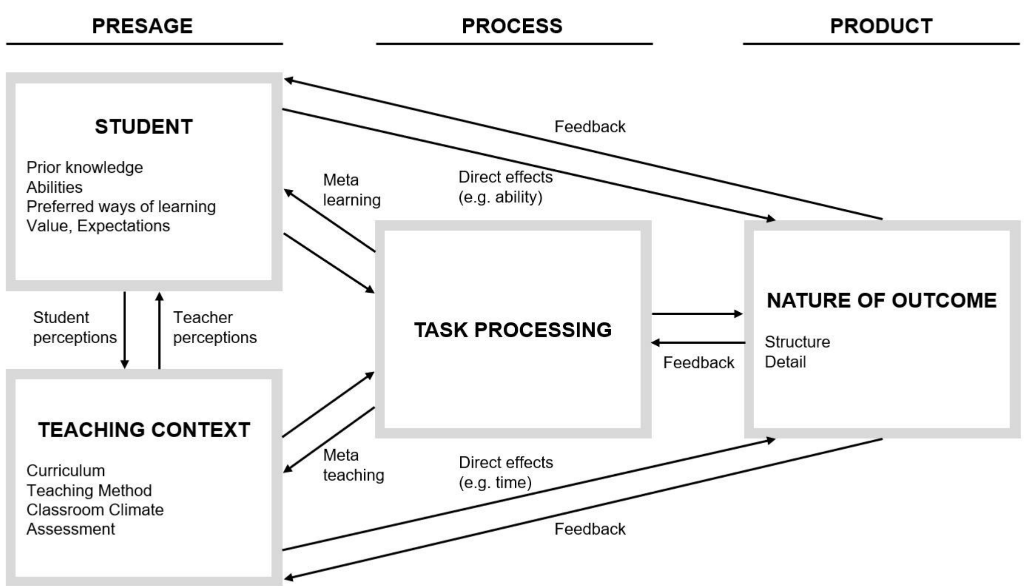

Figure 2.4: The 3P Model of Classroom Learning. Source: (Biggs, 1993).

The 3P model is certainly not a theory of educational systems designed for the contemporary educational landscape given it was produced in 1993, but it is the result of numerous iterations of a model to explain how components within education interact with each other. Hence, it can be very useful to understand relationships between components and what these actual components may be. Biggs (1993) contends that attempts to improve teaching and learning should be grounded in theory, and that theory should be built around the context in which it will be applied and so Figure 2.4 will now be discussed in the context of DS, level 3 qualifications and colleges.

The 3P Model has four main components which all influence one another; the student, teaching context, task processing and nature of outcome. For effective student teaching and learning, all four need to be in balance: to achieve an equilibrium. However, in the context of DS, colleges and level 3 qualifications, this equilibrium is not being achieved successfully. With regards to the nature of outcome, this refers to the mismatch between supply and demand of those people in society with the right DS and knowledge. Level 3 has been identified as an area where this problem may originate and so by using the 3P Model it is possible to classify three different areas that influence this. With regards to students, it has been shown that a students prior knowledge has an influence on the misconceptions and difficulties faced regarding computer programming (Qian and Lehman, 2017). Therefore, the teachers teaching these students need to be aware of any misconceptions they have as this will influence their own teaching practice. This is in alignment with constructivism, which contends that teachers should not be seen as knowledge transmitters, but instead as mediators who assist students in constructing their own knowledge (Armoni, 2011). This refers to the teaching context, which includes the curriculum being taught (i.e. the level 3 qualifications), the colleges itself, classroom sizes, methods of teaching and so on (Biggs, 1993). Task processing refers to the execution of the curriculum, which includes the teaching and learning activities taking place to try and achieve the desired outcomes. This model makes it clear that the student and teaching context would influence the teaching process, and hence, overall outcomes. Due to each component being part of a much larger system, the whole system must be understood when conducting educational research. Hence, understanding college context is extremely important.

To further understand college context, Biggs (1993) presents another systems model (Figure 2.5) based on the notion that education and learning has layers and that each system (e.g. a college) has several nested micro-systems embedded within it (e.g. teachers and senior leadership teams).

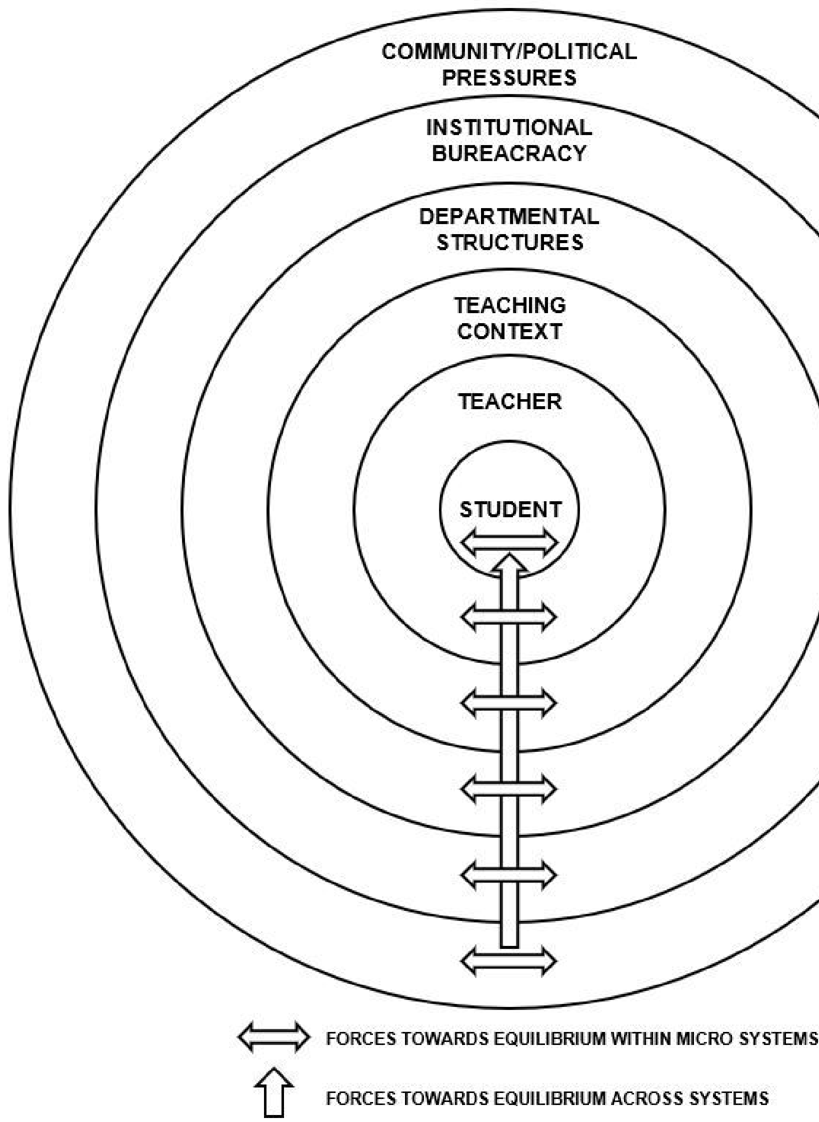

Figure 2.5: Macro and Constituent Micro-Systems in Tertiary Education. Source: Adapted from (Biggs, 1993).

While this model was presented in 1993, it can be seen how it can be applied to education institutions now. Biggs (1993) suggests that an equilibrium should exist between both each layer and also between layers, in particular where layers are adjacent to one another. For instance, a teacher may be most concerned with their own teaching, but ultimately, they are constrained to the teaching context they teach within, the department they are in, and any institutional bureaucracy that may exist. The main implication arising from this model is that educational research should not only consider the whole process of classroom learning (as shown in Figure 2.5), but to also consider the different viewpoints, experiences and perceptions of both those in the specific micro-system being targeted and those in higher or lower micro-systems. These systems are interdependent and larger systems can have serious impacts on the systems closer to the centre (Biggs, 1993).

To summarise, this section on educational systems theory has indicated that an individual part of an educational system should not be investigated in isolation. Instead, it should be considered in relation to the whole educational context and the different micro-systems that form the larger system itself.

2.5 Chapter Summary

A number of high profile policy reports have shown that there is a 'digital skills gap' (Crick, 2017), with demand being greater than supply with the possibility of this worsening over time (Aničić, Divjak, and Arbanas, 2017). There are a wide variety of DS qualifications and qualification reforms meaning that educational institutions offer different qualifications with employers often unsure and confused (Wolf, 2011) as to the quality and the depth of knowledge and skills that different qualifications provide. There is little evidence or evaluation about which policies and reforms have worked successfully (Norris and Adam, 2017), and so educational best practice is in short supply. This issue is worsened by the fact that curriculum change involves a period of transition which can take many years (Sentance and Waite, 2018). Further, the wide variety of qualifications can mean that in each qualification certain areas of DS may not be covered effectively, especially when providers can choose what units to offer in certain qualifications such as within the AGQs. Besides, just because a topic may be within a course specification, this plays just a small part in determining what is actually taught (Wolf, 2011) with Figure 2.4 indicating that classroom learning is part of a wider educational system, and that the challenge's educational institutions face, and the implications arising from changes in policy, are likely to influence what they teach.

The FE sector has been subject to continuous change over the last three decades (Norris and Adam, 2017), has historically had a lack of investment (Department for Education, 2021d), and has been described as over-complicated, challenging, frustrating and full of inconsistencies (Crawley, 2012). However, colleges offer a wide variety of qualifications and are pivotal to addressing the DS gap (House of Lords, 2015), with both the government and key reviews stating that FE should be at the forefront of providing learners with the tools and opportunities required to progress into skilled employment (Augar *et al.*, 2019; HM Treasury, 2020). Policy changes and reforms are providing many challenges to the FE sector (Chowen, 2014; Norris and Adam, 2017) while the varying characteristics of learners and complex curriculum offer for colleges can further exacerbate these issues (Greatbatch and Tate, 2018). Equally, Davenport *et al.* (2019) state that with all the different reforms, reviews, reports, and activities, that there is a lack of connectedness and policy coherency regarding addressing the DS crisis. With the UK leaving the European Union, this only creates a greater importance on the skills of the UK workforce (Shury *et al.*, 2017) and those who train and educate them, while the recent COVID-19 pandemic has not only had a profound effect on colleges (Association of Colleges, 2020d), but it has also emphasised the importance of basic DS as more people have had to adapt to online working.

Education should support students in engaging in curricula that is most effective at supporting the needs of the future economy by providing students with the necessary skills (Aničić, Divjak, and Arbanas, 2017; Passey, 2017). However, there are a culmination of issues indicating that the existing DS qualifications are either ineffective, or that there are challenges influencing how they are being taught.

2.5.1 2021-2022 Sector Updates and the BCS Landscape Review

In March 2022, the British Computer Society published their landscape review of Computing Qualifications in the UK (British Computer Society, 2022). Although focused on all four jurisdictions of the UK, and not explicitly focusing on colleges, the report provides a wider context of where this study is situated, and so the report's findings and recommendations provide the opportunity to help contextualise the need for research into DS at level 3 within colleges. In alignment with what has been presented so far regarding DS and level 3 qualifications, the BCS landscape review indicates the growing appreciation among policy makers and employers for the role of digital qualifications, which has been further exacerbated by the COVID-19 pandemic (British Computer Society, 2022). This has influenced colleges by having to teach online, with the recognition in literature that this transition is far more than just putting elements of learning onto an online environment (Hamer and Smith, 2021). Skills of this nature, in addition to the skills needed generally for teaching DS have been shown to be lacking in the general workforce, with the BCS emphasising how the supply of qualified and trained teachers for these qualifications is a challenge for all four nations (British Computer Society, 2022). Here, the report refers to teacher supply being an issue for a variety of types of educational institution, let alone colleges, which have been highlighted in this thesis as an area where teaching and recruitment is already a challenge generally.

Recent initiatives have now been introduced for the FE sector to address the recruitment concern, such as bursaries for FE teachers from 2021-2022, including for computing as a subject area (Department for Education, 2021a), but this does not address years of sector-wide neglect, nor does it make up for the shortfall in DS teachers that is seemingly apparent for colleges. Furthermore, there is little research exploring the effectiveness of teacher education programmes, with some authors questioning the unjustified assumption that employment and retention rates are suitable proxies for quality (Mayer and Oancea, 2021). Hence, these factors further warrant the investigation into colleges as to what constitutes good practice for teaching DS and understanding what it is like to teach DS in a college environment. Besides, there is a scarcity of research considering what is effective teaching practice in FE, with growing calls to support the performance of FE lecturers (Smothers, Cropley, Hanton, McKay, and Williams, 2021).

The BCS review also recognises that understanding what qualifications are geographically accessible to all remains a challenge (British Computer Society, 2022), with participation in vocational and technical qualifications being varied across the four nations, yet showing an overall decline in participation rate. In contrast, they report the new computing curriculum has been taken up rapidly, with more schools offering GCSE and A-Level Computer Science than previously offered (British Computer Society, 2022). However, the report also indicates that entries have reached a plateau and are still below the peak of 2014/2015, while also making reference to the digital skills gap, stating "this report also intimated concerns with a mis-match between what the system might offer and what employers and learners want and need" (British Computer Society, 2022, p. 57). However, the government is now taking strides to address these concerns, with particular mention given to the FE sector.

The Skills and Post-16 Education Bill outlines how the government's policy objective is to ensure that FE provision is aligned to local needs (Department for Education, 2021c), through initiatives such as 'The Skills Accelerator' that will help shape post-16 technical education and training through working with employers and colleges (Department for Education, 2021c). Similarly, the Skills for Jobs white paper discusses the creation of Institutes of Technology (IoTs) to allow further collaboration between colleges, universities, and employers, in order to provide higher-level technical education in STEM skills (Department for Education, 2021d). Recent studies have shown progress regarding these attempts at collaboration. For example, James Relly and Laczik (2021) explain that despite the recruitment problems in FE, there is good practice occurring between colleges and employers, such as in their study about apprenticeship provision. However, collaboration is more likely to occur in courses such as apprenticeships due to their workplace component. Whether collaboration occurs otherwise is not as clear, nor is it clear why institutions offer the curricula they do. Hence, with regards to DS curricula, the BCS identifies some key issues such as: identifying what a good number of students look like, securing appropriately qualified teachers, whether generic or specific DS should be emphasised, and what curricula should look like (British Computer Society, 2022). They recommend that regular reviews are conducted to assess DS qualifications and skills needs, and for a task force to examine and report on what qualifications are offered so that an understanding can be acquired of what works (British Computer Society, 2022). This is recommended for all four jurisdictions of the UK and would include all types of educational institutions offering level 2 and 3 DS related qualifications. However, given the neglect that is apparent within the FE sector (Orr, 2020), it could be argued that this trend may continue. Hence, understanding what DS curricula is offered by colleges and why, would provide a key contribution to the overall research need surrounding DS curricula. Therefore, what DS qualifications are taught within colleges and how that decision-making process is made is something that will be investigated in this thesis. This is particularly important given that there has been a paucity of research into the FE sector (Augar *et al.*, 2019; Ofsted, 2019a) and that there is a lack of UK capacity for research into computer science education (Crick, 2017).

2.5.2 Areas for Future Research

Based on the literature provided regarding the importance of DS, the variety of level 3 qualifications and the ongoing changes occurring within colleges, this culminates in the formulation of research question 1:

RQ1 – How do colleges decide what 'digital skills' qualifications and units of study to teach their post-16 level 3 students?

This research question aims to identify why colleges teach what they teach. This is because there a number of different qualifications that exist to choose from, and many units within many of the qualifications themselves. While DS are required everywhere, specific regions and counties have higher demand for certain types of DS than others which educators can exploit (Nania *et al.*, 2019). Each individual college will have their own idiosyncrasies, local context, history and strategic agendas and consequently colleges must make a choice of what education they offer, and research question 1 aims to understand the reasons behind that choice. To do this effectively, this will require understanding the viewpoints of those involved in the decision-making process of what is taught. This lends itself to qualitative research as this emphasises meanings and experiences (Coolican, 2013) which in this situation would be the reasoning behind offering certain qualifications and units of study. Semi-structured interviews would be a suggested form of data collection as these allow the interviewer the opportunity to further investigate interviewee responses (Saunders, Lewis, and Thornhill, 2019), which is likely to be needed to gain a depth of understanding regarding why certain decisions have been made.

However, for this to be effective, the right people within a college must be identified as the decision making process for what is offered may be chosen by different layers of an educational system, yet influenced by others adjacent to them (Biggs, 1993). Those involved in the decision may be teachers, head of departments, senior leadership teams or a combination of stakeholders. Additionally, colleges may suffer from a number of challenges which influence what they teach at level 3 and so these issues are also incredibly important. Therefore the next chapter will explore these challenges in more depth.

Chapter 3

Challenges of Teaching Digital Skills

Based on the context given of digital skills, the variety of level 3 qualifications available and information regarding colleges, this chapter will explore the challenges that influence the teaching of digital skills. This will be accomplished by first conducting a macro-environment analysis of the college sector through a PEST analysis. From this PEST analysis, themes will be identified which will then be explored in greater depth. After all the themes have been discussed, a summarising conceptual framework will be presented of how these challenges interlink in addition to recommendations for future research.

3.1 Macro-Environment PEST Analysis

The education sector is complex, and is influenced by a variety of factors, whether that be politically, economically or socially (Ingleby and Tummons, 2017). Therefore, a PEST analysis has been constructed (Figure 3.1) as this allows one to establish the macro-environment of the college education sector, (Johnson, Whittington, Angwin, Scholes, and Regner, 2013) by considering political, economic, social and technological factors. By looking at issues collectively, some key drivers for change can be identified (Johnson *et al.*, 2013). However, PEST factors may interact and so they could be placed in different categories, while a PEST analysis represents just a static view of the macro-environment and so these factors will likely change over time. Nevertheless, it provides a useful starting point to summarise the external factors that are affecting colleges and therefore helps identify the challenges that colleges are facing. It is important to understand what these challenges are so practices can be put into place to help overcome them, which could therefore help address the DS gap.

POLITICAL FACTORS

Wide variety of DS qualifications. Including an increase of those with a workplace element such as T-Levels (Department for Education, 2019). This can result in teachers without the necessary knowledge for teaching certain units. Concerns over the quality of teaching.

Changes to the requirements to be a college teacher with wide variation in initial teacher training (Greatbatch and Tate, 2018; Hanley, et al., 2018; Thompson, 2014). Results in teachers lacking the required knowledge.

Changes to curricula are ongoing without any scope for addressing the changes, such as CPD opportunities (The Royal Society, 2017). This can result in an extra time commitment for teachers and require them to adapt consistently.

Changes in Education Policy could affect DS teaching in numerous ways.

The school leaving age is 18 (Education and Skills Act, 2008).

Compliance with GDPR. This can result in increased security measures and costs.

ECONOMIC FACTORS

Salaries for college teachers are low relative to what computing specialists can earn in industry (Davenport, et al., 2019; Migration Advisory Committee, 2017) or what is earnt teaching in schools (Association of Colleges, 2018). This can result in a lack of teachers entering the profession to teach DS and teachers leaving the profession.

Decrease in government funding for colleges and insufficient funding (Association of Colleges, 2018; Greatbatch and Tate, 2018; Skills Funding Agency, 2016; The Royal Society, 2017; Sentance and Csizmadia, 2017). This results in insufficient funding for staff, resources, CPD etc for DS teachers.

PEST ANALYSIS

TECHNOLOGICAL FACTORS

Changes to standards, equipment (hardware and software) and course materials required (Black, et al., 2013; The Royal Society, 2017; Gal-Ezer and Stephenson, 2014; Department for Digital, Culture, Media and Sport, 2017). Results in added costs and time commitment for DS teaching.

Risk of selecting or using the wrong or not appropriate technology (The Royal Society, 2017). This can result in ineffective teaching for the curriculum.

Time and resources required to manage, update and learn new systems (Sentence and Csizmadia, 2017) lead to a lack of time for DS teachers.

Curriculums lagging behind industry (Hinds, 2019; Lucas, et al., 2012; Medhat, 2014; ECORYS UK, 2016). This can lead to curriculum concerns as what is taught is not what is needed.

Cyber security threats are ongoing. Can lead to Increased security measures (added cost) – can't access resources.

SOCIAL FACTORS

Demand for employees with digital skills is increasing (Association of Colleges, 2018; ECORYS UK, 2016; Skills Funding Agency, 2016; Stormer, et al., 2014).

The number of people entering the teaching profession is decreasing (Zaidi, et al., 2017; Sibieta, 2018) with colleges suffering from recruitment difficulties (Association of Colleges, 2018), due to there not being enough skilled staff (Department for Digital, Culture, Media and Sport, 2019; Moller and Crick, 2018; Black, et al., 2013; The Royal Society, 2017). This results in a lack of teachers with the required knowledge and places a strain on existing teachers.

College staff receive little CPD or upskilling opportunities (Association of Colleges, 2018; Greatbatch and Tate, 2018; The Royal Society, 2017), while initial teacher training is ineffective (Orr et al., 2019; Ofsted, 2019). Meanwhile, many teachers within colleges are employed without already having a teacher qualification (Greatbatch and Tate, 2018; Zaidi, et al., 2017). Results in teachers lacking the required knowledge.

Computer science graduate outcomes are poor (HESA, 2017; Wakeham, 2016). Concerns have been raised regarding curriculum and teaching standards.

Figure 3.1: PEST Analysis of the College Education Sector.

From this PEST analysis, a variety of themes have been identified. There are a number of factors that suggest there is a lack of knowledge regarding teaching DS, whether that be from a lack of CPD, poor ITT, or a lack of teachers entering the profession. Equally it is evident that a lack of funding is an issue for colleges generally but more pertinently for DS teaching due to the subjects' requirements. It is also suggested that many of the factors can lead to a lack of time for college staff, or inadequate resources for teaching. Meanwhile, wide variations in qualifications, learners and teacher's knowledge, combined with poor graduate outcomes suggests there are issues with the curriculum. Hence, within this chapter, these six main themes will be explored:

1. Lack of knowledge
2. Funding issues
3. Insufficient time
4. Curriculum concerns
5. Resource challenges
6. Other teaching difficulties

3.2 Lack of Knowledge

There is a lack of knowledge in colleges for teaching DS and this is due a number of reasons. There is a lack of teachers entering the teaching profession, which is a common issue internationally (Brown *et al.*, 2014). For example, for computing in particular within England, it has been reported that under 75% of the target figure has been met for the recruitment of computing teachers to initial teacher training from 2016-2017 to 2021-2022 (British Computer Society, 2022). However, pupil numbers are expected to increase by 15% between 2018 and 2025 (Foster, 2019b; Department for Education, 2019d). Hence, teaching training applications will need to increase to meet this demand as already from 2010 to 2018 the pupil: teacher ratio has increased from 15.5 to 17 (Sibieta, 2018). Therefore, within the education industry there is a premium on appropriately skilled staff (Department for

Digital Culture Media and Sport, 2019), with a survey of 138 colleges showing that the main staff recruitment difficulties are insufficient experience (47%), a lack of necessary specialist skills (74%), and applicants looking for more pay than could be offered (63%) (Association of Colleges, 2018b).

Acquiring teachers with the right DS knowledge is problematic. Across the UK, the greatest recruitment challenges are faced by those who are seeking workers with digital skills (Dass *et al.*, 2015; Medhat, 2014) and this is certainly the case for the education industry. Delivering education presumes that there is a supply of educators, but this is a major challenge for computing education within the UK (Brown *et al.*, 2014; Moller and Crick, 2018). There is evidence of a shortfall of suitably qualified and skilled computing teachers (Yadav *et al.*, 2016; The Royal Society, 2017; Webb *et al.*, 2017; Yadav and Berges, 2019) with one paper revealing that there is a need for strong subject knowledge in computer science with teachers feeling this is lacking (Black *et al.*, 2013). Furthermore, there are few computer science graduates entering the teaching workforce (Webb *et al.*, 2017) with computer science graduates representing just 2% of all teaching professionals (Migration Advisory Committee, 2017), and just 50-60% of technology teachers are reported to have a relevant degree (Sibieta, 2018). There is the risk this situation could worsen if support is not put in place (The Royal Society, 2017) as retaining early career teachers has been getting worse with over 20% of new teachers leaving the profession within 2 years and 33% leaving within their first 5 years (Department for Education, 2019d). This may be more prominent for computing and technology subjects as computer science graduates can earn substantially more outside the teaching profession (Migration Advisory Committee, 2017) as those with the right DS in the digital sector typically earn £10,000 more than in other sectors (Davenport *et al.*, 2019). There is a shortage of DS teachers, and this shortage is more prevalent than the general shortage of teachers entering the teaching profession overall.

Due to a lack of teachers entering the profession, this can cause problems for existing teachers. Teachers may have to teach in areas outside of those they are knowledgeable in (Ofsted, 2019a; Yadav and Berges, 2019) to make up for the shortfall in teachers. One paper which interviewed FE lecturers, revealed that some struggle with teaching a class at FE level one moment and then in the next, teaching HE content (Feather, 2012). Likewise, the resourcing of compulsory English and Maths provision presents further challenges on college teaching staff (Chowen, 2014; Association of Colleges, 2020a; Consulting, 2020) as they may not be suitably qualified to teach these subjects (Greatbatch and Tate, 2018). Notably, UCAS (2019) state that to teach in FE, you would need a minimum level 3 qualification in the subject area and also a teaching qualification relevant to the level of teaching responsibility. However, the employer (i.e. the college) is free to set their own entry requirements (UCAS, 2019), so the teachers may not initially be suitably qualified. This is important given that whether teachers have a relevant degree in the subject they teach is a key indicator of teaching quality (Sibieta, 2018), as effective teaching and learning requires strong subject knowledge (McCrone *et al.*, 2015). However, if the teacher has significant industry expertise they do not necessarily require a teaching qualification to teach effectively in colleges (Greatbatch and Tate, 2018) as they have been practicing those skills and competencies first-hand in the workplace. Consequently, many FE teachers complete their initial teacher training on the job (Lucas, Spencer, and Claxton, 2012).

A student's digital education depends on the skills and competences of those teaching them (ECORYS UK, 2016), which includes both the teacher's subject knowledge and pedagogical approaches used (Passey, 2017; Webb *et al.*, 2017; Yadav and Berges, 2019). Hence, the quality of teaching and training is the most influential factor for learners to achieve positive outcomes (Chowen, 2014; Lucas, Spencer, and Claxton, 2012; Villeneuve-Smith, Bhinder, and West, 2009; Wilson, Wilkin, and Rowe, 2012). Every student deserves to have teachers who have the confidence, up to date knowledge and skills, but it is evident that those teaching DS students may not always have the right expertise to do so effectively. This is exemplified in the work by Yadav *et al.* (2016) who explains how beginning computer science teachers may lack the experience or ability to explore concepts in depth with their students. Similarly, some teachers may not have used their degree for a number of years, and so their knowledge is outdated, or that their degree did not include a DS component at all (Brown *et al.*, 2014). Equally, existing teachers may have taught very different qualifications and so may not have the sufficient skills needed for the new curriculum they are teaching (Webb *et al.*, 2017). What these issues have in common is that they all relate to a lack of knowledge in some respect to the subject they are teaching.

Having teachers teaching subjects they are not proficient in can lead to ineffective teaching. This, combined with the large variation of level 3 qualifications regarding DS makes it unsurprising that the Skills Funding Agency (2016) state that the teaching workforce must be equipped to deliver the skills that digital qualifications require. For example, out of a survey of 5525 education employers, 56% declared that development of DS is required amongst staff (Winterbotham *et al.*, 2018). Furthermore, the infrastructure and skills in FE are inadequate yet the FE sector is vital for the UK to remain competitive digitally and to have a responsive workforce (House of Lords, 2015). This further demonstrates the importance of investigating what can done to overcome this lack of knowledge within FE, but it is important to distinguish what is meant by knowledge in the context of teaching.

3.2.1 Teacher Knowledge Theory

Early history of teacher education was predominantly focused on the teacher's knowledge of content (content knowledge; CK) that was intended to be passed on to students and this was seen as pedagogical accomplishment (Shulman, 1986). However, in the 1980s there was a paradigm shift with the focus on research in teacher education being on the ability to teach (pedagogical knowledge; PK) independent of CK (Ball and Mcdiarmid, 1990). Shulman (1986) explained that while viewing pedagogy as the ability to teach was a relatively recent development, both CK and PK were required for effective teaching but that there was a missing paradigm. This missing link was pedagogical content knowledge (PCK); which Shulman describes as going beyond the subject matter to the dimension of the subject matter knowledge for teaching. In other words, knowing how to apply PK in the context of specific subjects or topics. This can include understanding what makes a subject difficult, the preconceptions that students bring with them to the classroom, and the strategies that are most likely to be applicable to their classroom of learners (Shulman, 1986). Cochran, DeRuiter, and King (1993), later classified PCK as the synthesis of a teacher's PK and their CK while the construction of PCK results from multiple opportunities to teach and to reflect and observe one's own teaching and that of others. This is because PCK also includes having knowledge of environmental contexts and also knowledge of students (Cochran, DeRuiter, and King, 1993; Armoni, 2011). More recently, Sentance and Csizmadia (2017b) and Yadav and Berges (2019) both explain that computing teachers within England must feel confident in both their CK and their PCK, while Ofsted (2019a), explain that teaching requires three types of essential knowledge:

- Content Knowledge (CK): knowledge of the subject their teaching.
- Pedagogical Knowledge (PK): knowledge of how to teach.
- Pedagogical Content Knowledge (PCK): knowledge of how to teach the particular subject they are teaching.

Hence, theory on teacher knowledge has largely remained the same over time. However, over the last few decades, there have been some other developments concerning PCK. Researchers have proposed additional constituent knowledge areas such as types of learning tasks, and created PCK conceptualisations in specific knowledge areas such as mathematics (Hubbard, 2018). Most notably is the adaptation of PCK into technological pedagogical content knowledge, often referred to as TPCK or TPACK. This new framework suggests that technological knowledge (TK) is another sphere of knowledge, relating to the use of technology in the curriculum (Voogt, Fisser, Pareja Roblin, Tondeur, and Braak, 2013b; Hubbard, 2018), and hence, very relevant to DS. However, for the purpose of this thesis, and given that the subject matter is regarding DS, the researcher considers the original PCK framework presented by Shulman (1986) as sufficient, and these adaptations are not needed in the context of DS. The original framework describes PCK as including "the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986, p. 9), and so in the case of a DS teacher, using technology in the curriculum effectively would already be considered part of PCK.

Overall, PCK is a useful theory to help understand the different types of knowledge involved within teaching. Regardless of the criticisms that have existed over the years, PCK is a valuable construct in understanding and developing the teaching practice of teachers in a number of subject areas (Hanley *et al.*, 2018), with some authors of computer science education research explaining that PCK should be exemplified as much as possible (Armoni, 2011; Yadav and Berges, 2019). This is because while some teachers may have PK, they may lack the PCK for DS (Yadav *et al.*, 2016). For example, just because someone can teach Maths, this does not mean they can effectively teach DS. Equally, just because someone may be an expert in a certain field and have the relevant CK, this does not necessarily mean they are a good teacher as they could lack the PK. This is illustrated in a study of 23 computer science teachers which revealed that while some had a formal background of teaching, they did not necessarily have the computer science CK needed to teach it effectively (Yadav, Gretter, and Hambrusch, 2015). Within this sample, some had industry experience in programming (CK), but not the teaching background (PK) to effectively deliver the computer science lessons (Yadav, Gretter, and Hambrusch, 2015). This combination of knowledge can sometimes result in what is referred to as an 'expert blind spot' (Guzdial, 2016), where it is difficult for computer scientists to 'see' students misconceptions from a novice point of view, leading to teachers failing to understand students difficulties. Therefore, it is not surprising that a literature review on student difficulties in introductory programming concluded that all DS teachers should improve their own PCK (Qian and Lehman, 2017). Meanwhile, a study by Gal-Ezer and Stephenson (2014) suggests that ensuring computer science teachers have these different types of knowledge is a challenge likely to be encountered by many other countries too. Therefore, when investigating how to address a 'lack of knowledge' it must be recognised that there are three different types of knowledge and that for addressing the DS gap effectively, teachers need aspects of all three; CK, PK and PCK. Evidence suggests that PCK is possibly more important in STEM subjects (which includes DS) than elsewhere (Orr *et al.*, 2019), yet both CK and PCK are generally neglected in ITT for DS (Hanley *et al.*, 2018), and that there is sparse academic literature available which examines computer science or DS PCK (Armoni, 2011; Yadav *et al.*, 2016; Yadav and Berges, 2019). Therefore, when looking to address the issue of a lack of knowledge, the root cause must first be identified as to what type of knowledge is lacking in that specific context.

3.3 Funding Issues

In terms of funding for 16-18 year olds, the Education and Skills Funding Agency (ESFA) oversees all spending but uses different funding formulas. The ESFA pays grants to colleges and to schools with sixth forms via a single national funding formula which is allocated each year in March for the academic year starting the following September (Snelson and Deyes, 2016). This is calculated by the numbers of students enrolled in the previous year by a weighted average calculation based on their characteristics (Association of Colleges, 2018a). Since 2005, colleges have experienced a general decline in financial performance (Popov and Cattoretti, 2019) with the Augar Review (Augar *et al.*, 2019) reporting that spending in FE on 16-18 year olds has fallen by 15% in real terms between 2009 and 2018. 16-18 year olds account for 41% of FE college income and 77% of sixth form college income (Association of Colleges, 2018a). Hence, colleges funding streams are based on the learners they have, in addition to other sources of income they may use. Each college will vary drastically regarding funding available and this is important to consider if trying to implement new policies, strategies or agendas for colleges. Nonetheless, the Department for Education (2021d) are considering simplifying FE funding, but this is still early stages as of 2021.

Colleges are poorly funded, and college income has fallen from £7.8 billion in 2009-10 to less than £7 billion in 2017-18 with an overall deficit of £144 million in 2018 (Association of Colleges, 2018a). Still, the UK 2020 budget announced that the government would provide an extra £1.5 billion over five years to support colleges in bringing up their facilities to a good level (HM Treasury, 2020), but whether this is enough given how fast curricula and technology change is something only time will tell. Meanwhile, the impact on colleges due to COVID-19 has not helped their financial situation. Colleges have had to incur extra costs in 2020 for new IT resources to support online teaching, while many have received a loss of income due to lower enrolments in apprenticeships, international students and other commercial activities (Association of Colleges, 2020d).

Total college spending in England is £6.5 billion with the majority of that being on staff costs (Association of Colleges, 2019a; Consulting, 2020). College data from the ESFA (2020) shows that the average amount spent on staff is 71% of total costs with this amount differing by college type (see Figure 3.2)

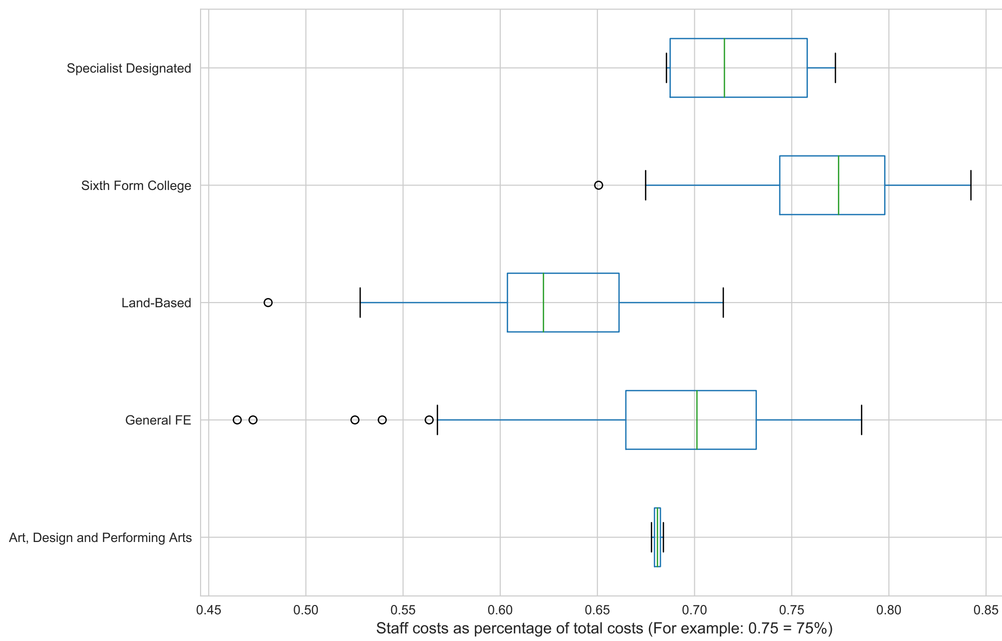

Figure 3.2: Staff Costs as Percentage of Total Costs by College Type 2019. Source Data: (Education and Skills Funding Agency, 2020)

Sixth-Form colleges have the highest proportion of total costs spent on staffing generally, but the range indicates how each college is unique in their spending. Therefore, any research concerning college challenges needs to contextualise that research with regards to individual funding circumstances. Still, due to staff costs representing such a significant proportion of total costs overall, there are pressures on staffing within colleges following funding reductions (Hanley *et al.*, 2018; Augar *et al.*, 2019).

It was highlighted that teachers should be upskilled to overcome any knowledge gaps, and educators should be able to access CPD programmes to update their DS (ECORYS UK, 2016). However, out of £4.4 billion spent on staff, little is spent on upskilling them. A workforce development report showed that in 2016/17, the majority of colleges (67%) spent less than 0.5%

of total income on workforce development (Association of Colleges, 2018b). This is likely due to the fact that CPD opportunities in FE are few compared to schools CPD and there is a lack of funding which makes accessing them difficult (Greatbatch and Tate, 2018). Furthermore, in the education sector, total spend per person for training averaged £1930, the 3rd lowest of all sectors (Winterbotham *et al.*, 2018), while the most commonly reported number of computing related CPD hours is zero (The Royal Society, 2017). Due to the aforementioned factors influencing the uptake of CPD, further research into DS CPD may be required to understand what could help colleges offer CPD for their staff, and so this will be explored in the following chapter.

Policy changes within the FE sector can also impact the funding available for colleges to offer competitive salaries, flexible contracts and ITT (Chowen, 2014). One survey of ninety colleges revealed that the top three college concerns are all monetary related (Association of Colleges, 2019a), with many colleges having plans for restructures, a reduction of hours, or redundancies within the next twelve months to reduce costs (Association of Colleges, 2019a) which will add to the issue of teacher retention (Department for Education, 2019d). Should a computing department not be a priority area of the college's senior leadership team, a funding reduction may be more significant as they will ensure adequate staffing in other departments. However, the opposite is also true. These monetary challenges also cause issues regarding inadequate resources for teaching (The Royal Society, 2017) with teachers explaining there is not always the resources to upgrade hardware (Yadav *et al.*, 2016), and so there is a need for funding to keep the resources for DS up to date (Black *et al.*, 2013) which will later be discussed.

There has been decreasing amounts of public funding available to support higher level DS (Skills Funding Agency, 2016) which would impact colleges and other educational institutions. Current funding levels are insufficient for study programmes now but may be worse for T-Levels. This is largely because this kind of specialist education is more resource intensive as it generally requires smaller class sizes, experienced staff and good quality facilities (Association of Colleges, 2019b). Therefore, without sufficient funding, colleges will teach what they have the funding and resources to teach, not necessarily what the best courses are to address skills gaps in society.

3.4 Insufficient Time

Teachers have a variety of commitments which ultimately can lead to insufficient time to complete every task. UCAS (2019) explain that the daily tasks for a FE lecturer could include:

- Teaching
- Lesson planning/prep
- Marking assignments, coursework, exams
- Monitoring and assessing student progress
- Developing new courses and teaching materials
- General administrative tasks
- Supervising students with practical work, work placements and field trips
- Interviewing prospective students
- Meetings, and attending CPD courses and workshops.

The scope of the above tasks will vary by college but importantly college lecturers will have to prioritise certain tasks over others. Tasks such as teaching, and marking assignments will be a key priority with The Royal Society (2017) reporting that commitments such as marking and lesson planning are placing high demands on teacher's time outside of normal work hours. This is not surprising when you consider a lecturers contracted teaching hours per annum (see Figure 3.3), which take up a large proportion of their overall work hours.

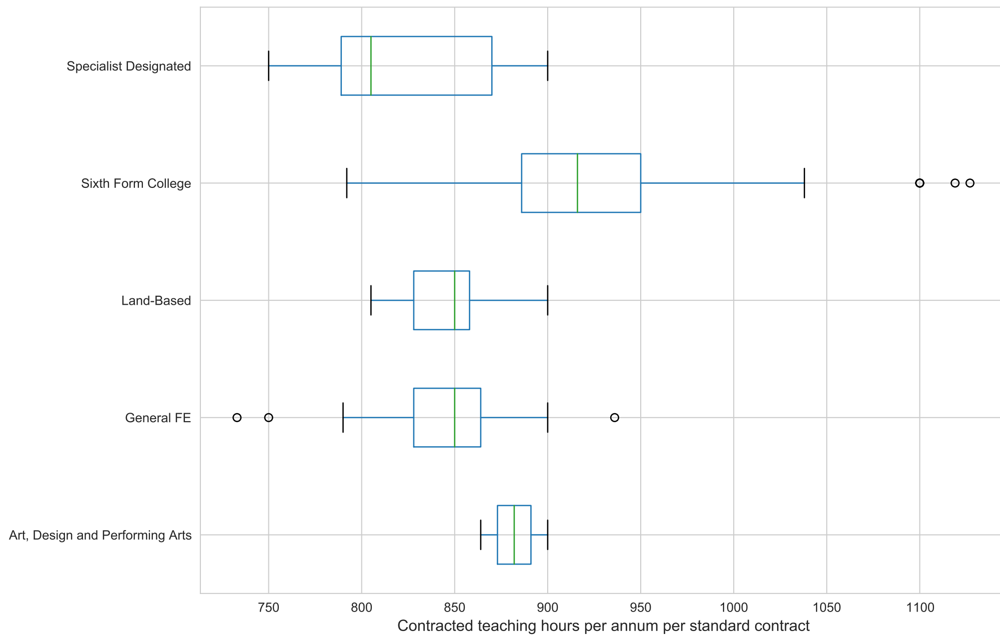

Figure 3.3: Contracted Teaching Hours per Annum by College Type 2019. Source Data: (Education and Skills Funding Agency, 2020)

As shown in Figure 3.3, it can be seen that contracted teaching hours are generally at least 790 hours per year, but the range of hours differs greatly by college type. Not accounting for outliers, lecturers in general FE colleges have between 790 - 900 contracted teaching hours per annum, but for sixth form colleges, it can be much higher, ranging from 792 to 1038 hours. Therefore, with tasks such as lesson planning, marking, general admin etc, many college teachers are suffering from a heavy workload (Feather, 2012; Orr *et al.*, 2019; Consulting, 2020). With insufficient time for these key tasks, others tasks such as CPD and developing new course materials may be ignored if they are not deemed as important, with one report explaining that teachers are stretched and do not have the time to engage in CPD (Greatbatch and Tate, 2018). However, with technology rapidly changing (House of Lords, 2015; Medhat, 2014; Störmer *et al.*, 2014), for those teaching DS, the need for CPD and developing new course materials is more important to keep up to date with industry needs. The latter of which being found to be one of the desires of computer science teachers (Black *et al.*, 2013).

With the aforementioned lack of teachers, existing teachers may be given extra teaching commitments from senior leadership teams which will further exacerbate the issue of insufficient time. Hence, the majority of teacher CPD is undertaken in their own time (The Royal Society, 2017; Sentance and Csizmadia, 2017b), but with many teachers having other commitments outside of work, CPD may be an afterthought with a workforce data survey of colleges revealing that over 60% of teachers spend no time at all on CPD (Greatbatch and Tate, 2018). However, as professionals, Villeneuve-Smith, Bhinder, and West (2009) argue that teachers have a personal responsibility to engage in CPD. A requirement of being a member of SET and retaining QTLS status for college teachers is the need to carry out CPD and provide evidence of this. This demonstrates that even though there is an onus on teachers to undertake CPD, they are often thwarted by issues within the sector (Broad, 2015) such as conflicting priorities leading to a lack of time (Qian, Hambrusch, Yadav, and Gretter, 2018). These conflicting time pressures have had a significant impact with the government reporting that workload was the most frequently mentioned reason for teachers leaving the profession (Foster, 2019b). 20% of those who resigned from college teaching stated it was due to the heavy workload (Association of Colleges, 2018b), while the Department for Education (2021d) reported that 52% of those who left the sector said more CPD opportunities would have made them less likely to leave.

3.5 Curriculum Concerns

There a wide range of DS qualifications and there have been concerns regarding curriculum at all levels. Within GCSE, there have been concerns that the new computing curriculum introduced in 2014 focuses too much on computer science at the expense of ICT with teachers believing this has been introduced with insufficient guidance regarding who would teach the subject and how CPD and other training for existing teachers would take place (The Royal Society, 2017). Similarly, industry feedback suggests that FE and HE institutions are too focused on immediate short-term skills requirements (Medhat, 2014), with just 7% of employers that completed the Manchester Digital Skills audit agreeing that current DS curricula are relevant to industry needs (Manchester Digital, 2019).

The skills taught need to be those that are required in the current labour market and what is needed for the future of the UK economy (Campbell, 2016). In spite of this, funding rules do not allow colleges to respond to local needs in the labour market (Augar *et al.*, 2019). Further, the supply of DS is predominantly via education and training routes yet there are challenges in changing curricula and training packages at the same rate as the rapid changes in technology and skill requirements (ECORYS UK, 2016). There is a misalignment in what industry expects and what education provides, with a three-year review of FE colleges revealing that "STEM provision was found to be inadequate in virtually every case" (Medhat, 2014, p. 35). Elliott (2017) describes that historically, the relationship between technology and education has been a race, and it appears as if education is struggling to keep up. As opposed to being reactive, education needs to start anticipating these future skills requirements and be proactive in changing their curriculum offer to meet industry needs.

Being able to predict future skills needs successfully requires the foresight, funding and time to do so, while issues surrounding the curriculum are worsened by there being little incentive for training providers such as colleges to adapt their offer to meet industry needs (Heseltine, 2012). With the variation in qualifications, and many optional units within the vocational courses to choose from as previously discussed, it is at the provider's discretion as to what they offer as they can "pick and choose" what they deliver (Heseltine, 2012). With other challenges such as a lack of knowledge, funding and time, colleges will likely deliver what they have the resource and time to provide as they may not have the knowledge or skill set to effectively teach what the UK economy truly requires now or in the future (i.e. where there are skills gaps in the workforce).

3.6 Resource Challenges

Computing (and more widely, digital) education is dependent on a variety of resources and technologies such as computers, tablets, multimedia devices and other equipment (The Royal Society, 2017), and teachers needs to be well equipped and supported for computing and digital qualifications to be successful (Gal-Ezer and Stephenson, 2014; Department for Digital Culture Media and Sport, 2017). However, many schools and colleges have insufficient funding to acquire the software and equipment required to deliver computing curricula effectively (Lucas, Spencer, and Claxton, 2012; The Royal Society, 2017; Augar *et al.*, 2019). Spending on IT by colleges averages just 2.56% of total costs (Education and Skills Funding Agency, 2020), while the distribution of IT spend can be seen in Figure 3.4. It should be noted that IT spend is the total calculated cost of spend on hardware, software, and contracted services only.

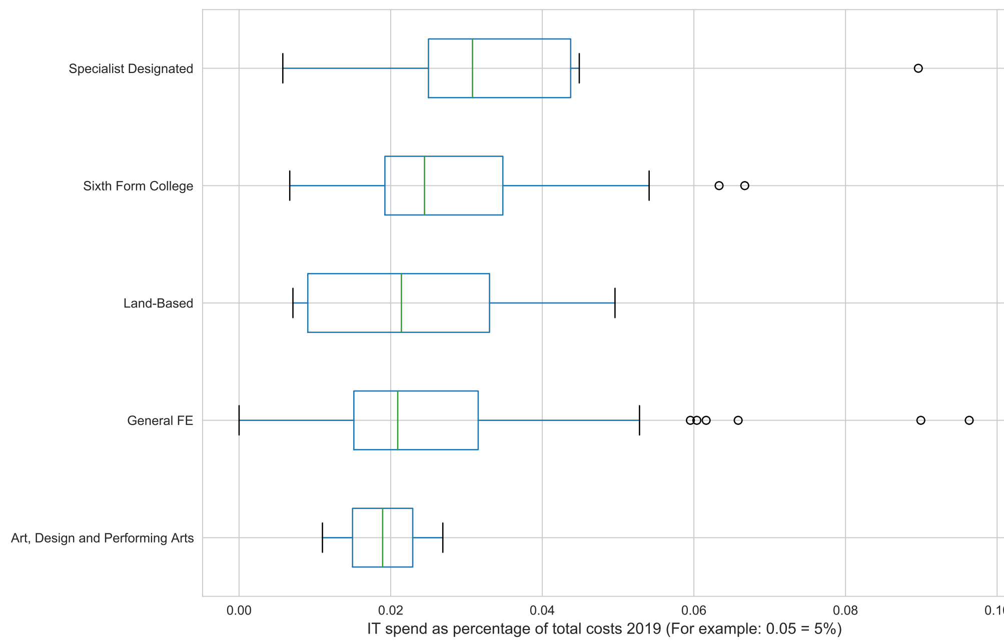

Figure 3.4: IT Spend as Percent of Total Costs by College Type 2019. Source Data: (Education and Skills Funding Agency, 2020)

This relatively low IT spend can cause issues for those teaching DS courses. As technology is constantly changing, so are the hardware and software requirements, and therefore DS teaching resources must be updated more frequently than other subjects which utilise technology less regularly. Similarly, there may be issues with getting the right up to date software as educational institutions may have security policies in place for the protection of pupils that prevent installing what is needed. One study revealed that DS teachers do not necessarily have administrator privileges on classroom computers and that getting IT staff to update software can be a slow process (Yadav *et al.*, 2016). While this study was not based on colleges, and hence, not necessarily comparable, this issue is reflected by Sentance and Csizmadia

(2017a), who explain how many teachers (both school and college) have concerns regarding the reluctance of technical staff to maintain and troubleshoot installed software on standalone computers or the wider network. This could slow down the process of getting exactly what is needed, and by the time approval is granted, the right software could have changed or require updating itself. A related issue within FE is the general unreliability of IT infrastructure (including Wi-Fi) (Armstrong, 2019), which if not working, will have detrimental impacts on DS education.

Schools and colleges often have a lack of information regarding what resources are available (Department for Education, 2013), and it has been reported that many schools have inadequate teaching resources for computing (The Royal Society, 2012). It must be recognised that teachers are not professional buyers, and with around 40% of Computer Science lessons being taught by teachers with no subject relevant post A-Level qualification (Migration Advisory Committee, 2017), a large majority of teachers may not have the knowledge of what products they should be purchasing for the most effective teaching of DS. Garneli, Giannakos, and Chorianopoulos (2015) explain that a significant challenge for teachers is choosing between the wide variety of programming tools, activities and methods that are available. Therefore, while procurement decisions should not solely be based on money, due to the funding issues previously discussed, it is more likely that procurement decisions will be based on cost as opposed to what leads to the best quality of teaching, particularly as assessing the quality of online resources is another challenge (Yadav *et al.*, 2016). Some teachers report that there is insufficient funding to acquire resources for new subjects (Sentance and Csizmadia, 2017a), which could be a major issue should a college wish to offer new qualifications or different units within a qualification than what they offered previously.

3.7 Other Teaching Difficulties

There are other challenges to contend with not already discussed. Pupil behaviour is an issue (Ofsted, 2019a), as this can cause disruption and so instead of spending time teaching, lessons may be partly taken up with dealing with a misbehaving student which can therefore influence the teaching for the whole class. As the FE sector has traditionally provided a 'second chance' for those who have not succeeded at school (Thompson, 2014) and due to the compulsory school leaving age being 18 (Education and Skills Act 2008), the FE sector is likely to have some less willing learners on their courses which can provide further pedagogical challenges for teachers (Bathmaker and Avis, 2005; Thompson, 2014). This is an issue which can be a key driver for teacher workload and stress, but many teachers feel unsupported in dealing with challenging pupil behaviour (Department for Education, 2019d).

Colleges have learners with a wide variety of characteristics and backgrounds and so teaching can pose various pedagogical challenges due to the diverse nature and motivations of students (Garneli, Giannakos, and Chorianopoulos, 2015; Greatbatch and Tate, 2018; Lucas, Spencer, and Claxton, 2012; Webb *et al.*, 2017). There are also unique pedagogic challenges regarding embedding accessibility in computer science education (Lewthwaite and Sloan, 2016). It is evident that students differ vastly in their use of technology and their technology skills (Voogt *et al.*, 2013a), and a related issue is having mixed ability students in one class (The Royal Society, 2017). This differentiation is a concern for teachers as due to the student-centred nature of DS work, keeping all students engaged can be difficult (Yadav *et al.*, 2016). In some cases, it is because students have different experiences of programming prior to level 3 at GCSE (Crick, 2017; Sentance and Csizmadia, 2017a). One survey of 1508 secondary schools revealed that 21% teach python, 19% teach Scratch, 10% teach JavaScript and the remaining 50% teach other programming languages (The Royal Society, 2017). Furthermore, a literature review on students misconceptions regarding introductory programming revealed that there are a number of factors which contribute to the difficulties experienced by students including prior mathematical knowledge, natural language, environmental factors, teachers knowledge and so on (Qian and Lehman, 2017). Once students come to study DS at level 3 there will be a wide variety of student ability with regards to using any one particular programming language, especially as there are also students who may not have studied any computing subject at GCSE. Similarly, an online survey of 750 school teachers revealed that just 56% of ICT and computing teachers agreed that their own students would meet age-related computing expectations while just half of teachers reported that they were confident in teaching the curriculum (Quinlan, 2015). This adds to the disparity of learners as it could be assumed that those that were taught by a confident ICT teacher would fare better in their computing education than those taught by someone who is not confident in the subject.

3.8 Chapter Summary

As reinforced by Ingleby and Tummons (2017), several authors have drawn attention to the challenges that exist within colleges, resulting in a sector that has become demoralised (Bathmaker and Avis, 2005; Augar *et al.*, 2019). Many of these challenges are likely to influence the teaching of DS, while any changes in curricula, assessments, and teaching methods has wider applications for other aspects of teaching, which must be considered (Biggs, 1993). In order to summarise these challenges and how they link together and influence DS, a conceptual framework has been created (Figure 3.5). A conceptual framework shows the version of what is currently being investigated and it can visually explain the key factors, variables or constructs and the presumed relationships between them (Miles, Huberman, and Saldana, 2014).

As shown in Figure 3.5, there are a number of challenges which ultimately all lead to 'Digital Skills Gaps'. This is broken down into two main categories:

- Skills gaps because of ineffective teaching, or
- Skills gaps due to it not being covered in current curricula or because colleges are not teaching it.

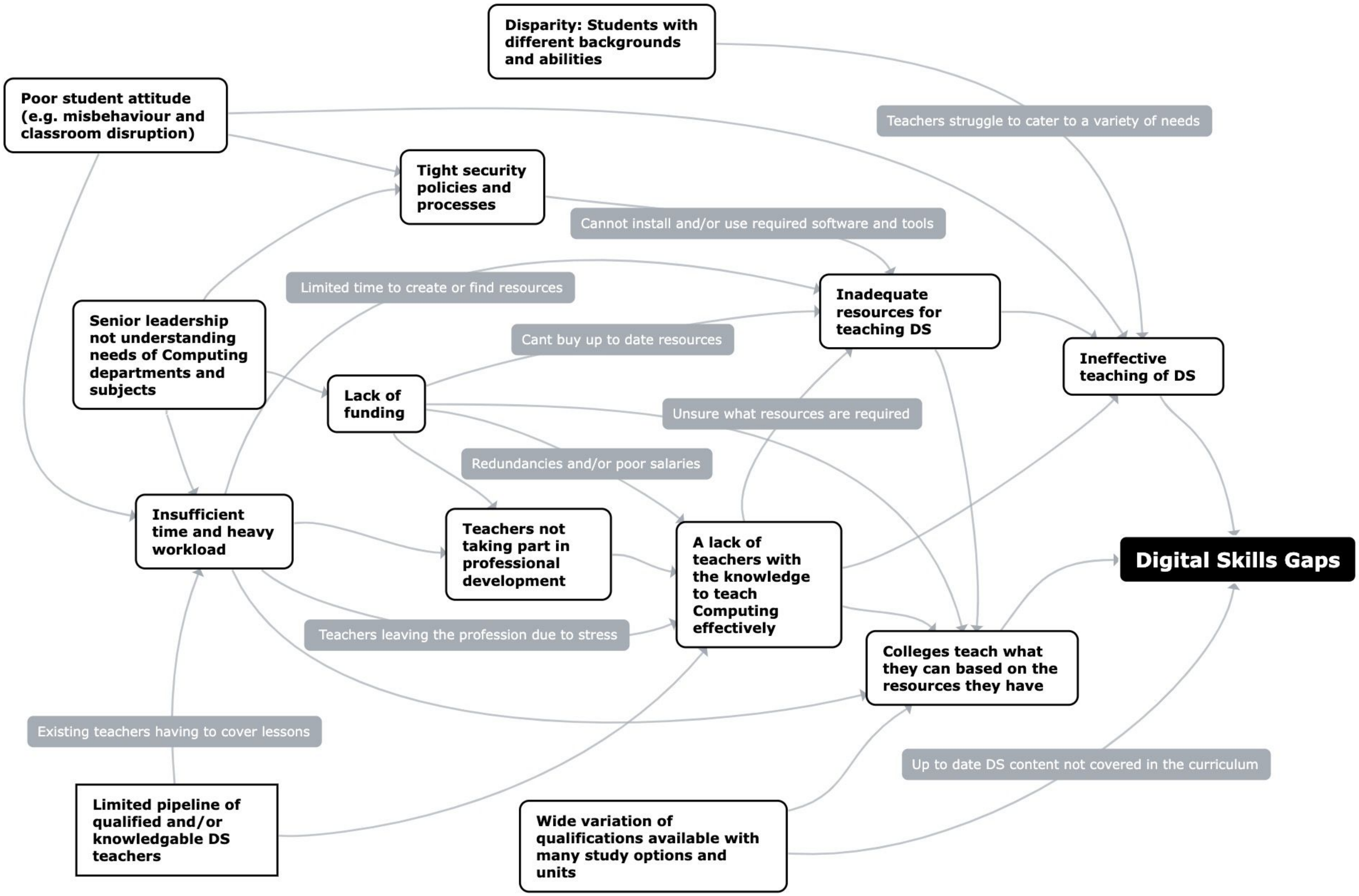

Figure 3.5: The Challenges of Teaching DS within Colleges.

It is in these areas where support is needed for colleges, yet a deeper understanding of colleges is required so a set of best practices can be created. Resource challenges can lead to ineffective teaching but resource challenges can stem from either; limited time to create new resources (e.g. lessons, workshops etc.), a lack of funding to update old resources or buy new ones, tight security policies and processes, or a lack of teacher knowledge so they don't know what resources they need for effective teaching. Any potential practices to overcome these challenges must consider the context. As shown in Biggs (1993) 3P Model (Figure 2.4), the educational system encompasses different components which all interlink and so understanding college context can help further understand each individual issue. If a college is lacking resources, the solution is not necessarily to create new software and let colleges have access to it, as they may not be able to install it due to college security policies. Therefore, the challenges outlined and their root cause must also be understood.

It is important to differentiate those challenges that are unique to DS teaching within colleges, and those that could be applied to any subject taught within college environments. A lack of funding, teachers not taking part in CPD, student behaviour, insufficient time and disparity of learners could be challenges that apply to most college teachers. However, there are some challenges that are unique to teaching DS, and others that exacerbate the general challenges. Tight security policies and processes would be applicable to a college overall but this is a much more pertinent issue for DS. This is because DS requires specialist software more often than other, non-technical subjects. Similarly, this emphasis on requiring specialist software more frequently than other subject areas can result in some problems being exacerbated. For instance, some teachers report challenges concerning the installation of software, technical difficulties with networks, and flexibility of technicians as particular challenges for teaching Computing (Sentance and Csizmadia, 2017a). Hence, this is more of a unique challenge for teaching DS and it worsens the issue of having inadequate resources.

With regards to resource challenges, this is an issue generally for colleges but is more so for the area of DS, predominantly due to changing technologies. Resources will need updating more frequently than other subjects where the content is more ‘static’. However, acquiring new resources generally requires time, knowledge and funding. Therefore, if these are in short supply, departments for DS may suffer more than other subjects that are less reliant on up to date resources.

Another unique challenge is that of a limited pipeline of qualified teachers. This is more of an issue with DS subjects such as Computing as those who are qualified can earn much more in industry (Migration Advisory Committee, 2017) so FE teaching is less appealing. However, the issue lies in what this challenge causes; a lack of teachers with the knowledge to teach DS effectively. Consequently, existing teachers may have to cover lessons which results in either someone who is able to teach DS effectively having less time for other tasks, such as CPD or developing new resources, or someone may teach the lesson who is not suitably qualified. The teaching style for teaching computer science principles is different for teachers (Sentance and Csizmadia, 2017a), and if someone does not know how to teach it effectively, this could lead to gaps in the students’ knowledge.

Regardless of all the challenges discussed, the most significant point is that due to the combination of varied qualifications (and options of units) available for colleges to choose from to deliver to students, and the variety of challenges they are facing, colleges are likely to teach what they have the resource and capability to teach. Hence, they can choose what education and training to deliver (Heseltine, 2012) for what suits them, as opposed to what society necessarily needs (i.e. where there are DS gaps). The Wolf Report (2011) further explains that colleges receive funding by qualification and whether the qualification is passed. Therefore this, combined with pressures from Ofsted, creates strong incentives for colleges to offer courses (and units of study) where they know they can teach it effectively, regardless of whether that meets the needs of the local labour market. Due to all these considerable challenges that the FE sector is facing, this can have important consequences on effective leadership, teaching and student outcomes, and not just for DS. It is therefore recommended that these challenges should be reviewed and how they are or could be addressed (Greatbatch and Tate, 2018). Besides, Lucas, Spencer, and Claxton (2012) suggest that given the widening gap of knowledge regarding the pedagogic nature of FE, it is inevitable that there is confusion regarding FE teaching and learning and whether it is improving (or not). Particularly as using digital technologies evokes a different kind of relationship between teachers, learners and the subject content (Beetham and Sharpe, 2013).

3.8.1 Areas for Future Research

Based on the aforementioned literature and summary of challenges presented, this leads itself to research question 2:

RQ2 – How does a college's specific context relate to the perceived challenges that influence the teaching of 'Digital Skills' at level 3?

This chapter has highlighted how there are many challenges colleges face which influence the teaching of DS. It was previously explained that each college has their own idiosyncrasies, local context, history and strategic agendas and each college will have their own diversity of stakeholders influencing DS provision where all are valuable (Freeman, 1984). Research must be conducted in the context of where it will be applied and a college as an educational system is composed of different layers which all should be understood, or at least considered (Biggs, 1993). Hence, research question 2 aims to understand the challenges colleges face but in a framed context of that particular college's situation. As opposed to just understanding what the challenges colleges face are at a surface level regarding teaching DS, as evidenced by the literature, the purpose of this research question is to understand why these challenges are challenges for them. Hence, establishing the perceptions of those college stakeholders. Thus, this research question aims to obtain a deeper understanding of the current situation within colleges than what already exists. Besides, it is important to understand how and why a resource or factor is having the influence it is having so that it is possible to make a meaningful contribution to practice (Collis and Hussey, 2014). To obtain this depth of context required for a comprehensive understanding of colleges, case studies are likely to be an effective research strategy due to their emphasis on context and that they allow for the use of multiple methods to obtain in depth knowledge (Collis and Hussey, 2014). Furthermore, case studies have proven particularly useful for evaluating programmes, informing policy and educational innovations (Merriam, 1998) and for this research, the teaching of DS at level 3 within colleges would be the target of evaluation for this case study.

Next, existing literature on potential best practices will be reviewed to see what is currently or can be done in the future to overcome the challenges influencing DS teaching, particularly with regards to addressing the overall lack of knowledge for effectively teaching DS.

Chapter 4

Potential Best Practices to Overcome the Challenges in Teaching Digital Skills

Now that the challenges that influence the teaching of DS within colleges has been acknowledged, this section will focus on what can be done to potentially overcome these challenges. This section will not focus on curricula, neither will it focus on issues such as pupil behaviour, the disparity of learners, or a lack of funding as these are general college issues. Instead, given that there are few papers which focus on possible ways to improve teaching methods and assessment, and student employability (Aničić, Divjak, and Arbanas, 2017), this chapter will focus on areas to improve teaching practice and look at how existing methods are, or could be applied to DS teaching. Therefore, the first section will look at CPD, as CPD could help address the issue of a lack of knowledge to teach DS effectively. Next, methods used to address the limited pipeline of qualified teachers will be discussed and lastly this chapter will explore how colleges can use partnerships with universities and industry to enable them to address a variety of issues they face in teaching DS.

4.1 Continuing Professional Development

To bring an effective change in FE teaching, there needs to be sustained, high quality professional development opportunities available for teaching staff (Department for Education, 2021d), and while CPD can help address the issue of a lack of knowledge, implementing CPD can be difficult. Many countries are likely to suffer from the challenge of providing ways for teachers to update their knowledge (Gal-Ezer and Stephenson, 2014) and as the challenges section of this thesis shows, this is certainly the case within the UK. Due to technology changing rapidly, and with curricula often lagging behind the changes in technologies (ECORYS UK, 2016; Elliott, 2017), it is imperative that teachers have the right up to date knowledge to pass on to students regarding DS (Brown *et al.*, 2014; Derrick, Laurillard, and Doel, 2016), and hence, there is a high demand for DS teacher CPD (Sentance, McNicol, Dorling, and Crick, 2012). The quality of FE teachers is particularly inconsistent (Lucas, Spencer, and Claxton, 2012), as they come from varied backgrounds (Yadav *et al.*, 2016), and this is not helped by many teachers being placed in the unwelcoming position of having to teach materials and skills they are not familiar with themselves (Haden, Gasson, Wood, and Parsons, 2016; Yadav and Berges, 2019). Therefore, it is important that those of a lesser quality have support to help them be effective FE teachers.

A lack of knowledge is a prominent issue and teachers need more training and to develop confidence regarding their skills in teaching computing (Sentance and Csizmadia, 2017a). A major approach of doing this and supporting computer science teachers is through effective continuing professional development (Venn-Wycherley and Kharrufa, 2019). However, there are various challenges affecting teachers' ability to partake in CPD; most notably due to a lack of funding, a lack of time due to excessive working hours, limited access to resources and the poor availability of support (Haden *et al.*, 2016; The Royal Society, 2017; Sentance and Csizmadia, 2017a; Augar *et al.*, 2019; Consulting, 2020). However, there is clear evidence that the quality and quantity of professional development can aid effectiveness and improvement within education (Sentance *et al.*, 2012; Ofsted, 2019a) as it can improve teachers practice which subsequently impacts positively on pupils learning outcomes (Wilson, Wilkin, and Rowe, 2012). Therefore, while CPD can help alleviate some of the challenges faced in teaching DS, there are challenges which influence whether CPD can be implemented effectively.

While there is a government initiative which sets out to commit £84 million up to 2022-23 to up skill teachers in computer science (Foster, 2019b), this is primarily focused on ensuring that each secondary school has a qualified computer science GCSE teacher, with the briefing paper neglecting the FE sector and college lecturers. This sector neglect can influence the ability of DS college lecturers to undertake CPD. Nevertheless, while the majority of a teachers professional development is expected to take place once they are teaching (Armoni, 2011), in many cases it is not mandatory for staff to upskill digitally (ECORYS UK, 2016), but for those college teachers who wish to maintain QTLS status they need to provide evidence that they are undertaking CPD each year. Besides, CPD is one way of equipping staff to thrive amidst challenging and changing policy environments (Villeneuve-Smith, Bhinder, and West, 2009) while also addressing gaps in knowledge. As previously stated, one can consider that there are three types of knowledge; content knowledge (CK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK) (Shulman, 1986; Ofsted, 2019a) and in the case of CPD for DS teachers, having the right balance of these types of knowledge is particularly relevant (Armoni, 2011; Sentance *et al.*, 2012). Therefore, DS CPD should cover all of these things (see Figure 4.1).

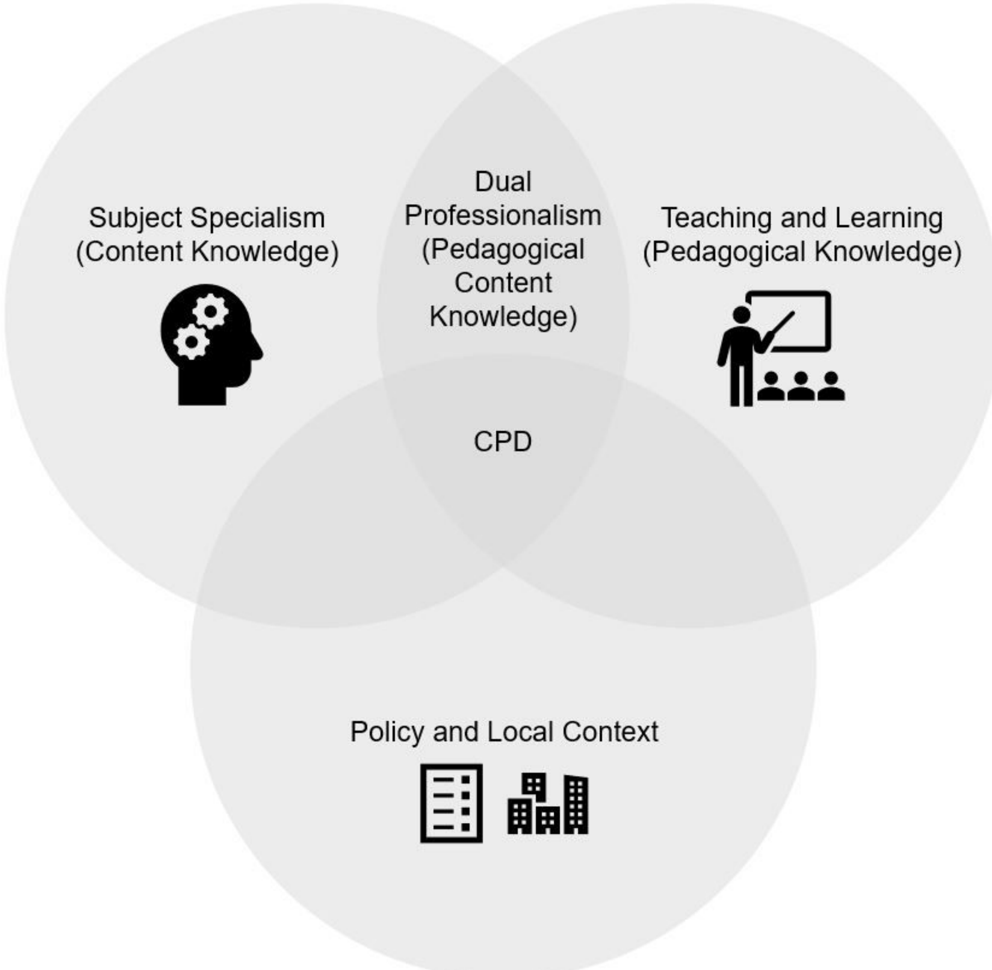

Figure 4.1: Model of the Teacher as a Dual Professional. Source: Adapted from (Learning and Skills Improvement Service, 2010).

As Figure 4.1 shows, CPD should address the CK (subject specialism), PK (teaching and learning), PCK (dual professionalism) and also changes in policy and local context (Learning and Skills Improvement Service, 2010). This is echoed by Crawley (2012), and later by Moller and Crick (2018), who suggest that regardless of if you are trying to train existing teachers or recruit new ones, the development of computer science subject knowledge (CK), pedagogic knowledge (PK) and emerging research and practice must all be prioritised when building a research engaged profession. Hence, the most effective CPD would help regarding both pedagogy and meeting the requirements of teacher's dual professionalism, in addition to keeping up to date with the sector (McCrone *et al.*, 2015) such as policy changes, and how

DS is affecting employment options and the economy (Passey, 2017). On the contrary, classifying the effectiveness of CPD depends on its intended purpose to begin with and this could be as preparation to implement reforms, or contributing to or changing educational policy (Kennedy, 2005). However, regardless its intended purpose, how effective CPD is ultimately depends on a number of factors.

4.1.1 What is Needed for CPD to be Successful?

The Education Inspection Framework by Ofsted (2019a) found clear evidence that both the quality and quantity of professional development are related to the effectiveness and improvement of schools/colleges. Meanwhile, a major review of reviews for CPD found a variety of factors that characterise effective CPD programmes with regards to teaching (Cordingley *et al.*, 2015):

- CPD should be designed in alignment with pupil outcomes.
- CPD must be relevant to the everyday work that teachers are taking part in.
- CPD and course content should build a strong sense of purpose.
- CPD must cover both pedagogical (PK) and subject knowledge (CK).
- CPD should have clear goals and objectives.

However, the above report focused on teaching generally and not specifically with regards to teaching DS. Meanwhile, one report suggested that good CPD is similar to good teaching in that it uses a range of techniques to develop skills, knowledge and reflective practice, including critical reflection on learning experiences and the resulting action planning (Villeneuve-Smith, Bhinder, and West, 2009). However, this report could be considered outdated and while it is specific to FE, it is not specific to DS.

CPD can also mean different things to different people (Broad, 2015) and overall, CPD needs to have variety as no single activity has been found to be universally effective (Cordingley *et al.*, 2015). For that reason, a mix of on-line training, and face-to-face learning is often more appropriate (Greatbatch and Tate, 2018). Therefore, while some factors of effective CPD have been mentioned, key aspects required for CPD to be successful will now be discussed.

Leadership

One factor needed for effective CPD is leadership. It has been found that when leaders within schools/colleges created conditions for CPD to be successful, it is more likely to be (Cordingley *et al.*, 2015). Meanwhile, it is reported that a lack of buy in to computing by school and college leaders can have knock on effects on resourcing, funding and access to CPD (The Royal Society, 2017). This is not surprising when you consider Figure 2.5, as this shows how the different layers within education (e.g. institution, department, classroom levels etc) all influence one another, and when you are trying to change something, considering more than one level is more likely to be successful (Biggs, 1993). DS requires subject specific pedagogy i.e. PCK) as well as practical skills with various technologies and college leaders and policy makers need to understand this (Feather, 2012; Cutts, Robertson, Donaldson, and O'Donnell, 2017), as if they do, they will be forthcoming to CPD for their teaching staff. Besides, Ofsted (2019a) report that leadership is central to curriculum development and accountability so ultimately if the heads of an organisation are not supporting a subject area or for their staff to access CPD, it is going to be very difficult for staff to do so. Equally, senior leaders within FE may just have an insufficient focus on learning and teaching due to their management and strategic responsibilities and therefore this can also lead to a lack of CPD for their staff (Greatbatch and Tate, 2018). To alleviate this problem Villeneuve-Smith, Bhinder, and West (2009) suggest that middle managers should identify teacher's needs and then consult with the senior leaders, where strategic planning for CPD could then be implemented. Furthermore, to increase the likelihood of leadership teams to agree to CPD, more localised CPD options are favourable as they require less of a time and financial commitment due to less travel (Brown *et al.*, 2014).

To conclude, leadership teams should be aware of the benefits and need for DS teachers to undertake CPD, but providers should acknowledge the constraints that colleges are under for staff to be able to attend such courses.

Classroom Observation and Feedback

Observation in the classroom has been used for years as CPD for teachers as it is an opportunity for teachers to obtain feedback on their classroom performance (O'Leary and Brooks, 2014), such as their pedagogical techniques (PK and PCK). For example, one paper describes an academic-year-long CPD initiative where DS teachers engaged in peer observation of classroom teaching and had to create a collaborative portfolio (Ni, Guzdial, Tew, Morrison, and Galanos, 2011). The authors found that these initiatives led to increased teacher confidence, a greater sense of community, and plans for changes in teaching practices and pedagogical approaches used. Other authors have come to similar conclusions. Case study research argues that post-observation feedback offers a learning space for the development of a teacher's pedagogy (PK) (Lahiff, 2015), while it has been reported that in-classroom coaching and observation can help positively impact a teachers PK and CK, and reduce feelings of isolation (Margolis, Ryoo, and Goode, 2017). However, over the past couple of decades, observation has increasingly been used with another focus on accountability (O'Leary and Brooks, 2014). Therefore, observation holds a dual purpose of both professional development and assessment for quality control which can cause tension (Edgington, 2013). While Ofsted and the inspection of colleges gave prominence for teaching observation to take place more often (Lahiff, 2015), Ofsted inspections themselves have caused other issues. It appears that they have in some instances become more of a 'tick box' exercise as opposed to focusing on professional development (O'Leary and Brooks, 2014), with one study revealing the following comments regarding Ofsted inspections and observation (Edgington, 2013):

- "I know how to tick all their stupid boxes ...."
- "I use the same lesson-plan I always do when I'm observed – it works like a dream."

The paper goes on to say how 13 out of 18 college teachers thought the main aim of observation was for quality control. As a form of CPD, observation has been weakened by demands for numerical data and that a valuable method of CPD has been tarnished in how it currently appears to operate (O'Leary and Brooks, 2014). However, CPD should include sufficient time for reflection

(Mouza *et al.*, 2016), and observation and feedback is a key tool for allowing reflection to take place.

Networking and External Input

In the context of computer science teachers, it is recommended that professional learning support networks should be established and that contexts should be provided where teachers can engage with peers in their subject (Derrick, Laurillard, and Doel, 2016; Cutts *et al.*, 2017). This is important as a main barrier to engagement with meaningful CPD is when teachers have limited opportunity to forge links with similar subject specialist teachers and networks (Broad, 2015). This is likely to be the case as CPD will be more effective if teachers are involved in collaborative design-based research regarding classroom activities (Swan and Swain, 2010), as opportunities like this would allow lecturers to share what pedagogical techniques (PK and PCK) they found work well with others. It could therefore be argued that models of CPD that are transitional and transformative (see (Kennedy, 2005)) are more effective than those whose purpose is transmission. It can be inferred that this may be the case due to increased capacity for autonomy in the CPD process (Kennedy, 2005). Likewise, it is suggested that the type of CPD most valued by teachers is when it is collaborative which can include peer observations, coaching and mentoring from external input, and formal and informal networks (Greatbatch and Tate, 2018). Similarly, Learning and Skills Improvement Service (2010) found the most effective CPD is based on learning from others such as sharing resources and peer support while learning with others is an essential part of the development in expertise in the workplace (Ertmer and Ottenbreit-Leftwich, 2010; Lahiff, 2015). A study of 23 secondary school teachers in the US highlighted that there is a need to form a community of computer science teachers as this could provide an opportunity for sharing ideas and resources about developing the curriculum (Yadav, Gretter, and Hambrusch, 2015). The desire to share knowledge and resources is not unexpected given that "the public nature of teaching makes trial-and-error learning and the possibility of failure daunting prospects" (O'Leary and Brooks, 2014, p. 543), but by learning together and from each other, each teacher is not alone. Additionally, CPD should have input from external providers as they can introduce new knowledge (CK) and skills and act as mentors (Cordingley *et al.*, 2015). For example, it was found that many computer science teachers have expressed interest in running computing clubs at their schools, but they need a strong support network for this to be effective (Black *et al.*, 2013). This being an opportunity where industry and HE could help these teachers.

Suitable Length of CPD

The length of CPD is an important factor to consider. Sufficient time is required that is devoid of the pressures of tight timetables and deadlines for CPD to be effective(O'Leary and Brooks, 2014; Qian *et al.*, 2018). It is recommended that CPD programmes should be at least two terms (Cordingley *et al.*, 2015), but for many teachers, this is likely to be impractical (Haden *et al.*, 2016). However, one-off short courses have been shown to be less effective long term as while they provide a good starting point for absorbing information and updating knowledge (development of CK), they are unlikely to lead to skills development (Villeneuve-Smith, Bhinder, and West, 2009), where the content knowledge can effectively be applied in the classroom (PCK). Instead, CPD should be a part of a teacher's weekly activity, not a one-off occurrence (Learning and Skills Improvement Service, 2010) as teachers require time and the opportunity to develop their methods and practice (i.e. PK) (Lahiff, 2015; Wilson, Wilkin, and Rowe, 2012). One teacher training initiative for Computer Science teachers in Wales explains that to make significant changes in teaching confidence and competence, prolonged, teacher-focused sessions are essential (Moller and Powell, 2019b). A study with regards to teaching programming evidences why this is case; as feedback from teachers revealed that in both one-off workshops and online training, although teachers can complete the tasks of the workshop or online tutorial, they are unable to move beyond those exercises with regards to delivering a programming course to their students (Haden *et al.*, 2016). In this instance, it is likely that the teachers would have gained some CK but not necessarily the PCK to teach what they know effectively. Hence, teachers need further support on how to implement what they know.

When teachers have engaged in CPD, there should be follow up and support (Cordingley *et al.*, 2015; Ertmer and Ottenbreit-Leftwich, 2010) to ensure that what is learnt is maintained and acted upon effectively. It is therefore important that teachers and educational institutions have the time to build relationships with employers as they should be informed by the latest industry experience (McCrone *et al.*, 2015). Crucially, it must be recognised that teachers can engage in many hours of CPD to improve their own skills, but even with a significant time investment, sometimes actual change can be a difficult task to achieve (Sentance *et al.*, 2012). Therefore, ensuring that the CPD is tailored effectively to who is receiving it should be a priority as it has been found that CPD which is matched to teachers backgrounds is the most effective (Qian *et al.*, 2018).

Applicable to Classroom Teaching

There are many different options available for online CPD such as Fujitsu's Certificate of Digital Excellence (CoDE) (Fujitsu, 2022), resources from the Society for Education and Training (SET), the National Centre for Computing Education (NCCE), or through the Rasberry Pi Foundation which offers online CPD courses through FutureLearn (FutureLearn, 2022). Many of these opportunities are simply online tutorial videos with a test to showcase that the participant has gained some subject knowledge (CK). However, implementing and using this knowledge in the classroom, and developing subject specific pedagogy (i.e. PCK) for DS is often not covered which is a major limitation for this type of CPD, and has been found to contribute to low confidence levels for those teaching computing (Greaves, 2017).

Teacher training should be convenient and directly transferable to what is to be taught in the classroom (Ertmer and Ottenbreit-Leftwich, 2010; Haden *et al.*, 2016; Qian *et al.*, 2018) and tying CPD opportunities to curriculum needs is an effective method to increase a DS teachers PCK (Yadav *et al.*, 2016). Therefore, classroom practice is something that should be part of CPD programmes, as by doing so this ensures that the transfer of learning for in the classroom happens (Cordingley *et al.*, 2015). Besides, Greatbatch and Tate (2018) suggest that some in house activities can be more effective than expensive courses. Furthermore, within technical education, any learning should be related to the workplace, and so PCK in FE needs to involve teachers knowing how to apply their CK and re-contextualise it for their students (Hanley *et al.*, 2018). Therefore, classroom practice, with the supervision of existing or external staff who can provide advice and guidance can be a form of CPD. However, with limited numbers of teachers and insufficient time, this method may not work effectively in the current climate. This is where online CPD opportunities do provide a useful starting point for those teachers who have a small amount of time to devote to further learning, where they can develop their CK.

4.1.2 CPD Summary

While many characteristics of effective CPD have been discussed, often this is related to CPD for teaching generally, not specific to DS. This is problematic; for instance, one journal article which reviewed CPD for computer science teachers found that CPD has usually related to how technology can help teach it and general pedagogies (PK) as opposed to the specific pedagogy (PCK) required for computer science and DS which teachers' value more (Cutts *et al.*, 2017). However, specialist options are rarely available, both in CPD and in the ITT for FE (Lucas, Nasta, and Rogers, 2013). Furthermore, in colleges, staff development and upskilling (i.e. CPD) has received less attention than that of schools and HE (Armstrong, 2019). Therefore, future research could investigate what characteristics are the most important for CPD regarding DS, or what CPD has been proven to be successful for college teachers and why. Approaches to CPD and effective pedagogical approaches are important areas for future research (Webb *et al.*, 2017), with Greatbatch and Tate (2018) stating how research investigating the nature of different CPD activities would be helpful.

While aspects of improving CPD such as having PCK may improve DS teaching, it cannot be assumed that having this subject specialist pedagogy will bring about a transformation of DS education (Sentance *et al.*, 2012). All of the improvements that could be made with regards to CPD would still not directly address issues such as the recruitment and retention of teachers and the heavy workload they face (Orr *et al.*, 2019). Therefore, while effective CPD can help alleviate some issues, it does not help solve all of them.

4.2 Encouraging More Teachers to Enter the Profession

While CPD can address a lack of knowledge of teachers within the sector, it does not help alleviate the issue of a limited pipeline of teachers entering the sector and so methods to overcome this issue should be investigated. FE teaching does not have a high-profile or a well-resourced national graduate recruitment scheme (Chowen, 2014), with more attractive job opportunities existing outside the sector (Consulting, 2020). As a result, there are recruitment difficulties for colleges generally. The previous chapter highlighted how this issue is more dominant regarding DS, and this can also cause further challenges. Nevertheless, there are a variety of programmes, funding schemes and other initiatives to support the recruitment of teachers (Greatbatch and Tate, 2018), and for DS and computing more specifically.

4.2.1 Funding Schemes

While there are some funding schemes available for teaching, historically, the majority has been focused on encouraging teachers within schools and not necessarily for FE. For example, the student loan reimbursement pilot scheme that was in the 2017 conservative party manifesto explained how teachers would be reimbursed for staying in the profession. For instance, a typical teacher in their 5th year of teaching would benefit from around £540 (Foster, 2019b). While being a teacher of computer science would make you eligible, teachers would also have to "be employed in a maintained secondary school, a secondary academy or free school, or a maintained or non-maintained special school" (Foster, 2019b, p. 24). Hence, FE teachers were not eligible, but there are other opportunities available. The Department for Education Website 'Get Into Teaching' (2019a) outlines computing trainees could be eligible for a bursary of £26,000 if they have a first, 2:1, 2:2, Master's or PhD. Similarly, if trainees had a 2:2 or above, they could be eligible for a tax-free scholarship of £28,000 from BCS, the Chartered Institute of IT (Department for Education, 2019a). More recently in 2021, the Department for Education announced that for the 2021/2022 academic year they were making more support available to "help FE providers attract high-quality individuals into the teaching profession in the FE sector in certain defined subject areas"

(Department for Education, 2021a, p. 4). This support included initial teacher education bursaries for priority areas, where computing was one of those subjects, with a £26,000 bursary available (Department for Education, 2021a). Furthermore, the Department for Education also announced that there would be investment in the FE workforce of over £65 million by the end of 2021/2022 (Department for Education, 2021d), which included ensuring that initial teacher education was based on employer-led standards, and to drive a provision of high-quality CPD for teaching staff (Department for Education, 2021d). However, regardless of these funding schemes, there is still a problem of attracting people to enter the teaching profession.

4.2.2 Teaching Computing via a School Placement

Another way to encourage more people to consider teaching computing is discussed in a paper by Moller and Powell (2019a), entitled 'Teaching Computing via a School Placement' which discusses a module that Swansea University have been offering since 2012 for their computing students. The module is a 3rd year 15 credit module run for computing students. The program is a ten-day placement (one day a week over a school term) which includes setting up and running a lunch-time 'Technoclub' and also supporting an after school extracurricular activity. Students are assessed on:

- A reflective log detailing their school experience (30%).
- Producing a 3-lesson teaching resource complete with notes, activities, assessment material and marking schemes (40%).
- A report written by the student's teacher-mentor (30%).

The main aim of the module was to give Computer Science students an impression of teaching and to encourage them to consider it as a career which hopefully should help alleviate issues regarding a limited pipeline of qualified teachers for DS. This model worked, but only to a small extent; the module coordinator received just two reference requests for students applying for PGCE places in the ten years prior to this module but in the six years the module has been running, at least two students each year have gone on to do a computing based PGCE programme. While this is an increase into the pipeline for Computer Science teachers, a lot of students undertaking the module do not progress to do a PGCE. However, if this model were to be replicated across the country, this could have a significant impact on the pipeline for teachers with DS. Even for those students who did not undertake a PGCE, they would have gained other transferable skills required for the workforce. The paper states that students gained skills such as team working, communication skills, interpersonal and improvisational skills, preparing presentation materials and receiving feedback (Moller and Powell, 2019a). This is important as soft skills are often lacking for many computer science graduates with some unemployed graduates explaining that they failed to appreciate the importance of work experience and the soft skills they would develop that employers need (Shadbolt, 2016). Hence, this module helps to address the lack of 'soft skills' amongst Computer Science graduates. Furthermore, with Computer Science students working in the classroom, they can provide teachers with computing support and expertise. However, challenges still remain, the placement module ran into difficulties such as:

- Arranging the school placement days that meet the needs of all stakeholders involved.
- Scheduling time for the module moderator to visit each participating school twice during the scheme.
- Moderating the teacher assessments of students.
- Identifying students who are able (and willing) to travel to schools that are remote.

This was a module used for schools and so it may not be applicable to a college environment. Nevertheless, this is one method that has potential to address some of the challenges previously stated if adapted to also be used in an FE setting.

4.2.3 Summary

While there are some initiatives to support the recruitment of teachers for DS, support for the recruitment for FE teaching is not as prominent as that as within schools. The IfL report on what can be done to promote teaching in FE (2014), concluded that the FE sector is 'second best' in comparison to other teaching professions and that FE teaching and training needs to become more competitive. They made 3 key recommendations to address the issue of teacher recruitment in FE:

1. Research should be carried out to investigate the perceptions, opportunities and barriers experienced by industry professional to consider FE teaching as a career option (Chowen, 2014). Unfortunately, the IfL ceased operations shortly after this report in 2014 and so they were unable to follow up on this research. Hence, this could be a suggested area for future research.

2. Greater links must be made between FE and university careers guidance teams (Chowen, 2014).

3. Public information regarding FE teaching should be overhauled with higher salaries and more CPD opportunities to be put into place (Chowen, 2014). However, due to the aforementioned issues such as a lack of funding, higher salaries may not be realistic. Particularly as staff costs for colleges are already exceeding the area review benchmark of 63% of income (Association of Colleges, 2018a). While the characteristics of effective CPD have been discussed with examples, further research is needed to establish what college teachers want from CPD specifically. Thereafter, this knowledge could be used to create a new program of CPD.

Building on these recommendations, it appears as if the Department for Education is finally making some progress. They plan on launching a national recruitment campaign in 2021-2022 which will guide prospective teachers to the 'Teach in Further Education' platform which will give potential applicants guidance and advice, including about training bursaries, vacancies, and development opportunities Department for Education, 2021d. However, until this is up and running for a substantial amount of time, it will be difficult to measure its effectiveness.

4.3 University and School/College Partnerships

There are some identified advantages for universities to work with colleges and collaborate. The 'Digital Skills for the UK Economy' report (2016), recommends that colleges should work together with HE and industry to determine the digital skills needs for local areas so education and provision is better suited to meet local demand. By collaborating, needs can be better understood and therefore this should allow for many benefits to be achieved (Derrick, Laurillard, and Doel, 2016). Hence, it is not surprising that a new type of institution has been created, which are Institutes of Technology. They are a combination of further education colleges, universities, and employers with a focus on STEM subjects (Augar *et al.*, 2019; Department for Education, 2021d). The March 2020 budget stated that the government will provide £120 million to help open eight of these institutions to help reduce skills gaps (HM Treasury, 2020), with the Department for Education (2021d) stating how these institutions will increase the provision of higher level, high quality technical education and training. Given that these are new institutions, it is not yet possible to deduce whether they will be effective and so this is a potential area for future research. In the meantime, there are other ways colleges and universities can collaborate too. It could be argued that many of the previous examples within this chapter already reflect partnerships between universities and schools or colleges such as 'Teaching Computing via a School Placement' (Moller and Powell, 2019a) or 'Technoteach' (Moller and Powell, 2019b). Nevertheless, this section will explore some other ways where partnerships with universities can be used to help alleviate the challenges of teaching DS.

4.3.1 Outreach Initiatives

Many parents and teachers are not informed appropriately regarding supporting their children/students with decision making around skills development and career options (ECORYS UK, 2016). This is despite that good information, advice and guidance (IAG) is crucial for anyone seeking advice about qualifications and careers (Augar *et al.*, 2019). Colleges rate their own IAG regarding university choices highly (UniTasterDays & HELOA, 2019), but employers feel like careers advice regarding DS careers is poor. A survey of Manchester based employers found that just 7% agree that career advisers understand the DS industry and can accurately advise on opportunities available to young people (Manchester Digital, 2019). Evidently, there is more work to be done regarding the collaboration between education and industry regarding DS IAG.

There is a general lack of awareness of career opportunities regarding DS (ECORYS UK, 2016; Snelson and Deyes, 2016; Aničić, Divjak, and Arbanas, 2017) and this will only continue as technology continues to evolve. One Association of Colleges survey found that 50% of colleges struggle to offer 1:1 careers advice (Association of Colleges, 2020b), but outreach programmes are one way that can help alleviate this issue (Shadbolt, 2016). A main aim of outreach is to raise aspirations of students and outreach activities could encourage students to work harder in their studies which could make teaching easier for staff. For example, a University of Gloucestershire report on outreach activity between 2015 and 2018 (Gray, 2019) showed that valid evaluations (surveys) were collected from 23,175 participants of various ages within schools and colleges. From these students, the statistics show that after the activity 72.8% are now considering university as an option, while 85% of students learnt something new, and this was particularly the case when the activity was delivered by academic staff. However, this piece of quantitative research only provides a general overview of student's perceptions, and lacks any depth which could lead to more detailed suggestions of what works well (or not).

It can be inferred that an Outreach activity for 'Computing' could potentially raise awareness of careers options in that field and also teach students some new subject content. This would be particularly useful for teachers who are lacking some knowledge in teaching DS (whether that be CK of a specific topic, or seeing new ways of teaching), which would inadvertently be a form of CPD for teachers in this instance. Besides, awareness of career options has been highlighted by industry as something that is lacking in schools and colleges, with careers advice being reported as underfunded (Augar *et al.*, 2019; Association of Colleges, 2020b). This issue could be resolved through outreach interventions. In fact, one of the recommendations from the University of Gloucestershire report was that Outreach activity could be more strategically focused using evidence from the evaluations, for example offering subject specific sessions encountering academic staff wherever feasible (Gray, 2019). Besides, staff in industry and HE should work more in colleges (Medhat, 2014) and by educational institutions and employers working together this will ensure that the right skills are developed within curricula (ECORYS UK, 2016). The House of Lords (2015) recommends that the government should encourage partnerships between industry and colleges, whilst the IfL suggested that greater links should be made between FE institutions and universities careers guidance teams (Chowen, 2014). Therefore, targeted outreach programmes, delivered by experienced academic staff in the field of DS could address some of the challenges highlighted in Figure 3.5 such as a lack of knowledge in college staff whilst simultaneously teaching students some new skills or content. This is predicated on the assumption that universities have academic staff with the time and resource to do so, but this is unlikely to be the case. It is assumed that colleges would likely support targeted outreach programmes given the challenges they are facing, as evidence shows that the brilliant teachers are the ones that already develop and build links with industry and HE (Learning and Skills Improvement Service, 2010).

4.3.2 Service Learning

The educational philosophy of service-learning promotes active learning through community engagement that also includes a reflective element (Brooks, 2008; Salam, Awang Iskandar, Ibrahim, and Farooq, 2019). Active learning means students having an opportunity for a hands-on experience, similar to work experience or an internship but in this case it is engaging in a project to serve the community (Salam *et al.*, 2019), where they can apply what they have learnt in the classroom (Tan and Phillips, 2005). If university courses offered computing UG students the opportunity to work on service learning projects, this would allow them to develop the soft skills needed for their future employability (Tan and Phillips, 2005; Salam *et al.*, 2019; Venn-Wycherley and Kharrufa, 2019), while also building links between the university and the community (Brooks, 2008; Tan and Phillips, 2005). Hence, there are opportunities for service learning projects where universities could form links with colleges.

There are a variety of examples of service learning projects where universities and their UG students have been engaging with schools. Community Connections was a service learning project created in 2003 for the University of San Francisco's UG computing students (Brooks, 2008). The main focus of their work was in San Francisco with regards to students helping maintain labs, upgrading machines and rebuilding servers to address the digital divide. However, as the project progressed another focus came in which was education (Brooks, 2008). Community Connections other work based in Peru, revolved around setting up computer labs and teaching courses in schools. Meanwhile, in a three-year period Saint Anselm College in the US had 80 UG students participate in service learning projects whereby they completed 20 hours of service in schools (Traynor and Mckenna, 2003). Similar work in England by Newcastle University involved 9 UG students being recruited to the "Create, Learn and Inspire with the micro:bit and the BBC" initiative where they developed and delivered 30 computing lessons within schools to year 8 students (Venn-Wycherley and Kharrufa, 2019), which could be viewed as being a form of outreach. With regards to being both outreach and service-learning, Carpenter (2015), conducted a study where 11 UG students were interviewed who were involved in 7 different outreach programmes. All 11 reported benefits to their career, academic study and soft skills while also providing benefits to those schools involved (Carpenter, 2015). A limitation of this study, which is shared with many others, is that the study had a relatively small sample. Furthermore, the participants for the interviews were self-selecting so they are more likely to provide a positive experience of their involvement (Carpenter, 2015).

All these pieces of work benefited the community partners and the university students in developing a variety of skills while also building links between universities and schools. Therefore, it is suggested that a service learning model could be adopted by UK universities where UG computing students could deliver sessions or help out more generally within colleges regarding DS, specifically with regards to providing some further knowledge or classroom support. This would need further research regarding requirements of how this could work for the colleges involved. Besides, in the service learning projects already discussed, they were not without their challenges. Service learning projects involved complicated logistical organisation, management of expectations (both of the student, university and community partner), and commitment of all those involved (Brooks, 2008; Venn-Wycherley and Kharrufa, 2019). Additionally Salam *et al.* (2019), who conducted a literature review on service learning, identified additional challenges such as a lack of financial resources, time management, and monitoring student progress. Furthermore, if applying service learning as a way to help colleges regarding to DS, it must be noted that the service learning projects discussed were extra-curricular activities for students while extra-curricular activities are typically not popular options for UG computing students (Venn-Wycherley and Kharrufa, 2019). Service learning is primarily designed to educate the students (Brooks, 2008; Salam *et al.*, 2019) with helping the community partner being a secondary objective. This could provide an incentive for universities to consider programmes like the aforementioned examples if they had students who needed to further develop their skill-sets. Besides, there is a need to integrate university-school partnerships into the wider computing curricula of UG study (Venn-Wycherley and Kharrufa, 2019), and applying this idea to include colleges could see benefits for all involved. However, research is needed concerning how this collaboration could work effectively.

4.4 Chapter Summary

The previous chapter highlighted various challenges that colleges face in teaching DS with Figure 3.5 providing an overview of the challenges faced and how they may link together. Not every challenge that was highlighted in Figure 3.5 has been addressed in this chapter, as varied curricula, pupil behaviour, disparity of learners and a lack of funding could be considered general issues for colleges, not specific to DS. Those more pertinent in DS teaching include the limited pipeline of qualified teachers, inadequate resources (often because of a lack of awareness, time or funding) and a lack of teachers with the knowledge to teach DS effectively. These challenges combined often lead to colleges teaching what they have the resource and knowledge to teach. Hence, this chapter has covered three main areas of potential best practices to overcome the challenges in teaching DS; CPD, ways to address the limited pipeline of teachers, and forging university and college partnerships.

CPD could address a lack of knowledge in teachers while also having the potential of providing participants with more resources that they could use in the classroom. However, for CPD to be implemented effectively, it needs to be timely, supported by college leadership, and affordable. Meanwhile, addressing the limited pipeline of teachers does not need to only be achieved through funding schemes; as university students working in schools could entice more students to enter the teaching profession. If a model similar to that of Swansea University was adopted by other university computing departments this could have a significant impact on those becoming computing teachers. Similarly, other links being created between universities and colleges such as outreach initiatives and service learning projects can also help alleviate some of the challenge's colleges face in teaching DS.

4.4.1 Areas for Future Research

This chapter has highlighted potential best practices to overcome the challenges that influence the teaching of DS. However, many will not be relevant to colleges depending on their own specific contexts and resource capacities and constraints. This is explained with the example of CPD as although many CPD opportunities exist, the potential of them to reach a significant number of college teachers to have a meaningful impact to DS teaching is limited (Hanley *et al.*, 2018). As recommended by Crick (2017), care must be taken when considering the applicability of studies that took place in a different context (e.g. HE) and applying their relevance to colleges. Meanwhile, many of the potential best practices could be argued as being reactive to the challenges faced and not proactive or preventative. Hence, this leads to research question 3:

RQ3 – What practices do colleges currently employ to overcome the perceived challenges that influence the teaching of 'digital skills' at level 3?

This research question aims to establish what colleges are already doing to overcome the challenges unique to them as perceived by internal college stakeholders. By understanding what has worked (or not) for a college within their own specific contexts, this allows for a more accurate set of best practices to be created. Primarily as they would be related to specific challenges colleges have faced and how they have worked in specific contexts. Besides, future research regarding the relative value of different approaches within DS teaching is recommended (Garneli, Giannakos, and Chorianopoulos, 2015; Crick, 2017; Webb *et al.*, 2017), as good design of teaching practice often evolves from a range of practical examples (Beetham and Sharpe, 2013). Hence, it is important to understand how colleges overcome the challenges that influence DS teaching, so it is possible to evaluate what they do and share this practice with other colleges. For example, in terms of CPD it has been suggested that future research would be useful regarding what teacher CPD has had the biggest influence on the quality of teaching (Greatbatch and Tate, 2018). By understanding teachers' perceptions of what has worked for them, it is possible to answer this, and in rapidly changing contexts such as that of DS and colleges, it is important to share best practice with others (Beetham and Sharpe, 2013; Derrick, Laurillard, and Doel, 2016). Once more, there is a need for an in depth understanding of college context to answer research question 3, particularly with regards to the challenges faced. This research question therefore builds off research question 2 by going further into understanding what colleges do to overcome the challenges unique to them.

To further aid in this analysis and understanding of colleges, another research question is posed:

RQ4 – How do college stakeholders differ regarding their perceptions on the challenges that influence the teaching of 'digital skills', and the practices used to overcome those challenges?

Understanding the perceptions of different stakeholders regarding research question 2 and 3 and how these perceptions may differ adds a further layer of understanding to colleges regarding level 3 DS education. It is important to speak to those who are neighbours to a phenomenon, not just those central to it (Biggs, 1993; Miles, Huberman, and Saldana, 2014) which in this case could be senior leadership teams, technicians, and other support staff in addition to that of the college teachers and heads of departments. By using a combination of multiple perspectives, this can help counter threats to validity (Robson and McCartan, 2016) and is also a proven method used when investigating colleges. For example, a study of CPD within colleges used data triangulation of stakeholders to enrich the data gathered (O'Leary and Brooks, 2014). Meanwhile, it is argued that different groups of people within an organisation experience a different workplace reality (Saunders, Lewis, and Thornhill, 2019), and by speaking to these different groups of people, it is possible to obtain a fuller understanding of the actual reality of the situation taking place within colleges. However, while stakeholder theory suggests that all of those who have an interest and influence on an organisation should be valued (Freeman, 1984), for this thesis the stakeholders considered for this research question are the internal college stakeholders of teachers, head of departments and senior leadership teams. It is recognised that other stakeholders will influence DS teaching at level 3 too within colleges but these three stakeholders are considered the most important to achieve the research aims.

Part II

Research Methodology and Processes

Part I provided the introduction and context of the study, reviewed existing literature, identified gaps, and generated research questions for this thesis. Now that this has been provided, Part II presents the research methodology and research design and processes that underpin this study on English colleges regarding digital skills provision, challenges and best practices. First, it offers a discussion on the philosophical and theoretical foundations on which the research is based.

Part II then discusses the research design and the processes which have allowed the aims, objectives and research questions of this study to be met. It highlights key issues in relation to how data was collected, managed, analysed and interpreted, while also considering research ethics and other research considerations. The chapters in Part II are as follows:

5) Research Methodology

6) Research Design and Processes

7) Research Considerations

Chapter 5

Research Methodology

This chapter will outline the research methodology of the thesis. The research methodology provides a framework for making a series of decisions regarding the research including how research is conducted, assumptions about what research can be considered valid and the claims that can be made (Braun and Clarke, 2013). Crotty (1998) contends that research methodology can be defined as the strategy and plan of action that lies behind the choice of methods used and these factors should be considered before discussing which research design would be most appropriate. To do this successfully, this thesis will consider the research onion, created by Saunders, Lewis, and Thornhill (2019).

The research onion in its original form is not a perfect representation of all the factors involved in conducting research. Nevertheless, it provides a useful starting point to ensure key stages of research are considered. There are other assumptions that must be considered that are not outlined in the original research onion that underpin both philosophy and approach to theory development which together determine the orientation to a particular approach (Crotty, 1998). These assumptions include the perspectives regarding ontology, epistemology and axiology (Saunders, Lewis, and Thornhill, 2019) and these influence how a researcher creates knowledge and derives meaning from data (Moon and Blackman, 2014). As a result, the original research onion has been modified to include these three additional aspects (see Figure 5.1).

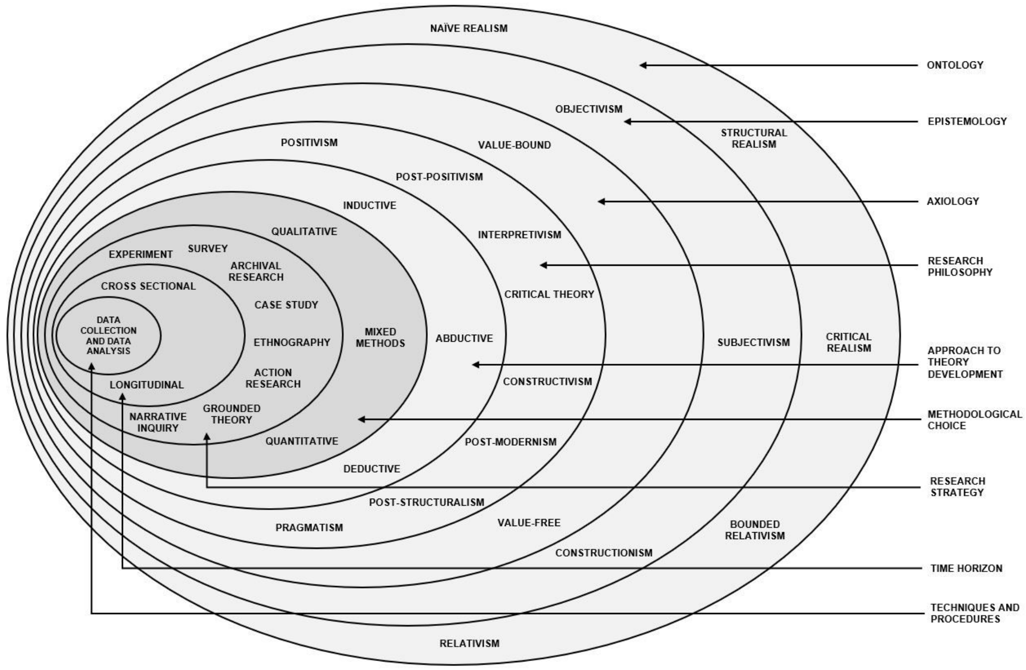

Figure 5.1: The Research Onion. Source: Adapted from (Saunders, Lewis, and Thornhill, 2019).

This chapter will focus on the five outer layers of the modified research onion, starting at ontology, and moving inwards towards approach to theory development. The researcher's perspectives on these five areas will be explored in relation to the research questions of this thesis.

5.1 Ontological Stance

Ontology refers to the theories regarding the nature of reality (Collis and Hussey, 2014; Saunders, Lewis, and Thornhill, 2019), and whether one believes that reality exists entirely independent of human practice and understanding (Braun and Clarke, 2013). Ontology could be considered as whether one believes there is one singular reality or whether there are multiple realities and this has important implications for research. Whilst acknowledging there are many variations along the continuum of ontological perspectives, Braun and Clarke (2013) outline how there are two ends of the spectrum; realism and relativism.

Realism is the view that reality is entirely independent of the human ways of knowing about it (Braun and Clarke, 2013). Hence, postulating that there is just one reality and this reality can be discovered using appropriate investigate methods (Coolican, 2013). The researcher does not agree that this view is appropriate for this thesis. For example, RQ1 sets out to investigate how decisions are made regarding what qualifications are taught within colleges. Unless one is the individual making that decision, one cannot know the exact thought processes behind how these decisions were made and the historical and cultural contexts that would have influenced that choice.

At the other end of the spectrum is relativism. Relativism is the view that reality is entirely dependent on human interpretation (Braun and Clarke, 2013). Therefore, there are multiple realities and that objective facts are an illusion (Coolican, 2013), as reality does not exist beyond the mental constructions' subjects create (Moon and Blackman, 2014). The researcher does not agree that this is the case either as the researcher believes that there is just one reality, and in the context of this thesis, this would constitute the situation the college is in. However, the researcher does agree that individuals would have different interpretations, and hence, different perceptions of the situation the college would be in based on their role, experience, and socio-economic and cultural background.

The belief that there is a bigger picture, where each individual only sees a small part of it, is more in line with a critical realism perspective (Saunders, Lewis, and Thornhill, 2019). Critical realism instead sits in between realism and relativism (Braun and Clarke, 2013) with the focus being on explaining what we see and experience of that one reality (Saunders, Lewis, and Thornhill, 2019). Critical realists see reality as external and independent, but one cannot directly access it through our observation or knowledge of it as our senses deceive us and so context is very important (Saunders, Lewis, and Thornhill, 2019). In other words, critical realists position themselves as that there is a single real world (reality) out there, but we can't fully access it, as it is blocked by a subjective lens. However, perceptions provide some understanding and knowledge of what is out there. For this thesis, a critical realist ontological perspective is therefore deemed the most appropriate. First, because critical realist research often takes place regarding social and organisational structures (Saunders, Lewis, and Thornhill, 2019) and for this thesis, the organisation would be each college and an understanding of college's specific context in relation to the challenges they face is required. Furthermore, the study intends to investigate the differences in stakeholder perceptions, and a critical realist approach is important as one would want to understand the different subjective lenses these stakeholders are looking through of the one reality (the college) they are situated in, as this would help build that 'bigger picture' of gaining a fuller understanding of each college.

5.2 Epistemological Stance

Epistemology refers to the nature of knowledge (Braun and Clarke, 2013), and how knowledge is constructed (Coolican, 2013). Therefore, epistemology provides the philosophical background for what knowledge is deemed adequate, legitimate and valid (Collis and Hussey, 2014; Gray, 2017; Saunders, Lewis, and Thornhill, 2019). Consequently, epistemology is concerned with the aspects of validity, scope and methods used to acquire knowledge and what that knowledge can claim (Moon and Blackman, 2014). In simpler terms, epistemology considers whether knowledge is something that exists that can be measured, or whether knowledge is perspectival and produced. Therefore, epistemology can also be relativist or realist (Braun and Clarke, 2013).

A realist epistemological position assumes it is possible to obtain the single universal truth through valid knowledge production (Braun and Clarke, 2013). In other words, it is possible to discover reality through the process of research. This view is synonymous with what is referred to as objectivism. Crotty (1998) states how an objectivist epistemology holds that meaning exists independently from the operation of consciousness. Hence, there is an objective reality 'out there' to be discovered (Gray, 2017). The value of objectivist research is in its external validity and reliability (Moon and Blackman, 2014) and ontologically, objectivism embraces realism (Saunders, Lewis, and Thornhill, 2019). While the researcher agrees that there may be one reality 'out there', the researcher rejects that this reality can be measured and is independent of human consciousness, particularly as this thesis aims to find meanings behind how stakeholders make decisions and also their perceptions on the challenges they face. This knowledge is perspectival by the very nature of what one finds to be a challenge for them. As a researcher we cannot measure this like one may measure things in the natural sciences but one can try to understand these perceptions within its local context for a fuller understanding of the one singular reality the subject is in.

A relativist epistemological position may therefore be more appropriate for this study and is embraced by those who are critical realists (Saunders, Lewis, and Thornhill, 2019). A relativist epistemological position states that a singular truth is impossible as knowledge is always perspectival (Braun and Clarke, 2013). It recognises that knowledge is situated historically as it is a product of its time, which includes the social facts and constructions that are agreed on by people as opposed to existing independently (Saunders, Lewis, and Thornhill, 2019). However, there are two epistemological positions linked to relativism which are constructionism and subjectivism.

Constructionism rejects the objectivist view of human knowledge stating that meaning is constructed not discovered, as subjects construct their own meanings in different ways even if regarding the same phenomenon (Crotty, 1998; Gray, 2017). This is heavily linked to the aims of this study, as the study intends to investigate college's specific context and stakeholder perceptions on the same situation. In a constructionist approach, multiple and contradictory but equally valid accounts of the world (the college) can exist (Gray, 2017) as this epistemological position assumes different individuals construct meaning of the same phenomenon in different ways (Moon and Blackman, 2014). Consequently, it can be considered that there are multiple knowledges, rather than knowledge which forms an understanding of reality, as knowledge is formed by personal context and is a product of how we come to understand it (Braun and Clarke, 2013). This epistemological position has a lot of value for in this thesis as constructionist research generates contextual understandings of a defined problem (Moon and Blackman, 2014) which is what this study required of level 3 digital skills college teaching.

Subjectivism on the other hand, contends that meaning is already in the mind, as opposed to being constructed (Moon and Blackman, 2014). A subjectivist epistemology holds that knowledge does not emerge from the interchange between subjects and their world (reality and objects) but instead meaning is imposed on the object so they construct meaning, but from a collective unconsciousness (Gray, 2017). Subjectivism is very much tantamount to the view that there are multiple realities and thus multiple meanings due to each individuals' own perception of reality (Saunders, Lewis, and Thornhill, 2019). This, as mentioned previously has been rejected as a notion for how the researcher views reality. Therefore, constructionism is considered the most useful approach for the proposed study.

To summarise, the researcher views that there is one singular reality but this cannot be measured. It can however be attempted to be understood, by investigating perceptions of individuals regarding the same phenomenon. Hence, for this thesis, the researcher adopts a critical realist ontological perspective and a constructionist epistemological perspective as they are deemed the most useful philosophical underpinnings for conducting the research.

5.3 Axiological Stance

Axiology is the branch of philosophy regarding the role of values within the process of research (Saunders, Lewis, and Thornhill, 2019). What is recognised as facts, and the interpretations gained from them is dependent on researcher values (Collis and Hussey, 2014) and this can influence data collection. For example, conducting a study where the greatest importance is placed on face-to-face interviews suggests that the researcher values data collected through personal interaction with participants more highly than views expressed through other techniques such as an online questionnaire (Saunders, Lewis, and Thornhill, 2019).

There are two main stances regarding axiology: the first being value-free research which is where the researcher is detached and independent of what is being researched (Saunders, Lewis, and Thornhill, 2019). Here, the researcher would remain objective, and should strive to ensure that their own feelings and values do not influence the research process (Gray, 2017). However, the researcher is interested in peoples' perceptions and understanding these perceptions requires interpretation. This interpretation means that the researcher is involved in the research process and so axiologically, is more in line with the stance of being value-bound.

Value-bound research is when the researcher is part of what is researched, as researcher interpretations are key (Saunders, Lewis, and Thornhill, 2019). The researcher views the impact of their own values and beliefs as a positive thing, as researcher interpretation is believed to be needed to understand how a colleges context and multiple stakeholder perceptions ‘fit’ together. Besides, the choice of focus in research is influenced by the researcher’s values in the first place (Cohen, Manion, and Morrison, 2018). Therefore, axiologically, the researcher is value-bound and values the perceptions of multiple groups of people within an organisation regardless of their role in the hierarchy and that effective education is the responsibility of everyone involved within an educational institution, even if not directly involved in teaching. Due to being involved in the research process, the researcher must be reflexive of their practice and how much their values influence the research process (Saunders, Lewis, and Thornhill, 2019). As such, reflexivity will be discussed in more detail later in this thesis.

5.4 Research Philosophy/Paradigm

Now that the underpinning assumptions of ontology, epistemology and axiology have been discussed, it possible to discuss the research philosophy, or paradigm. Philosophical perspectives can be viewed as a set of assumptions which structure the approach to research and how it is conduced (Moon and Blackman, 2014), and in the original research onion, Saunders, Lewis, and Thornhill (2019) contend that there are five research philosophies: positivism, critical realism, interpretivism, post-modernism, and pragmatism. There are others such as post-positivism, while critical realism could be considered as not being a philosophical position but instead a perspective of ontology as previously discussed (Braun and Clarke, 2013). Moon and Blackman (2014) agree on this issue and add that there are other research philosophies/paradigms such as constructivism, critical theory and post structuralism. Therefore, these were added to the modified research onion (Figure 5.1). This wide variation in research philosophies could provide enough discussion for an entire study itself. Therefore, this section will consider just the two positions of positivism and interpretivism and their usefulness to this thesis. These two positions are viewed as the two extremes on a continuous line of paradigms and are the main paradigms in business research (Collis and Hussey, 2014) while the business in question for this study is colleges.

Positivism originates in the natural sciences and assumes that social reality is singular and objective (Collis and Hussey, 2014). Ontologically, positivists view the world as having one reality like the researcher. However, epistemologically positivists believe that only what can be observed and measured can be accurately regarded as valid knowledge (Collis and Hussey, 2014). This is an advantage of positivism for the natural sciences as it assumes a straightforward relationship between our perceptions and the world (Braun and Clarke, 2013), and that the world consists of regularities, consistencies, laws and absolute principles (Crotty, 1998). Here, positivists may use existing theory to generate hypotheses and look for causal relationships in data to create law-like generalisations that can be universally applied (Saunders, Lewis, and Thornhill, 2019). Consequently, positivists are likely to use existing theory to develop hypotheses while also collecting measurable quantifiable data for unambiguous and accurate knowledge (Saunders, Lewis, and Thornhill, 2019). However, the aim of this thesis was not to create law like generalisations and quantifiable data that can be measured, but instead on perceptions and reasons underpinning decision making. This is not something that can be accurately measured due to relying on what the individual says. Hence, positivism was not a useful position for this research, predominantly as the main weakness of positivism is that it is objectivist and neglects the opinions, beliefs, and feelings of individuals (Crotty, 1998). However, this is exactly what the thesis was looking to obtain.

Due to the limitations of positivism, interpretivism was considered more applicable. Interpretivism emphasises that humans are different from physical phenomena as they create meanings (Saunders, Lewis, and Thornhill, 2019), and assumes social reality is subjective and multiple (Braun and Clarke, 2013). While the researcher disagrees with the notion of multiple realities, the researcher does agree that people's subjectivity will influence how they see that reality. Hence, the researcher agrees with interpretivism epistemologically. A main difference between positivism and interpretivism is that while positivism focuses on measuring social phenomena, interpretivism aims to explore the complexity of social phenomena (Collis and Hussey, 2014). For this study, the aim was not to measure how many colleges offer different qualifications, or how many suffer from a certain challenge, but instead to understand the reasons why colleges offer those qualifications and why a certain challenge is a specific challenge for them. Hence, this thesis is grounded in an interpretivism approach.

The purpose of interpretivism research is to map the variety of perceptions and views people take on a given research topic (Robson and McCartan, 2016) in order to create rich understandings of social worlds and their contexts (Saunders, Lewis, and Thornhill, 2019). This could mean looking at organisations from the perspectives of different groups of people (i.e. stakeholders) as it can be argued that different groups will see and experience an organisation differently and so will experience different workplace realities (Saunders, Lewis, and Thornhill, 2019). This approach is highly relevant to this study but it is important to recognise that there are limitations to interpretivism approaches. An interpretivism researcher will have to enter the world of the research participants to understand the world from their point of view (Saunders, Lewis, and Thornhill, 2019). Consequently, the researcher is part of the research itself and not separate from it. Therefore, unlike positivism, interpretivism research results are likely to be biased as the researcher interacts with the phenomena under study (Collis and Hussey, 2014).

5.5 Approach to Theory Development

Based on the philosophical positions to research, this will influence the approach to theory development. There are three main approaches to theory development: induction, deduction and abduction (Saunders, Lewis, and Thornhill, 2019). Through an inductive approach, plans are made for data collection and then data is analysed to see if patterns emerge which suggest relationships. From this, generalisations, relationships and theories can be generated (Gray, 2017). Hence, inductive research focuses on 'building theory' (Saunders, Lewis, and Thornhill, 2019) by investigating particular instances and creating general inferences from these instances (Collis and Hussey, 2014). Therefore, induction is associated with an interpretivism philosophy and typically involves in depth investigations with qualitative methods of analysis (Saunders, Lewis, and Thornhill, 2019).

In contrast to an inductive approach, a deductive approach is more aligned to hypothesis testing (Gray, 2017) as data follows the theory (Saunders, Lewis, and Thornhill, 2019). With a deductive approach, a theory and hypothesis will be generated and then data collection will commence to test this theory. Therefore, particular instances are deducted from general inferences (Collis and Hussey, 2014). This approach is more suited to a positivist philosophy (Collis and Hussey, 2014). Unlike inductive and deductive approaches, an abductive approach moves 'back and forth' between generating theory from data, and generating theory to then test (Saunders, Lewis, and Thornhill, 2019). Based on the research questions of this thesis, an inductive approach was adopted as there was no testing of hypothesis but instead exploring reasons behind actions, perceptions and factors in relation to local college contexts. Hence, generating theory from data.

5.6 Chapter Summary

This chapter has discussed the research methodology of the thesis, which included ontology, epistemology, axiology, research philosophy and approach to theory development. Figure 5.2 summarises the position of the researcher regarding these aforementioned methodological factors.

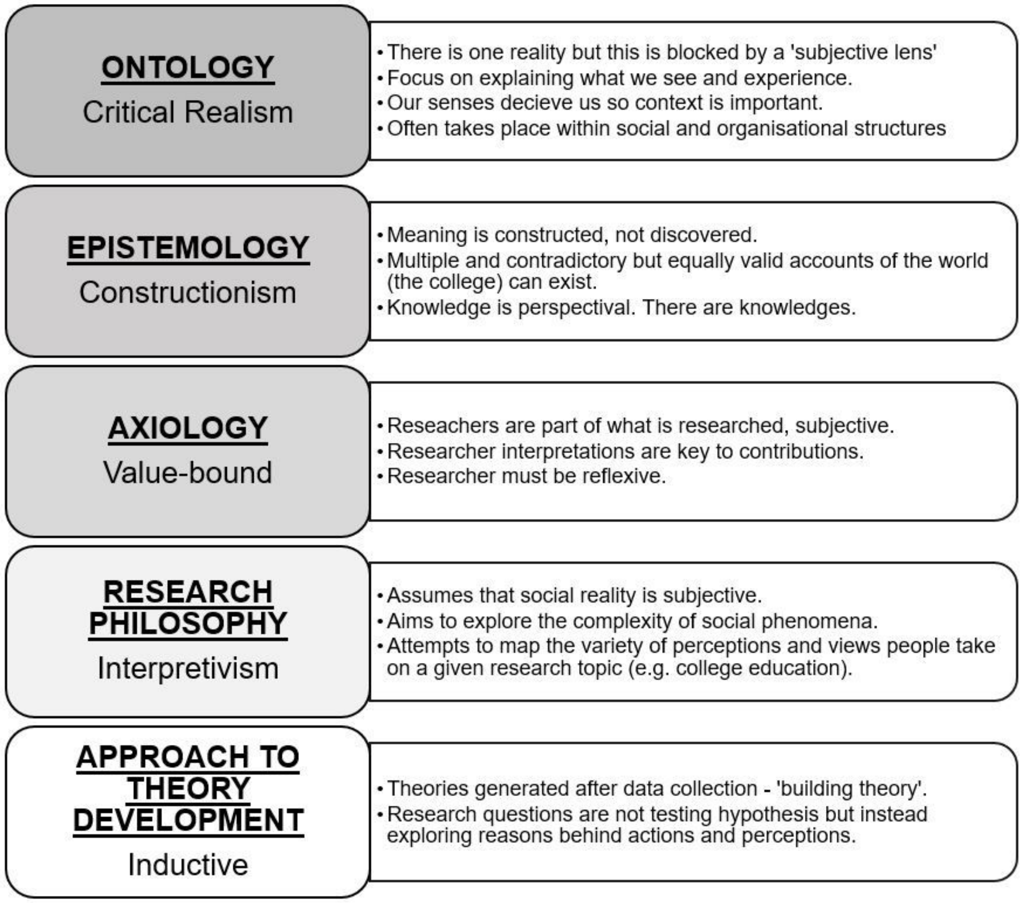

Figure 5.2: Methodology Choices and Assumptions Summary.

Chapter 6

Research Design and Processes

This chapter focuses on the inner four stages of the 'Research Onion' (Figure 5.1) which includes; methodological choice, research strategy, time horizon and the research techniques and procedures which consists of both data collection and data evaluation and analysis. These factors must be considered as the process of research can be considered as just as important as the outcomes generated (Cohen, Manion, and Morrison, 2018).

6.1 Methodological Choice

Methodological choice refers to whether the research is taking a qualitative, quantitative, or mixed methods approach. Which approach is taken often depends on the research questions of the study and the underpinning philosophical perspectives (Crotty, 1998). Either way, quantitative and qualitative research have some commonalities. They both require careful planning and implementation to the research, both must comply with appropriate ethical guidelines and both must present their findings with integrity, amongst other factors.

While sharing some features, both quantitative and qualitative research have their own strengths and weaknesses. Quantitative research often results in findings with a high degree of reliability, as they use large samples and are often more precise (Collis and Hussey, 2014). This type of research often produces relatively artificial results that are not applicable to everyday life

(Coolican, 2013), and given that education is full of contradictions, complexity and richness (Cohen, Manion, and Morrison, 2018), a quantitative approach was not deemed suitable for this study.

In contrast, qualitative research has a strong potential for revealing complexity (Miles, Huberman, and Saldana, 2014), as it considers that there can be multiple interpretations of reality (Cohen, Manion, and Morrison, 2018). Qualitative research values people and their perceptions of the world and encourages natural responses from participants (Coolican, 2013). In order to reveal this complexity effectively, qualitative research usually results in findings understood only in their context, consisting of relatively small samples (Collis and Hussey, 2014) and so generalisability can be seen as an issue in qualitative research. However, some authors note how participants are not meant to be generalisable in qualitative research so this is not something to be concerned about (Bryman and Bell, 2011; Robson and McCartan, 2016). Besides, it has been highlighted already that each college is unique, and a focus on context was desired in this study.

Based upon ontological critical realism, an intepretivist philosophy and an inductive approach, qualitative research would generally be considered the most appropriate methodological choice (Braun and Clarke, 2013; Saunders, Lewis, and Thornhill, 2019). Given the aims of this thesis, which was to obtain a depth of understanding into the college environment and different stakeholder perceptions, a qualitative approach is deemed the most suitable, particularly as qualitative research emphasises meaning and experiences (Coolican, 2013). Besides, qualitative research can be very valuable to educational research (Cohen, Manion, and Morrison, 2018) and to make a meaningful contribution to practice, it is vital to understand how and why certain resources have the influence that they have (Collis and Hussey, 2014).

6.2 Research Strategy

The next layer within the 'research onion' (Figure 5.1) is the research strategy and there are a wide variety of research strategies that can be used (Saunders, Lewis, and Thornhill, 2019). Experiments for instance are often used to test hypotheses and treat situations like a laboratory (Cohen, Manion, and

Morrison, 2018). They require control of behavioural events (Yin, 2009) and take the phenomenon out of context (Yin, 2009), but context was important for the aims and questions of this thesis and so experiment was not a suitable research strategy. Similarly, survey research is also usually associated with deductive approaches and the testing of hypotheses, and the ability to investigate context is limited (Yin, 2009). Meanwhile, archival research alone does not focus on contemporary issues (Yin, 2009), and action research involves the researcher being a practitioner with the aim of improving one's practice (Cohen, Manion, and Morrison, 2018).

Some research strategies were initially considered for their potential usefulness but ultimately rejected. One was narrative inquiry which focuses on 'story-telling' through narrative accounts of participants with the aim to derive theoretical explanations (Saunders, Lewis, and Thornhill, 2019), but it can be intensive and time-consuming (Saunders, Lewis, and Thornhill, 2019), so the researcher must collect enough data to ensure the full 'story' is told. Grounded theory suffers from the same limitations, and is also used to develop theoretical explanations, but this thesis was seeking understanding, not necessarily to develop theory. Meanwhile, ethnography which focuses on the portrayal of events from subjects' perspectives in natural situations (Cohen, Manion, and Morrison, 2018) could have potentially been a viable option for the research questions of this thesis. Ethnography has a large focus on people and culture, but perhaps too much of a focus on people, and less so on colleges overall.

Overall the choice of research strategy often depends on the research questions of the study (Yin, 2009), and within this study the focus was on obtaining multiple perceptions on a phenomenon situated within its local context. Therefore, a case study research strategy was deemed the most suitable.

6.2.1 Justification for using Case Study

A case study strategy was chosen as the most suitable research strategy, and is usually used by interpretivism researchers (Collis and Hussey, 2014). Case study research deeply investigates a contemporary phenomenon within its real-life context (Yin, 2009), and can penetrate situations that are not always necessarily susceptible to numerical analysis (Cohen, Manion, and Morrison, 2018). Case studies benefit from using a variety of data collection methods to obtain knowledge (Collis and Hussey, 2014), while it could be argued that collecting sufficient data is an essential aspect of case studies as this is needed to put forward interpretations that are more representative of the phenomenon being investigated (Bassey, 1999). Case studies are particularly relevant for studies where the research questions require an extensive and in-depth description of a phenomena (Yin, 2009). Likewise, case studies are useful for answering 'how' and 'why' questions, and they recognise that context is a strong determinant for causes and effects (Cohen, Manion, and Morrison, 2018), and these factors were all significant for what this study involved.

Case studies can also make unique and distinctive contributions for educational research (Cohen, Manion, and Morrison, 2018), with Merriam (1998) contending that case studies have proven particularly useful for educational innovations, for evaluating programmes, and informing policy (Merriam, 1998). For example, Lahiff (2015) used in-depth qualitative case studies to focus on ITT within FE colleges, concluding that case studies resulted in clear implications for practice. Within case studies though, context is always important and by providing examples of real people in real situations, this enables readers' to understand ideas and situations more clearly than by using abstract theories (Cohen, Manion, and Morrison, 2018). However, it is important for phenomenon to be allowed to speak for themselves, without factors being presented out of context, and without being too heavily evaluated and judged by the researcher (Cohen, Manion, and Morrison, 2018). Hence, reflexivity of the researcher will be discussed later.

6.2.2 Case Study Type

There are three types of case study which can be defined as exploratory, explanatory, and descriptive (Yin, 2009). Exploratory case studies, also called 'theory-seeking' by Bassey (1999), are used to generate hypotheses, while explanatory case studies are testing theories (Cohen, Manion, and Morrison, 2018). Descriptive case studies provide narrative accounts (Cohen, Manion, and Morrison, 2018) and could be considered as 'story telling' (Bassey, 1999). A descriptive approach is deemed most appropriate given the aim is to gain a familiarity with how decisions are made within colleges and the perceived challenges faced and how to overcome them. The study is not testing theory, nor is it looking to create a theory, but instead create a shared understanding of the situation actually taking place within colleges from the perspectives of different employees. A descriptive case study would allow the reader to understand the topic in question which is level 3 college education regarding DS.

6.2.3 Case Study Design

Within case study research, theory development during the design phase is essential (Yin, 2009) and theory development, prior to data collection, is a key difference between case studies and other research strategies such as grounded theory and ethnography (Yin, 2009). In the context of this thesis and section, theory development relates to the theory of what is being studied. Figure 6.1 shows the theory of what is being studied within this thesis and the factors that interact together.

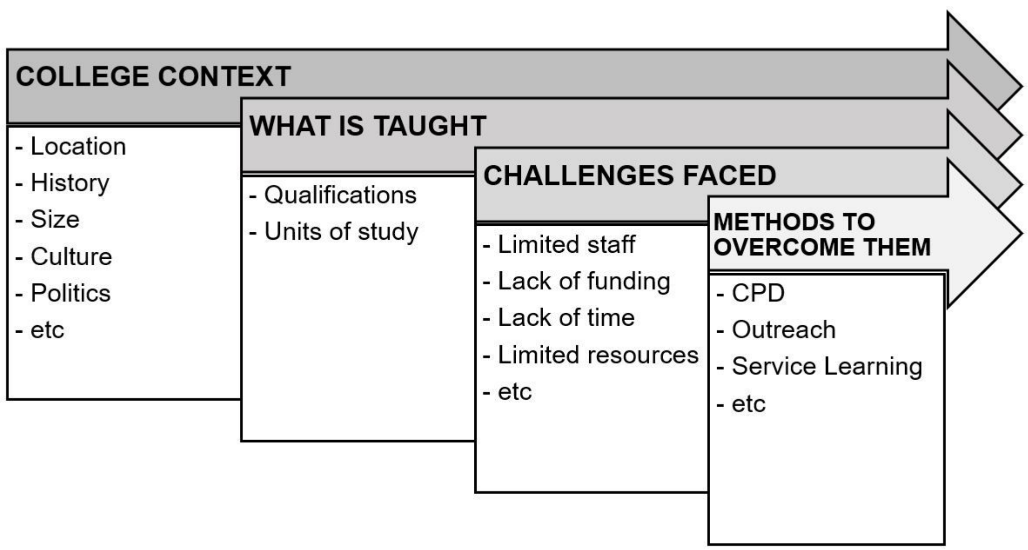

Figure 6.1: Theory of what is being Studied.

The suggested theory is that college context will influence what is taught within a college, as suggested in Biggs' (1993) 3P Model (Figure 2.4). Meanwhile, the challenges faced within the college will be influenced by both college context and what is taught, while the methods to overcome the challenges will be influenced by college context, what is taught, and the challenges faced. Hence, the suggested theory is that all these factors within colleges are interconnected and you need an understanding of all four to gain a true understanding of DS teaching within colleges. An additional theory not demonstrated in Figure 6.1 is that due to having different roles, it is also presumed that different college stakeholders will have different perceptions on the four different factors presented. The use of theory in the design stage can aid the development of the full research design and data collection methods to undertake (Yin, 2009).

Another factor to consider in case study research design is the unit(s) of analysis. The unit(s) of analysis refers to the problem of defining what the 'case' is (Yin, 2009), which is a common problem in case study research (Saunders, Lewis, and Thornhill, 2019). While case studies have set boundaries (Merriam, 1998), which can be temporal, geographical, or organisational based (Cohen, Manion, and Morrison, 2018), a case could be classified as anything (Robson and McCartan, 2016). For example, Moller and Crick (2018), in their study of 'Technocamps' to support computer science education, categorise the 'case' in their research as the country of Wales. Therefore, it is important to define what is meant by the 'case' for this study.

In the context of this study the overarching case context and focus are colleges in the geographic region of the South West of England. By investigating multiple colleges within this region, this can be considered as a multiple-case study design which are typically stronger than single-case designs (Yin, 2009). We can better understand social phenomena when contrasting cases (Bryman and Bell, 2011; Merriam, 1998), and multiple-case study designs are often more compelling (Yin, 2009). It has been suggested that researchers of DS education should move beyond isolated case studies and individual examples of good practice and move towards developing widely applicable solutions for recognised issues (Aničić, Divjak, and Arbanas, 2017). Hence, considering multiple colleges within the case of the South West of England should provide a more provoking insight into answering the research questions.

Another factor of consideration is whether the case study design is embedded, which is where there is more than one embedded 'unit of analysis' incorporated into the design (Cohen, Manion, and Morrison, 2018). In educational settings, a unit of analysis where the case study is a school could be teachers, classes, students or parents, and each of these units may require different methods of data collection and so may be kept separate for each case (Cohen, Manion, and Morrison, 2018). This study follows a similar format in that for each college investigated, the embedded units of analysis are represented by the different types of employees at three different levels; senior leadership teams (SLT) which includes members of the governing board, head of departments (HoD), and teachers (illustrated in Figure 6.2). This is beneficial as each of these levels represents a different micro-system as part of the larger educational system (Biggs, 1993), and so should yield different perceptions due to being part of a different layer (as shown in Figure 2.5).

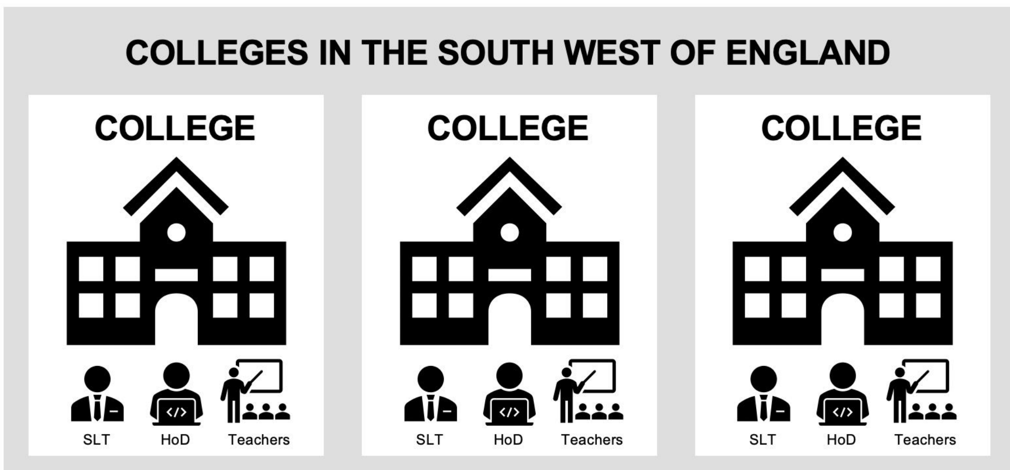

Figure 6.2: Multiple Case Study Design and Embedded Units of Analysis.

Defining the units of analysis can help with the replication and comparison of case studies (Yin, 2009), but overall each case (i.e. each college) is to be examined collectively as part of the larger case context of the South West region. The reason for this is that a pitfall of embedded case studies is when they focus too much on the sub-units and do not return to the larger unit of analysis (Yin, 2009). To summarise, this research follows a multiple-case study design where each case is a college and the embedded units of analysis are the three different types of employees, yet each case is situated within the overarching case that is colleges within the South West of England.

6.2.4 Case Selection

Focus on South West of England

Due to there being over 240 colleges in England, this is too many to consider for a case study approach and to be completed within the boundaries of this study. Therefore, this study will focus on a subset of England, the case of colleges in the South West of England. During the academic year of 2019/20 there were 24 colleges in the South West; three sixth-form colleges, two land-based colleges and 19 general FE colleges (As seen in Figure 6.3). However, in August 2020, New College Swindon and Swindon College merged together taking the total at the end of 2019/20 to be 23.

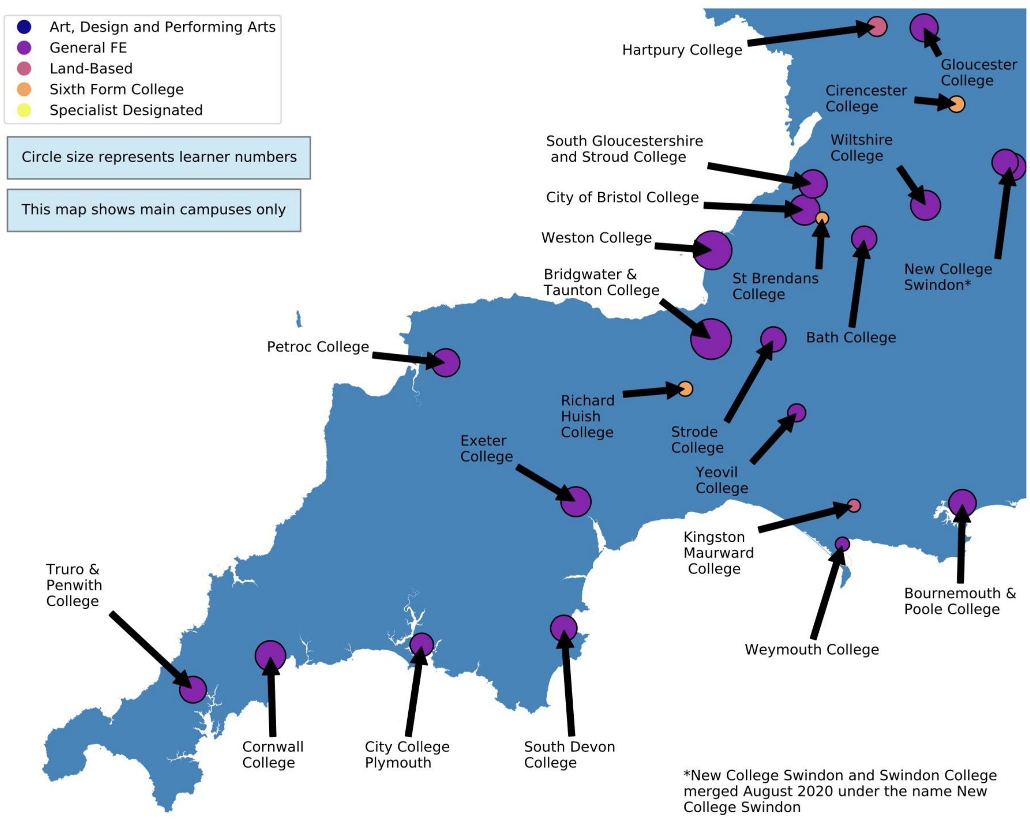

Figure 6.3: Colleges in South West of England 2019/20. Learner Source Data: (Department for Education, 2020a)

The Swindon merger is not unique, and over time there have been a number of college mergers in the South West, and so Figure 6.3 does not give the full picture of campus locations as many colleges have multiple college sites. Cornwall College Group has the largest number of distinct sites with eight different locations. Still, learners typically have greater choices of providers and employers in major cities such as London and Birmingham, with the South West being described as a region where are pockets of 'not spots', where there are no providers of certain courses (Snelson and Deyes, 2016), and a lack of appropriate employers for computer science graduates (Department for Business Innovation and Skills, 2016). This makes the South West an interesting area to consider regarding DS teaching.

When considering the area of the South West, so called 'not spots' are not surprising. The South West is the largest region in the UK, yet has the lowest amount of people per square km at 236 (Statistics, 2020). The next lowest being the East Midlands at 309, and far below the highs of London which has 5701 people per square km (Statistics, 2020).With 31.6% of the population living in rural areas, learners in the South West are more likely to have to travel further to go to college than those in more urban areas.

The South West is also interesting to consider based on teacher statistics. Staff turnover in colleges is highest in the South West at 19.9% (Association of Colleges, 2018b), and it has the highest official vacancy rate in England for teachers (Migration Advisory Committee, 2017). The South West also has the lowest percentage of ethnic minority learners on teacher education courses at 6% (Zaidi, Howat, and Caisl, 2017), and while the situation may have now changed, it still stands that in 2010, 71% of in service ICT teachers in the South West were not categorised as being 'qualified' in the subject they teach (The Royal Society, 2012). Qualified in this instance being described by the Department for Education as having a relevant first degree and/or teacher training qualifications. From a general workforce skills perspective, the Department for Education 2017 employer skills survey report revealed that the South West had the highest proportion of unfilled vacancies within the UK caused due to a lack of skills (30%) and also the highest proportion of employers (17%) reporting that one or more current employees are not fully proficient in their role (Department for Education, 2018a). Digital demand in the South West has higher than UK average demand for those with skills in Computers and Networking, and Machinery Tech (Nania *et al.*, 2019). Further to this demand for software programming, data analysis, digital design, and productivity is just below the UK average (Nania *et al.*, 2019).

These are important contextual factors to consider regarding the courses that colleges in the South West offer, and what skills they are teaching to their students. Due to the aforementioned factors, the South West is considered a suitable and noteworthy region to use in order to narrow the scope of colleges considered for this study.

6.3 Time-Horizon

Another consideration is the time-horizon, or time-frame of the study. Two common types are longitudinal and cross sectional (Saunders, Lewis, and Thornhill, 2019). A longitudinal study is a study where variables or a group of subjects are investigated over a long period of time and they are typically associated with a positivist methodology (Collis and Hussey, 2014). Conversely, cross sectional studies investigate a particular phenomenon at a particular point in time (Saunders, Lewis, and Thornhill, 2019) and that phenomenon could be variables or a group of subjects in different contexts (Collis and Hussey, 2014).

A cross-sectional study is deemed the most appropriate as this research is regarding perceptions of college stakeholders (i.e. the 'group of subjects' being investigated) within specific college contexts at a specific point in time, not how they have changed over time. Besides, in five years for example, the context of colleges (politically, economically etc) may have changed dramatically.

6.4 Data Collection

Case studies do not have specific methods of data collection associated with them (Bassey, 1999) and in many cases use a variety of methods (Cohen, Manion, and Morrison, 2018). Bassey (1999) states there are three major methods of collecting data: asking questions, observing events and reading documents. However, within those three methods, there will still be a variety of data collection methods. As classified by Yin (2009), there are many types of sources of data which can be used in case study research including:

- Archival records.

- Direct observation.
- Documents.
- Interviews (structured, semi-structured etc).
- Participant observation.
- Physical artefacts.

This study utilises two of the major data collection method types as contended by Bassey (1999): asking questions and reading documents. More specifically semi-structured interviews and document analysis. Hence, this study uses multiple qualitative methods. When the case is an organisation such as a college, data sourced from individuals may be how and why an organisation works the way it does, while data sourced from the organisation can include organisation outcomes (Yin, 2009). Both help answer the research questions of this study. Besides, by using multiple sources of evidence this can provide convergent and concurrent validity (Cohen, Manion, and Morrison, 2018).

6.4.1 Semi-Structured Interviews

Many case studies use interviews as a data collection method conducted over a short period of time (Saunders, Lewis, and Thornhill, 2019) and the interview can be targeted, meaning that topics of the case study can be focused on (Yin, 2009). Interviews allow researchers to obtain multiple perspectives (Robson and McCartan, 2016), a key factor within this study, and they can provide causal inferences and explanations on specified topics (Yin, 2009).

Semi-structured interviews were chosen as the most effective interview type. They are particularly useful when trying to investigate a case in depth (Bryman and Bell, 2011), as they allow for the opportunity to further investigate interviewee responses (Saunders, Lewis, and Thornhill, 2019), something not available in structured interviews due to being highly controlled. For example, in a semi-structured interview, questions and topics are given but the order of them, and the exact wording can be changed if required to suit each individual interviewee (Cohen, Manion, and Morrison, 2018). This allows for a more natural conversation and allows the respondent to explore ideas and thoughts more openly (Coolican, 2013), augmenting the depth required in case studies. Using semi-structured interviews with different internal college stakeholders has been successfully used in studies before (Orr and Simmons, 2010; Feather, 2012; Edgington, 2013; O'Leary and Brooks, 2014; Lahiff, 2015; Broad, 2015; Hill and James, 2017) and therefore deemed as an effective data collection method for this study too. However, other factors must be considered when conducting interviews and these will now be explained.

Formulation of an Interview Guide

Interviews require careful preparation (Robson and McCartan, 2016), and so an interview guide was created (see Appendix A) to ensure the right areas were covered within each interview (Bryman and Bell, 2011). An interview guide is useful for semi-structured interviews as in addition to the questions and themes to cover within the interview, prompts for further discussion can also be included (Saunders, Lewis, and Thornhill, 2019). This allowed the researcher to be able to identify in advance, any questions which would allow for a deeper response from interviewees.

Typically, the lack of standardisation in semi-structured interviews can result in concerns regarding the studies dependability and reliability (Saunders, Lewis, and Thornhill, 2019). Although semi-structured interviews are not meant to be repeatable as they result in the complex perceptions of an individual at a given point in time, having an interview guide permitted for a greater similarity in the types of questions being asked. This later allowed for a greater ease of analysis between interviews and question responses.

Interviewee Sample

Qualitative research usually only consists of small samples (Miles, Huberman, and Saldana, 2014) but in case studies, typical sampling logic should not be used, and therefore the typical criteria regarding sample size is not applicable (Yin, 2009). Much like O'Leary and Brooks (2014), whose case selection of colleges was based on having colleges with differing profiles in terms of size, location and curriculum offered, this study aimed to have an interview sample which contained participants from a range of different colleges across the region. Hence, a purposeful sampling strategy enabled the selection of individual participants from each college. Purposeful sampling is non-random and allowed for the selecting of participants most likely to make a significant contribution to the research (Coolican, 2013). Snowball sampling, a technique that can allow for further relevant people to be identified for the research (Coolican, 2013), was also used when initial contact had been made with a college interviewee to further gain other college contacts.

32 employees were interviewed from 13 colleges (10 general FE colleges and 3 sixth form colleges) across a range of stakeholder types including teachers (n=14), head of departments (n=10), and senior leadership teams (n=8). Interviews commenced in September 2020 with the final interview taking place in December 2020. The spread of participants across different colleges is shown below in Table 6.1

ID	County	Type	SLT	HoD	Teacher
01	Bristol and Somerset	FE	1	1	2
02	Gloucestershire	SFC	1		2
03	Devon	FE			1
04	Cornwall	FE	1	1	
05	Wiltshire	FE		2	3
06	Devon	FE	1	1	1
07	Bristol and Somerset	SFC	1	1	1
08	Bristol and Somerset	FE	1	1	1
09	Bristol and Somerset	SFC	1	1	1
10	Cornwall	FE			1
11	Bristol and Somerset	FE	1	1	
12	Wiltshire	FE		1	
13	Bristol and Somerset	FE			1

Table 6.1: Interview Sample Information.

Interview participants were originally contacted via email using contact details found via the contacts institutions website, and in some cases, this involved emailing the generic college email address and asking for the appropriate contact details. In other cases, the researcher already had the necessary contact details available. An email template was created and adapted for each individual contacted (see Appendix B).

Anonymity, Confidentiality, and Informed Consent

Within interviews there are ethical considerations due to the potential for harm, stress, anxiety and other consequences for participants interviewed as part of the research (Robson and McCartan, 2016), and therefore, researchers have “a responsibility to ensure as far as possible that the physical, social and psychological well being of their research participants is not detrimentally affected by the research” (University of Gloucestershire Research Committee, 2018, p. 9). Furthermore, honesty, trust, privacy, research integrity and confidentiality are other important ethical factors that should be considered (Miles, Huberman, and Saldana, 2014).

One way of considering these aforementioned factors is informed consent. Informed consent involves ensuring that research participants have sufficient information about the research and what it entails (Saunders, Lewis, and Thornhill, 2019), and this research followed the guidelines set out in ‘Research Ethics: A Handbook of Principles and Procedures’, and specifically where it states that research should honour “the requirement of informed consent and continuous dialogue with research subjects” (University of Gloucestershire Research Committee, 2018, p. 7). As recommended by Saunders, Lewis, and Thornhill (2019), and as used by other FE researchers (for example Armstrong (2019)) this information was provided to participants through a participant information sheet (see Appendix C). It is also recommended that informed consent should be supplemented by a written agreement such as a consent form (Saunders, Lewis, and Thornhill, 2019), and so this was also created (see Appendix D) and provided to interview participants prior to the interview.

Recording the Interview

Three main ways of saving data obtained from interviews include note taking, audio recording and video recording (Coolican, 2013). Audio recording provides a valid description of what was heard and avoids inaccuracy and missing data (Robson and McCartan, 2016). This is important for the detailed analysis required in qualitative research (Bryman and Bell, 2011). Besides, video recording is unnecessary and intrusive unless the study requires analysis of non-verbal communication (Coolican, 2013), which this thesis did not, while note taking can slow down the interview, and remind interviewees they are being recorded (Coolican, 2013).

Audio recording was deemed the most suitable way to record the interview process as it allows the interviewer to converse naturally (Coolican, 2013). However, ethically, it is important to ask participants for permission to audio record the interview (Robson and McCartan, 2016) and so this was asked within each interview, in addition to being stated on both the participation information sheet and consent form.

Interviews were originally going to be conducted face-to-face in the Spring/Summer of 2020. However, due to COVID-19 the decision was taken to delay the interview process until lockdown was over. As months progressed, it became evident that the lockdown was simply just the first lockdown and face-to-face interviews would be difficult to arrange. Hence, in August 2020, the decision was taken to conduct online interviews using software such as Microsoft Teams. As a result this necessitated a change in recording device. The majority of interviews were conducted via Microsoft Teams, as this became a tool familiar to the researcher and many college contacts. When Microsoft Teams was used, the in-built recording functionality was used to record the interview if interviewees agreed to this when the meeting began but before the interview commenced. Interviewees were given the option to have their video on or off. These recordings were saved to Microsoft Stream and only available to the researcher. They were also downloaded and saved upon a password protected external hard-drive. In some instances, interviewees wanted to use different software than Microsoft Teams, such as Google Classroom, and Zoom. In these cases, the researcher audio recorded the interviews using the in-built software of Quick-time Player to record the interviews. Again, this was only conducted with approval of the interviewees, and the recordings were saved on the same password-protected external hard-drive.

6.4.2 Document Analysis

Educational research should consider the wider context of where it is applied (Biggs, 1993), and an in depth understanding of context is required to do justice to case studies (Cohen, Manion, and Morrison, 2018). While archival research was dismissed as a research strategy, elements of it can be combined with the strategy of case study by using documentary research to supplement the case (Saunders, Lewis, and Thornhill, 2019). Organisational documents allow for the triangulation of the data that is provided in interviews (Saunders, Lewis, and Thornhill, 2019), or help inform the interview process, and by combining data from different sources this can lead to a more robust analysis (Cohen, Manion, and Morrison, 2018) of the college environment. Furthermore, secondary data is often an easily accessible resource to researchers, the documents can be reviewed repeatedly, and they can cover a long period of time, history and events (Yin, 2009). Therefore, document analysis was also chosen as a data collection method for this study and was used to supplement interview data and provide further college context. By considering different document sources prior to interviews, this allowed for more targeted or relevant questions to be asked during the interview process, but also to use for context when interpreting interview data. In the context of education, secondary data can include official statistics, ongoing databases (e.g. the National Pupil Database), educational institution records or administrative records (e.g. from the Department for Education) (Cohen, Manion, and Morrison, 2018), and with each document sources used, issues of integrity and authenticity must be considered along with any potential reporting biases that may stem from the author or institution of the document in question (Yin, 2009).

For this thesis the documents used included information as detailed on the educational institution website such as courses offered, and annual reports. As these websites are owned by the colleges themselves, there is a great potential for bias, or presenting themselves as what they want to be seen as. This bias was acknowledged when using data from college websites, but this information was often useful to inform the interview process. For instance, in clarifying what courses colleges offered since qualifications can and were presented with different names but were ultimately the same qualification.

A prime example of this was the BTEC Computing course being portrayed as a BTEC in cyber security, or a BTEC in digital from two different college websites.

Another source of information from documents was Ofsted reports. These were not explored in as great as detail as interview data but provided some good overviews. However, some Ofsted reports were more outdated than others, so were not necessarily relevant for when the interviews took place. Ofsted reports were sourced initially from Department for Education (2021b).

A final source of information was from the Education and Skills Funding Agency which provides a database titled 'College accounts academic year 2019 to 2020 data' (Education and Skills Funding Agency, 2021). This database contained data regarding college finances, number of learners, number of staff, income per learner (and type) and other useful statistics to inform both the interview process and how to interpret interview data. While whole studies could use this data-set to form or test hypothesis, in this thesis the data was used to simply provide greater context and insight into each college. Nevertheless, future studies could utilise this data-set to a greater effect in providing insights into college education research. Both the data from the ESFA and Ofsted reports provided general information about colleges and were not specific to DS. Hence, document analysis was a data collection technique to augment data collected from interviewees.

6.5 Data Evaluation and Analysis

6.5.1 Analysing and Coding Interview Data

A critical realist ontology underpins a variety of different methods of qualitative data analysis, including grounded theory, discourse analysis, thematic analysis and interpretative phenomenological analysis (IPA) (Braun and Clarke, 2013). Methods such as grounded theory focus on building theory from data, (Braun and Clarke, 2013), but it can be time consuming and intensive (Saunders, Lewis, and Thornhill, 2019), and there are many varieties of grounded theory so it can be difficult to clarify exactly what it entails (Braun and Clarke, 2013). Other methods such as discourse analysis focus on the use and patterns of language used (Braun and Clarke, 2013), but does not help meet the research aims. Some methods such as IPA were considered due to its focus on how people make sense of their own lived experiences, but IPA is more of a methodology than just an analysis method, and lacks the theoretical flexibility that thematic analysis can provide (Braun and Clarke, 2013).

Thematic analysis was the chosen analysis method and it is a method for identifying patterns of meaning and themes across a set of data in relation to a research question(s) (Braun and Clarke, 2013). Unlike template analysis which involves creating a hierarchical template of data codes or categories as the data is being analysed, which can result in too much focus on applying the template of codes to the data (Saunders, Lewis, and Thornhill, 2019), in thematic analysis, all items are coded before identifying and constructing themes begins (Saunders, Lewis, and Thornhill, 2019). Thematic analysis focuses on patterns across a dataset, as opposed to specific details within individual accounts, and it lacks the ability to make claims regarding use of language (Braun and Clarke, 2013). These are known weaknesses of thematic analysis, but these limitations do not effect this study due to what the research questions aim to answer. Hence, thematic analysis was deemed appropriate for this study, particularly due to its inherent flexibility.

According to Braun and Clarke (2013), thematic analysis has six main stages, or seven if you include the writing up of results and finalising analysis:

- Transcription
- Reading and familiarisation of data
- Complete coding across the data set
- Searching for themes
- Reviewing themes - creating a thematic map
- Defining and naming themes

These steps were followed and will now be explained in more detail.

Stage 1: Transcription

Transcription is a key stage after interviews were conducted to ensure that data was not lost and to reduce the complexity of data (Cohen, Manion, and Morrison, 2018). While transcribing interview data allows for the ease of analysis, transcriptions do not capture everything. Still, thematic analysis focuses on what was said, rather than how it was said (Braun and Clarke, 2013) and so a full transcription of non-semantic sounds, pauses or hesitations was not required. To ensure consistency throughout each transcript, the researcher created a transcription notation system (Table 6.2) which also helped to prevent confusion during later analysis regarding what aspects within the transcripts meant (Braun and Clarke, 2013). The researcher also made some field notes during interviews to allow for any important factors to be noted that may have been 'lost' in the audio recordings. In each transcription, participant information such as college and stakeholder type were recorded, as this information was essential for future reference during the analysis (Miles, Huberman, and Saldana, 2014). A sample interview transcript can be found in Appendix E.

Feature	Notation and Explanation of Use
Identity of speaker.	The speakers name to be followed by a timestamp (e.g. Jordan 15:06), on a new line when the speaker changes.
Laughing/Coughing.	Not needed for this study so are omitted.
Lengthy pausing.	Not needed for this study so are omitted.
Spoken abbreviations.	Use of abbreviation the speaker uses (e.g. TV).
Inaudible speech.	Use of double brackets (e.g. ((inaudible))).
Non-verbal utterances.	Not needed for this study so are omitted.
Spoken numbers.	To be spelt out explicitly, (e.g. thirteen).
Cut off speech.	Not needed for this study so are omitted.
Emphasis on certain words.	Use of underlining (e.g. this is <u>fantastic</u>).
Reported speech.	Use of inverted commas around the speech. To be used when providing an account of what someone else said (e.g. she said 'This is the best way to teach programming').
Reference to media.	Presented in Italics (e.g. *Question Time*).

Feature	Notation and Explanation of Use
Identifying information.	Identifying information to be changed such as locations, names, ages etc.

Table 6.2: Transcription Notation System. Source: Adapted from (Braun and Clarke, 2013).

Interview recordings were initially transcribed using the software of Otter.ai, a speech to text transcription application to reduce the amount of initial time spent that transcription usually requires. Although this software was fast and accurate, the researcher listened to each interview through twice. This was so manual transcription additions and amendments could be made to the generated transcription where there were errors, and to ensure each transcription was consistent by following the transcription notation system (Table 6.2). As Otter.ai was third party software, in order to be ethical, it was important that the interviewees consent was gathered before uploading the audio recording to Otter.ai. Hence, reference to this software was included in both the consent form (Appendix D) and the participant information sheet (Appendix C), in addition to being discussed during the interview process to ensure whether interviewees were happy or not for transcription to initially be processed in this fashion. Once transcripts were processed by Otter.ai, they were downloaded into a password protected external hard-drive, and subsequently deleted from the Otter.ai software.

Although transcripts are in fact two-steps removed from the actual interview which took place (Braun and Clarke, 2013), asking the right questions during the interview process, using a transcription notation system, and making notes during interviews reduced the likelihood of important data being lost. The transcription process provided an important first step to the analysis and allowed the researcher to become more familiar with the data-set. In practice, transcriptions of interview data was completed alongside the conducting of further interviews.

Stage 2: Reading and Familiarisation

While not as formally structured as transcription and coding, reading and familiarisation of the data set was an important step before coding began. This stage is about becoming more immersed with the data set and to notice things that may be relevant to the research questions (Braun and Clarke, 2013). This stage simply involved reading through all of the interview transcripts and making informal notes about initial ideas or anything noteworthy and of interest. This stage was only completed for each transcript once all transcripts had been created.

Stage 3: Complete Coding

The third stage was the beginning of coding interview transcripts. To do this effectively, Computer Assisted Qualitative Data Analysis Software (CAQDAS) was used to aid in the analysis process. CAQDAS, such as NVivo or ATLAS.ti packages, are widely used to facilitate the analysis and management of qualitative research which can include managing files, writing analytical memos, and exploring and searching the data (Collis and Hussey, 2014; Saunders, Lewis, and Thornhill, 2019). CAQDAS can make the coding process more efficient (Bryman and Bell, 2011) but it is important to note that CAQDAS is not catered for specific methodological or analytical approaches as it is the researcher who is in control and facilitates the analysis and interpretation of findings (Bryman and Bell, 2011). In this sense, CAQDAS is just a tool to help manage and organise files (e.g. interview transcripts), while it is the researcher's role to make sense of these findings. The software does not analyse the material (Cohen, Manion, and Morrison, 2018), so researchers must consider the time and costs involved in learning and using CAQDAS (Saunders, Lewis, and Thornhill, 2019). Due to its advantages, the researcher decided to use the CAQDAS of NVivo 12 Pro. This software was used as the researcher has used it before meaning that the limitation of learning new software was absent, and because the researcher had free access via the home institution's license.

All transcript files were uploaded to NVivo and were assigned as individual cases. Thereafter, a case classification was created, called case-profiles, which allowed for further details to be assigned to each interview transcript. This is akin to metadata, but is researcher led. The details assigned to each file included; gender, FE experience, job role, college name/ID, college type, and whether they are a provider of the digital T-Level. Adding this metadata through the classification process allowed for later analysis of how assigned codes may be distributed between data items. For instance, in helping answer research question 4 of how stakeholders perceptions differ.

The next stage was the actual coding, and to be in line with a thematic analysis approach, coding was complete across the data-set. A complete-coding process was employed, which involved identifying anything and everything that may be relevant or of interest, without being too selective (Braun and Clarke, 2013). This was referred to as 'Phase 1: Open Coding', and was given the description of 'Initial first stage coding of all data. Complete coding, coding everything that may be relevant. But no categories of codes yet'. This resulted in 134 different codes (also called nodes in NVivo), with some elements coded being just a few words, with others being whole paragraphs. For instance, one code that was created was 'Teach to our specialty'. This was given the description of 'Comments how teachers aim to teach their specialist area, and how curriculum may be decided based on staff expertise' and after this first stage of coding it had 16 references from 13 interview transcripts. An example quote for this code is below:

> *"We have our guided learning hours that we fit into our contracts, we kind of have to pick, pick a module that fits into our skill set. But we are we are still given the choice of module to play into our own skills. For example, the background, mine is like network security and cyber security." (Interviewee 6: Lecturer, General FE College)*

Once phase 1 had been completed for all interview transcripts, next was 'Phase 2: Creating Initial Categories'. As per its description, this involved 'Creating categories based on all of the initial nodes creating from open coding, and checking whether those codes fit appropriately or not through checking each coded item'. Some codes ended up being grouped together, and some split if appropriate. This resulted in 170 different codes in total but it should be noted that 23 codes had no direct elements (i.e. coded data) attached too them, as they were simply categories containing other codes. A good example of this is the category code 'Difficulties of recruiting qualified staff' which had the description of 'This node collates the issues of staff recruitment for computing/digital teachers'. This category code had two codes within it which were 'Lack of experienced staff out there', which focused on general comments about how there are not many suitable qualified teachers available to recruit, and 'Earn more in industry', which focused on comments about how computing professionals can earn substantially higher salaries outside the teaching profession. Not every code was assigned to a category in this phase as in some cases, each code itself could have been considered its own category at the time, or simply an isolated code.

Stage 4: Searching for Themes

During Phase 2, some ideas about themes were generated and these were noted down separately, and so once it became difficult to categorise further, the next phase began. This phase was referred to as 'Phase 3: Check Categories and Create Initial Themes' with the description of 'This phase refers to developing further categories (and initial themes) and whether nodes fit correctly within the previously created categories. Once again checking all coded data items'. Like the other phases, Phase 3 involved checking over coded items again, refining ideas, and finding appropriate naming conventions for codes and categories, before developing themes. Here, it is important to distinguish that while a code represents an idea, a theme represented a central organising concept (Braun and Clarke, 2013). This was particularly challenging for some ideas that were similar but appeared overlapping. For example these codes:

- Work-life balance
- Too much work
- Stress
- Playing it safe
- High expectations (of self)
- Finding a balance

- Cynical

All the coded data items within these codes were outputs. In other words, other factors such as the college environment led to these different feelings or situations. After reviewing all of the coded data items within each of them, it became apparent there were two similar but distinct themes, which were 'Difficulty of Work-Life Balance' and 'Mental Well-being'.

Phase 3 resulted in 170 different codes, but they all fitted within 15 overarching themes. There were still some isolated codes and some researcher ambiguity about some of the created themes, which could be described as an internal struggle to identify whether what was coded was effectively representative and appropriate. This was not a concern as themes identified at this stage were candidate themes, not the end product (Braun and Clarke, 2013). It was at this stage where the decision was made to leave the coding process for a period of around 3-4 weeks, before returning with a fresh perspective.

Stage 5: Reviewing Themes and Creating a Thematic Map

The break from coding proved very beneficial, and coding resumed with what was called 'Phase 4: Refining Themes' which involved the following: 'This phase builds on phase 3 by refining themes and categories so they are more specific and precise, and are truly themes, not features'. Unlike a theme, a feature does not necessarily have a centrally organising concept but instead clusters together codes that are similar (Braun and Clarke, 2013). This distinction was crucial as even at this stage, some created themes were in fact features. That was not to say they were not themes, just that the naming and description was not appropriate. For instance, one theme created in Phase 3 was 'BTECs'. This does not have a clear concept and simply grouped together codes with reference to BTEC courses. After reviewing codes within this theme, there were two main divisions of codes; those that discussed BTEC as a choice of qualification, and the differing perceptions about BTECs as a qualification. The former codes were distributed elsewhere, and the latter were kept as part of the newly named theme 'Perception of BTECs'. Conversely one code that was created was 'Programming', and at this phase, it didn't fit within any other themes, nor was it a theme itself, as it just simply clustered comments about programming, much like a feature.

The coded items within this were evaluated and many of them were more appropriate within other created codes while some were not relevant and so discarded. These choices represent just an example of what happened during the coding process, not an exhaustive list.

In thematic analysis, themes can be at three hierarchical levels, overarching themes which typically do not contain codes or data, but instead a number of themes. Then you have themes, and within those, sub-themes (Braun and Clarke, 2013). Themes were continually refined and checked until there was a final set of distinctive coherent themes, as opposed to trying to find a perfect fit. This resulted in 6 overarching themes which together contained 19 themes. To represent these themes, a thematic map was created (Figure 6.4) as thematic maps provide a visual aid that is useful for exploring the relationships between themes, while also being a vital tool for analysis (Braun and Clarke, 2013).

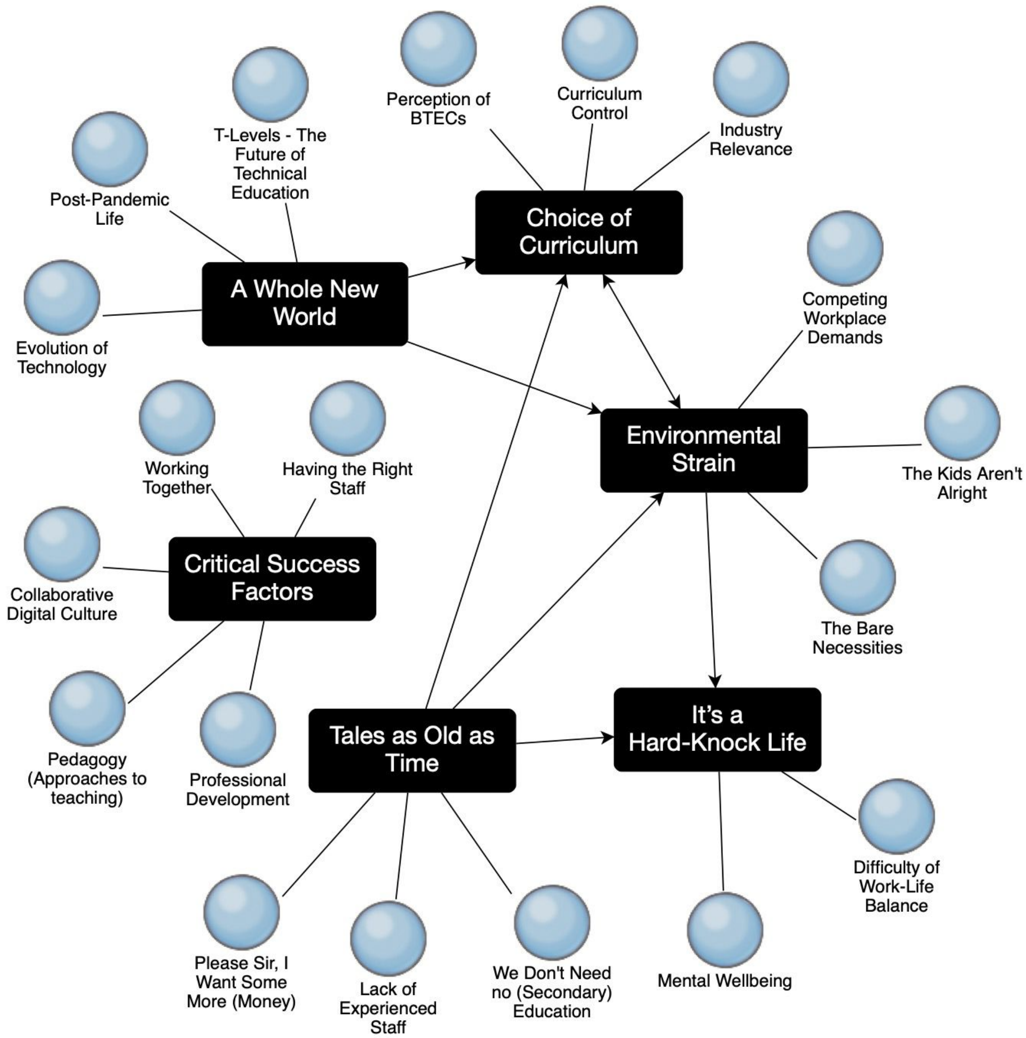

Figure 6.4: Thematic Map (Overarching Themes and Themes)

Stage 6: Defining and Naming Themes

Writing theme definitions was conducted using NVivo, with a description given to each code and eventual theme as they were created. Each theme should have a clear focus, scope and purpose, and writing is the final process of how analysis develops into its final form. As stated by Braun and Clarke (2013), defining themes and writing a report happens at the same time in practice, where from the coded and collated data for each theme, extracts (interview quotes) should be selected, and then a narrative should be written for each one telling readers the 'story' of each theme. These stories will be presented in the chapter 'Overview and Analysis of Themes', and serves as the penultimate stage of analysis before comparing the findings to existing literature in the subsequent chapters. Regardless of the written narratives, readers should also note how the naming of the themes indicates both the content and the researchers analytical 'take' on the data provided (Braun and Clarke, 2013). This gives an initial insight into the theme and the data, but also reiterates the significance of the researchers role in the research process.

6.5.2 Within-Case and Cross-Case Analysis

As well as theme creation, further analysis was undertaken of these themes, interview data, and college data to provide a more thorough understanding of colleges in the South West. While colleges in this geographic region is the overall case in question, individual colleges can be considered as individual cases themselves, and so for some areas a cross-case analysis approach was taken to see how colleges differed between each other. Equally each stakeholder type could be considered as different 'cases', so an analysis was undertaken to see how stakeholders differed by the themes created. Not only does this type of analysis help further answer the research questions, but we can better understand social phenomena when contrasting cases (Bryman and Bell, 2011), and together any cross-case analysis provides a more detailed presentation of what combines to form the overall case of colleges in the South West.

The main method used to produce a cross-case analysis was to use two types of NVivo queries, matrix queries and cross-tab queries. By conducting queries based on the themes created, in addition to college metadata (e.g., college type), a tabular form could be created to see how either colleges or stakeholders compare according to differently assigned attributes. While different queries were used or tested within NVivo, three cross-case analyses were created:

- A cross-case analysis of colleges which considers curricula offered, who makes curriculum decisions, and what factors influence curriculum decisions. This directly relates to research question 1 and is presented in Figure 9.1 found later in this thesis.

- A cross-case analysis of colleges which considers the themes identified relating to challenges faced in the teaching of DS, in addition to some college contextual information such as college type, number of learners, Ofsted rating etc. This directly relates to research question 2 and is presented in Figure 10.1 found later in this thesis.

- A cross-case analysis of stakeholders considers all of the created themes (and sub-themes), and which stakeholders referred to each of the created themes by both number of cases and number of coded references. This directly relates to research question 4 of differing perspectives between stakeholders and is presented in Appendix F.

These analyses helped create a clearer picture of colleges in the South West regarding level 3 DS teaching, and so in some respects the cross-case analyses together form an overall within-case analysis.

6.6 Chapter Summary

This chapter has discussed the research design and processes of the thesis. Hence, this chapter has discussed the methodological choice, research strategy, time horizon and the research techniques and procedures which consists of both data collection and data evaluation and analysis. Figure 6.5 summarises the chosen methods for all of these with some brief justification as to why they were chosen.

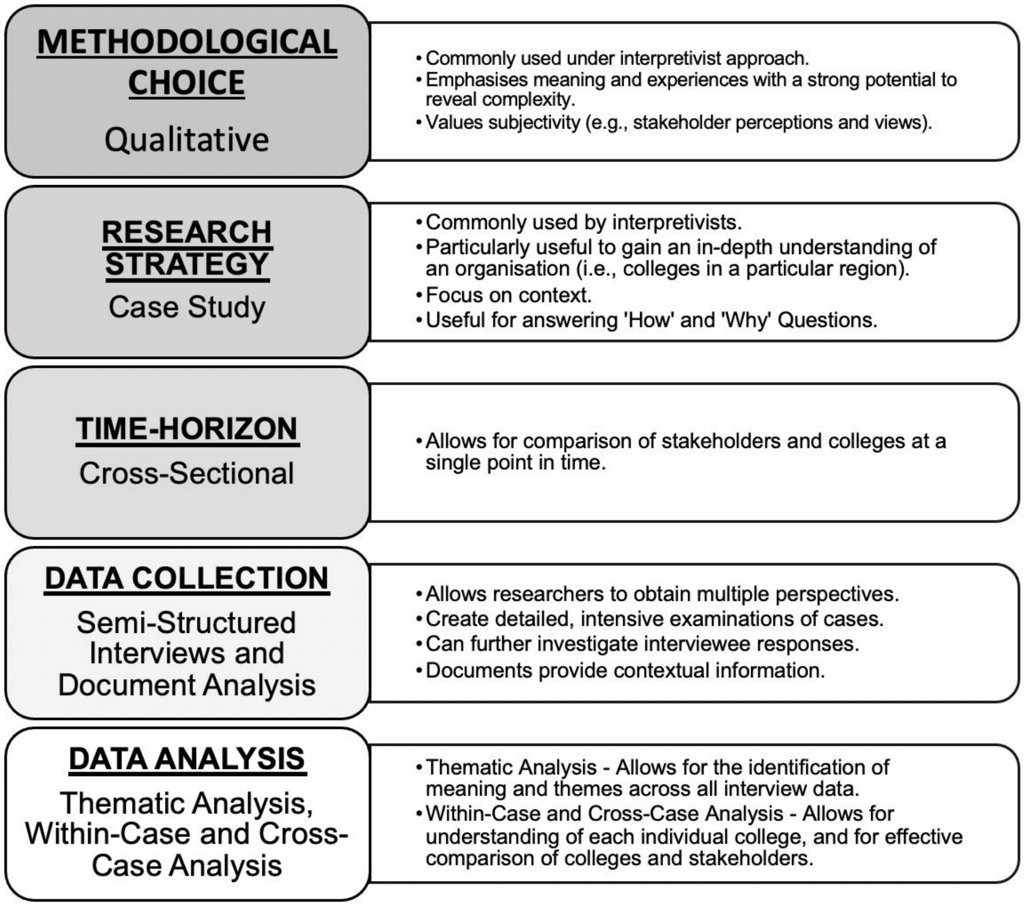

Figure 6.5: Research Design Choices Summary.

Chapter 7

Research Considerations

This chapter focuses on research considerations including validity and reliability, limitations of the methodology, ethical considerations and reflexivity of the researcher.

7.1 Validity and Reliability

Case studies can maximise their quality through four main conditions: construct validity, internal validity, external validity and reliability (Yin, 2009). Equally, Lincoln and Guba (1985) contend how in qualitative research there are four key considerations for validity consisting of credibility, transferability, dependability, and confirmability. Some of these factors overlap but all will be discussed regarding what they are and the steps taken to ensure that they were met during the research process.

7.1.1 Construct Validity and Confirmability

Construct validity refers to the researcher using the correct measures for what they intend to measure (Saunders, Lewis, and Thornhill, 2019), with confirmability referring to the degree that the findings, interpretations and recommendations are supported by the data (Lincoln and Guba, 1985). In other words, by the participants, and not influenced by researcher bias. One method used to achieve this was to ensure participants were prepared (Bassey, 1999). To do this, interviewees were provided with a list of interview themes prior to the interviews taking place, as this allowed participants to prepare more effectively for the interviews meaning they were more likely to recall relevant information (Saunders, Lewis, and Thornhill, 2019). This resulted in the data being collected being more in line with the questions that were asked by the researcher.

Another method used was using multiple sources of evidence (Yin, 2009), whereby the author considered college documentation such as Ofsted reports, college websites and published statistics prior to the interviews. This allowed interview questions to be more informed, through allowing the ability to greater explore any answers with more suitable follow-up (probe) questions. This also involved considering multiple stakeholders perspectives from multiple colleges so a more comprehensive view of DS teaching within colleges could be established. The final measure used was to establish a chain of evidence (Yin, 2009), where different stages of the data collection and analysis process were kept and documented so findings and interpretations can be traced to the original source data. These different stages include audio recordings, interview transcripts, phases 1-5 of the coding process, followed by the presentation of interview findings (themes) with associated quotes.

7.1.2 Internal Validity / Credibility

Internal validity is the consideration of the extent that findings support any claims made about cause and effect, or in other words any causal relationships created. For case studies such as this one, internal validity is not something that needs to be considered in great detail (Yin, 2009), as this study does not intend to provide explicit cause and effect relationships. In qualitative research such as this, the similar construct of credibility is more appropriate, which refers to how believable or trustworthy the findings are. To have credibility, the researcher must represent the experience of those who were interviewed so that the reader can understand. A variety of tactics were used to help improve the credibility of the research. A variety of quotes from interviewees are presented in addition to their interpretation, so readers can draw their own conclusions, while a sample interview transcript is provided in Appendix E. Furthermore, multiple stakeholders were considered from multiple colleges for the interviews, and this triangulation of evidence is another approach to enhance credibility of what was found (Lincoln and Guba, 1985). Additionally, there was a prolonged engagement with the data sources (Lincoln and Guba, 1985), with a detailed description provided of how data was collected and analysed, and this should give confidence to readers in the credibility of interpretations.

7.1.3 External Validity / Transferability

External validity or transferability is concerned with how much the cause and effect relationships can be generalised to other contexts (Yin, 2009). For case studies, this concept can be problematic (Bassey, 1999), as typically case studies consist of small sample sizes and hence, there are concerns of how case studies can be generalised to other situations (Gray, 2017), which in this research would be other colleges. In comparison to quantitative research, concerns about external validity are not as prevalent in qualitative research (Bryman and Bell, 2011), with some authors viewing it as irrelevant (Cohen, Manion, and Morrison, 2018), as qualitative research seeks to merely represent a phenomenon. Besides, Bassey (1999) contends that case studies can lead to what is referred to as 'fuzzy generalisations' which is where qualitative estimates can be made. For example, 'it is very likely that…'. This can be viewed as what is considered an analytical generalisation, as opposed to the typical statistical generalisation based on sample sizes and applying results elsewhere (Yin, 2009). Here, generalisability considers how the results and findings lead to a broader theory, but it still remains that this theory must be tested elsewhere to see if it holds true in different circumstances (Yin, 2009).

7.1.4 Reliability / Dependability

Reliability and dependability refer to the accuracy and precision of what was found and whether other researchers would come to the same conclusions (Collis and Hussey, 2014). The goal is to minimise error and bias (Yin, 2009), so that there is trust in the research and integrity in the presented outcomes. By recording the interviews, this meant that at any stage of the analysis, the interviewees words could be listened too so the researcher was not solely dependent on the transcription, even though this was checked over multiple times for accuracy. Yin (2009) also recommends the use of a case study protocol and case study database to ensure reliability, and versions of these were followed. Through providing artefacts such as the case study theory, an interview guide, and participant information sheet, this allowed for consistency between interviews, and as guidelines for others to follow. Furthermore, NVivo was used as a database with folders for transcripts by colleges with assigned metadata, and with all five phases of the coding process outlined with every code and process at each stage having a description of what it means. This allowed the researcher to identify how the analysis evolved, and where codes were situated within a wider passage of text. By doing so, this helped to ensure accuracy in the codes.

7.2 Methodology Limitations

Due to the nature of an interpretivist approach, the researcher must enter the world of research participants to try and understand their perspective (Saunders, Lewis, and Thornhill, 2019). This can lead to bias as the researcher interacts with those involved in the research process and through the analysis and interpretation of the acquired data (Collis and Hussey, 2014). This emphasises the importance of reflexivity but also raises concerns of the reliability of research data. This is why a comprehensive overview of the research process has been documented since this is what can give transparency and clarity. Due to the nature of the research, it would not be possible to have the same outcome if the study was repeated with the same participants. The interviews and perspectives provided are a product of their time and the context that surrounded the individuals in those specific circumstances. Equally, if the study was repeated with other participants, this would involve different perspectives and world-views.

One of the challenges in qualitative research, especially one that uses methods such as interviews, is that the method can result in an extensive amount of rich data to analyse that presents findings only truly understood in their context (Collis and Hussey, 2014). Processing and analysing this data to finally create the final iteration of themes which reflect the accuracy and meaning behind the data is both time consuming, and heavily influenced by researcher interpretation. There is also the tension between something that may be interesting and a noteworthy theme in its own right, and the frequency of how often something may be mentioned or discussed. To alleviate this concern, a five phase coding process was used which originated in initially coding everything that could be deemed worthwhile so that nothing could be missed, while also not excluding something simply because it was not a 'common' occurrence. This is particularly important as one isolated factor could be extremely important.

It could be argued that a weakness of the study was that the sample did not have an equal representation of each stakeholder type, or an equal distribution of personal characteristics (e.g gender, years of experience etc). Conducting interviews with more stakeholders per individual college may have provided the opportunity to undertake a more thorough analysis of perspectives between colleges, as opposed to a general perspective from 13 colleges within the South West. Both methods have strengths and weaknesses, but a few stakeholders from multiple colleges yielded the ability to observe the wide variation of DS teaching and perspectives that existed between colleges overall.

Another potential limitation was how COVID-19 led to the decision to conduct interviews online as opposed to face-to-face. This had benefits such as being quick, easy, and convenient for both the interviewees and researcher (Cohen, Manion, and Morrison, 2018), but it may have been beneficial to see the interviewees place of work to gain extra contextual information through observation such as their classroom sizes or resources available. This could have allowed for the opportunity to potentially meet interviewees colleagues, which could have resulted in a more organic snowball sampling approach leading to greater recruitment of participants per individual college.

7.3 Ethical Considerations

Within case study research, ethical guidelines should be created (Bassey, 1999), and this section sets out and discusses the ethical issues surrounding this study. That said, some ethical concerns have already been highlighted such as anonymity, confidentiality and informed consent in section 6.4.1 and the storing and recording of interview data as discussed in section 6.5.1.

The research proposal for this study was reviewed and approved by two supervisors, the school postgraduate research lead, and another reviewer, while the research abided by two main ethical frameworks. The University of Gloucestershire's 'Research Ethics: A Handbook of Principles and Procedures' (2018), and secondly the ethical guidelines for educational research (BERA, 2011) from the British Educational Research Association. This ethical framework has been used to inform educational research guidelines for other studies investigating the further education sector (see (Feather, 2012; Hill and James, 2017; Armstrong, 2019)), and was deemed appropriate to consider to ensure sound ethical practice.

As this research involved conducting research with people, there were ethical considerations due to the potential for stress, anxiety, harm and any other consequences for the interviewed participants (Robson and McCartan, 2016). Hence, the researcher created both a participation information sheet (see Appendix C) and a consent form (see Appendix D) for the completion by every interviewee. These documents were created so that interviewees were fully aware of the nature and purpose of what the research was about and what the interviews involved. Interviewees were required to read through both documents and confirm this (through the returning of the consent forms) before participation in the interview commenced. These two documents indicated how key ethical considerations such as anonymity, confidentiality and informed consent were addressed. Assurances concerning these factors were also repeated verbally at the start and and end of each interview. Throughout the interview process, interviewees had the right to not answer certain questions if they wished, or to stop the interview entirely. Each interviewee was reminded of this at the beginning of each interview. Anonymity was achieved through the use of changing identifying information and including a minimal amount of information in the findings and discussion which could be ascribed to any particular individual or institution. Permission to record and transcribe interviews was dealt with on an individual basis, with the processes used for each interviewee only being what each interviewee was comfortable with and formally agreed. Any recordings and transcripts were securely stored on a password protected external hard-drive.

Another consideration was the power-relationship between each participant and the researcher. Within an interview, this relationship is typically described as being hierarchical, with the researcher in control of the interview (Braun and Clarke, 2013), through determining the agenda, timing, duration and content of what should be covered in the interview (Cohen, Manion, and Morrison, 2018). Some authors argue how power relationships occur during the interview, based on how participants perceive the researcher (Braun and Clarke, 2013). These can be based on factors such as status, position, knowledge and role (Cohen, Manion, and Morrison, 2018), and this can influence how an interviewee answers questions and their willingness to disclose information. Some information may be perceived as common knowledge between both parties so they do not discuss it, or something they are 'scared' to share in fear that it may be disclosed to other stakeholders within their organisation. This is another reason why confidentiality was important and emphasised to interviewees.

To avoid power relations becoming problematic during the interviews, three main techniques were used: enabling participants to have power over decision making in the research, to establish rapport and trust, and trying to match the characteristics between the researcher and participant (Cohen, Manion, and Morrison, 2018). By not following a rigid question structure, but instead responding to interview answers with questions that logically flowed made the interviews more conversational. While it has been argued that participants may feel more comfortable disclosing sensitive information to someone who is broadly similar to them with the same characteristics (Braun and Clarke, 2013), this is easier said than done when acting as a sole researcher. Some interviewees perceived the researcher as an 'expert', with one interviewee in particular wanting to also use the interview as a form of professional development, so it was important to state from the offset how it is their knowledge and perspectives that are important, so positioning them in a greater position of power. On the other hand, some interviewees who were typically much older than the researcher or in a senior leadership position initially tried to talk about many things outside the scope of the interview, presumably to give greater educational context due to the researcher's position as a student and being less experienced. For instance with comments such as "you probably won't remember this, because it's way before your time". Hence, in these cases it was important to take an approach where the researcher guided the questions more thoroughly to prevent these interviewees going ‘off-track’.

7.4 Reflexivity

Within qualitative research, bias is a key issue as the researcher is part of the world they are researching (Cohen, Manion, and Morrison, 2018). Therefore, reflexivity is integral to qualitative research (Braun and Clarke, 2013). Reflexivity involves the researcher reflecting on their role and how the research aims, methodology, analysis and findings would have been influenced by the researchers position and assumptions (Coolican, 2013). It is based on the view that our assumptions will shape the knowledge that we produce (Braun and Clarke, 2013), and so researchers should deliberately acknowledge and disclose themselves in the research (Cohen, Manion, and Morrison, 2018).

There are various different motivations for choosing a research topic and that research can take months and years (Cohen, Manion, and Morrison, 2018), a significant personal commitment. The researcher’s assumptions about a chosen topic are likely to influence how they study that topic and this will influence their research questions and the trustworthiness of the research project. Providing reflections for different stages of the research process should help readers understand the ‘point of view’ the researcher is coming from. Regarding the topic selection for this study, the author has several reasons for its choosing. The author was involved in working in the ‘Educating the Educators’ work package for the Institute of Coding (IoC), which focused on addressing the UK DS gap. The author was provided with an initial overview of DS gaps within education, with colleges being highlighted as a particular area of research interest for the IoC. The broad range of qualifications which existed was something that was highlighted as a potential concern. Hence, these areas were naturally an area of interest for the researcher. Prior to this role, the author was an Outreach Officer for Business and Computing at the University of Gloucestershire where the role included delivering workshops, presentations and events at numerous schools and colleges across the country for both business and computing. The author recognised the many variations in qualifications that were taught, the numerous challenges faced, and the methods employed to overcome them, and this would have influenced the initial aims and research questions used for this study. Moreover, the outreach role also meant that the researcher had some known contacts in the school and college sector, and ease of access through gatekeepers, or familiarity with colleges would have likely influenced the decision-making process on what approach to take in the research.

Anecdotal knowledge influenced and guided the initial review of literature which further highlighted that there was an absence of literature focusing on the depth into colleges specifically, and the reasons they taught what they did, the specific challenges faced, and what they did to try and overcome this. A better understanding of multiple stakeholder perceptions was thought as being a unique insight that can provide policy makers and practitioners relevant ideas that can be used to achieve more successful outcomes regarding DS teaching within colleges, while also providing a foundation for conducting further research. The author has also previously undertaken educational research that consisted of semi-structured interviews with multiple stakeholder groups. Due to the experience in this approach, and the recognised benefits that were seen for establishing depth into an educational environment, this would have influenced the authors decision to adopt that approach in this research.

Due to the author's role as an educator of computing in a higher education institution, and their previous background and experience, reflexivity needed to be addressed in various ways in the methodology so readers can acknowledge where there may have been a likelihood for bias. First, the philosophical positions of the research were explained regarding how that related to the research questions of this study. Second, a variety of research strategies were explained with reasons given as to why some were dismissed as a research strategy before providing a full justification of why a case study strategy was used, and how it would be used, including the data collection and analysis methods used to implement that strategy effectively. Due to its subjectivity, analysis of the qualitative research relied on what the author deemed significant (Bryman and Bell, 2011), and therefore, the analysis would have been influenced by any prior assumptions. Consequently, a full audit trail of how this research process was completed was documented. Finally, research considerations such as validity, reliability, and limitations of the methodology were explained. Therefore, regarding the methodology, reflexivity is about explaining how and why the research was conducted the way it was so the author can be held accountable for the analysis and findings generated.

7.5 Chapter Summary

This chapter concludes Part II of 'Research Methodology and Processes', through the discussion of research considerations which included issues of validity and reliability, limitations of the methodology, ethical considerations and reflexivity of the researcher. Now that the research methodology and processes have been explained and discussed, the next part of this thesis will present the findings, analysis, and discussion, which together help answer the research questions of the thesis.

Part III

Findings, Analysis and Discussion

Part II presented the research methodology, design and processes that underpinned the study and how the aims, objectives and research questions of this study were to be met. Now that this has been provided, Part III presents the findings, analysis and discussion that resulted from implementing what was discussed in Part II. First, this part will provide an overview and analysis of the themes created which culminates in how themes differed between stakeholders which directly answers research question 4. The next three chapters focus on answering the first three research questions of the study respectively, by discussing the created themes in relation to each other and existing literature.

The chapters in Part III are as follows:

8) Overview and Analysis of Themes

9) Choice of Curriculum

10) Perceived Challenges and College Context

11) Best Practices Used.

Chapter 8

Overview and Analysis of Themes

This chapter outlines the six overarching themes that were created during the analysis of interview data which consists of the following:

- Theme 1: Tales as Old as Time
- Theme 2: A Whole New World
- Theme 3: Choice of Curriculum
- Theme 4: Environmental Strain
- Theme 5: It's a Hard-Knock Life
- Theme 6: Critical Success Factors

These six overarching themes contain 19 themes, and all will be discussed in this chapter with interview quotes to support the analysis and give a perspective where readers can make their own interpretations. Following the presentation of these themes, there will be an overview of how stakeholder perspectives differed between the presented findings.

8.1 Theme 1: Tales as Old as Time

'Tales as old as time' is an overarching theme that explains how colleges are subject to ongoing external factors which influence their ability to provide an effective teaching and learning environment. The naming convention of 'Tales as old as time' is a hyperbolic expression which represents how these external factors have been omnipresent, known to many, and have been around for a significant length of time. Much like a storybook, this overarching theme contains three ongoing stories (themes), that are well known to the masses yet are continually recurring, and all of which, are largely negative. The theme 'Please sir, I want some more (money)', centres on how colleges are underfunded, and symbolically represents the power relations that exist between those who are funding providers, and those who require funding, akin to the relationship of a parent and child. The theme 'Lack of experienced staff' captures another ongoing concern within the FE sector on two fronts, first that there are problems regarding staff recruitment, and second, that existing staff do not have the appropriate experience to effectively teach DS related courses. Frequent references to failures in pre-16 education are discussed in the theme 'We don't need no (secondary) education'. This theme explores how perceptions of ineffective secondary education influences the teaching and learning that takes place in a FE environment.

8.1.1 Please Sir, I Want Some More (Money)

'Please sir, I want some more (money)' captures a tentative feature of colleges in that they are an inferior type of institution that must simply take what they are given regarding funding, and are always left yearning for more. Much like a parent giving their child pocket money, the child may want more but ultimately it is the parent who is in charge. This metaphor is not one of author creation, but that of interviewees. For example:

> *"We [colleges] are the forgotten middle child, middle child of education, funding wise, and so on, and so forth. I think in many ways, we're the most important step, you know, it is my job to get kids from school. And make them not kids from school, make them ready to be University learners. And we do that with a lack*

of funding and a lack of visibility". (Interviewee 14: Head of Department, General FE College)

Here, colleges are constructed as being subject to not receiving a sufficient amount of funding for the role they play in the education landscape, where the youngest child is seen as schools, and the eldest child being universities. The actual term used of 'forgotten middle child' is synonymous with being described as invisible, forgotten and having to fight harder for attention than the other siblings, and applying this to funding within the education sector has some truth. The Department for Education (2021d) has acknowledged how there is a historic under-investment in the further education estate, while the Augar Review stated how the capital budget for FE is too small relative to its needs (Augar *et al.*, 2019). This specific issue was explicitly explained by one senior leader:

"There's a process by which they [departments] can identify things that they, they want. They don't always get it, our capital spend is much lower than our capital requirement, both in equipment, learning space". (Interviewee 12: Principal, General FE College)

Having to distribute limited amounts of funding across college departments can put pressure on those staff in charge of the distribution, while potentially causing the chance for internal conflict between departments of who they think should get more funding. However, many comments from teachers regarding a lack of funding implied that they understand that the lack of funding is a sector issue, not just internally for their college. One teacher (Interviewee 10) stated "But at the end of the day, we don't have a lot of money. Nobody does". That being said, this does not stop individuals wanting more money for their department. One lecturer demonstrates how they know the issues senior management must face regarding funding, but everyone still wants it for themselves, and ultimately in their own way asking, please sir, I want some more:

"The budget is in a lump, and it might come into the department. And then they've got to carve it up amongst all of these different competing people that have got their hands in the air shouting, I need this or I need that, or we just need to do this". (Interviewee

4: Lecturer, General FE College)

For a department that does not get much funding, this can have massive implications for the teaching and learning experience. For DS courses, this may be more problematic than for other courses due to high resource requirements in terms of infrastructure and equipment (The Royal Society, 2017), particularly as technology is continually updating and changing. As a result of the general structural under funding that exists in the further education sector (Association of Colleges, 2019b), some interviewees have commented on techniques they have resorted to in order to mitigate funding deficiencies. One such example linked to another overarching theme 'Choice of curriculum', through one lecturer explaining how they choose qualifications that warrant the most amount of available funding per student:

> *"FE colleges, they're more run like businesses than they are educational establishments, the whole point of it is that we need to make money, we need to have some sort of money come in, and you get so much more money per student on the T-Level, than you do on a BTEC." (Interviewee 26: Lecturer, General FE College)*

While appearing as a necessity, being run more like a business as opposed to an educational establishment may have a negative impact on teaching and learning. But with the emphasis on 'need' as opposed to just wanting more money, this implies that if colleges were not run like a business, then perhaps they would not survive and cease to operate altogether. This would be more impactful to the local community and the learners they serve. As a result, one principal of a sixth-form college (Interviewee 28) discussed the need of having to develop 'financial resilience' through either income generation methods or cost savings. Both lead to the construction of having to survive as an educational establishment, as opposed to thriving and offering the best teaching and learning experience possible for students, not just for digital skills courses, but all courses. While having a lack of funding is an ongoing concern and can be seen as a tale as old as time, the contemporary concern is that it is impacting both curriculum choice, and the general teaching and learning environment now.

8.1.2 Lack of Experienced Staff

As a theme, 'Lack of experienced staff' outlines the shortage of staff with the relevant experience for the teaching of DS courses in two very similar but distinct areas: the difficulties in the recruitment of new staff, and the lack of experience in current staff.

Recruitment of new teaching staff in colleges has been an ongoing concern and cited in many reports (Association of Colleges, 2018b; Consulting, 2020; Department for Education, 2021d), but for DS teachers, this can be more of an issue. Leading on from the issues of funding as described in 'Please sir, I want some more (money)', many interviewees cited how the salaries of those teaching computing related courses in the FE sector is paltry in comparison to what can be earned in industry. For instance, one lecturer stated:

> *"But my salary would be doubled if I went in industry to what I'm teaching effectively. So I'd say look at look at the salary and carefully decide if you want to teach or you just want an easy life." (Interviewee 6: Lecturer, General FE College)*

Not only does this quote show the perceived dichotomy between earnings in industry and that of lecturers, which is synonymous with existing literature (for instance see (Migration Advisory Committee, 2017)), it leads to some noteworthy insights. If one can earn so much more in industry, why are they still in the teaching profession, especially as that quote signifies the binary differences between being a teacher and wanting an easy life. This suggests that teaching is not an easy life, with lesser earning potential than working in industry. This creates what could be considered as a barrier to entry and off-putting to prospective teachers. Therefore, it is not surprising to hear some of the comments stated by senior leaders. Interviewee 22 (Senior Leader, General FE College) stated how "[recruitment] is always a challenge and... is even more focused when it comes to digital subjects" while Interviewee 2 (Senior Leader, General FE College) explained that to attract people into teaching they are "having to uplift salaries for teachers in engineering and computer science", which corresponds with literature explaining how there is a premium on appropriately skilled staff (Department for Digital Culture Media and Sport, 2019). However, in some cases, this may be unfeasible for some colleges, since staff costs as a percentage of income has been cited as already exceeding area review benchmarks (Association of Colleges, 2018a).

Unsurprisingly, the problems of recruitment appear to be having a wider college impact, especially in terms of what curriculum can be offered. For example, one head of department talked about this very issue influencing them:

> *"We can't explain to you how difficult it is to get teachers for computing work. Often, you know, I think, our longest job advert of 18 months for a computing teacher, and we did, still didn't recruit. So as a consequence, you know, we had to shrink the curriculum offer that we offered here." (Interviewee 31: Head of Department, General FE College)*

Not only does this impact on the opportunities for learners attending that college, but this is not a single college issue, with some colleges relying on current staff who do not have the necessary experience to take on such a role. A head of department of a sixth-form college explained how they had no background in computing but were persuaded to take on the job as no was else was willing, and if they did not take on the job, the qualification itself may have been removed from the curriculum:

> *"They had zero applicants, that that, that subject would have collapsed, would, would have gone... I mean, initially, the big challenge was learning the subject in the first place because I was new to it... So I spent the first year teaching computer science I was actually learning it myself and teaching it." (Interviewee 24: Head of Department, Sixth-Form College)*

Teaching course content while simultaneously learning it is certainly not ideal for an effective teaching and learning environment, but this lack of experience of current staff was shared in the comments by other interviewees too. Interviewee 4 (Lecturer, General FE College) talked of his colleagues as having "no kind of subject specific knowledge" as a result of only ever being a teacher without industry experience, while Interviewee 19 (Lecturer, Sixth-Form college) discussed how some of the staff they have recruited "couldn't hack it on an intellectual level, or they couldn't handle the students, or they were just not appropriate people to be teachers". This lack of experience of current staff, in addition to the recruitment of new staff is a major problem which is not just affecting colleges, but other educational institutions too. Interviewee 10 (Lecturer, General FE College) explained that this issue is influencing the ability of schools to offer computer science as a qualification, stating how this has resulted in the South West having "one of the lowest levels of GCSE computer science rates". This can cause problems later down the educational journey of students since these same students who are missing out on DS teaching at school, are the same ones who will be studying it in a college environment. However, this particular issue will be further explained in the final theme within this overarching theme, 'We don't need no (secondary) education'.

8.1.3 We Don't Need no (Secondary) Education

This theme reflects on the problems that exist in secondary schools prior to FE, and the challenges this poses for college teaching. The double-negative implies that secondary education is in fact needed where it is currently lacking. One such example was through the frequent identification that for some colleges in their local area, secondary schools do not offer a computing or related qualification at GCSE level at all, resulting in having to get students 'up-to-speed' while simultaneously teaching level 3 course content. One head of department talked about how this was certainly a local contextual issue for them:

> *"There's such a big gap from them not doing GCSE, but they're, you know, then they've got the entry requirements to do a level three qualification. So what we find is that we're we're sort of chasing our tail a bit by delivering GCSE content at a level three qualification... I'd say that's the national picture. But locally, it's pretty bad here". (Interviewee 31: Head of Department, General FE College)*

This quote alone leads to two questions, the first being why are schools not offering computing qualifications at GCSE? This could be explained by the lack of experienced staff available to teach the qualification as discussed in the previous theme. But the second question relates to entry requirements: as in this case, there appears no prerequisite for students to have studied computing at GCSE and the question of why could again be asked. Having prerequisites would limit those being able to study a DS course at level 3, which, in itself, would not help address the DS gap, and secondly there are already problems in recruiting students to study a computing related qualification at college, even if students have studied one at GCSE. One lecturer explained that the reason for this may be due to how DS courses are taught in schools and that the curriculum content is not very engaging:

> *"Recruitment is always a challenge... all of our local schools offer level one and level two BTECs which are not engaging. They're just Excel and Word and PowerPoint and building a simple website in 20 year old software, that doesn't engage a student and make them think I really want to do this at college." (Interviewee 10: Lecturer, General FE College)*

This indicates problems with the course content at GCSE before level 3, but this is just one concern. As noted by Passey (2017), while curricula indicates what should be taught to students, they do not indicate how to address student issues. Therefore, when there are staff that do not fully understand the subject themselves in schools, this can result in the subject being taught in a very structured and uninspiring way, which can impact on student achievement and attitude. One head of department talked about the interesting concept of 'over scaffolding' that can exist within schools:

> *"it's the, the habit of secondary schools, I've previously worked in a secondary school for, for a few years. Of what I would describe as over-scaffolding learners so, the capacity for independent thought is the question, what should I do next? What should I do next?" (Interviewee 21: Head of Department, General FE College)*

Here, the concept of 'over-scaffolding' refers to how schools give too much structure to students, with students acquiring the expectation of being told how to do things. Students bring this attitude to their learning in college, with college teachers having to try and change the attitude to learning of their students, in addition to teaching the course content. This issue is not surprising when considering how many subjects taught at GCSE level are exam based, with good exam results becoming the goal within schools as opposed to using exams as an indicator of learning (O'Leary and Brooks, 2014). Until the issues discussed in this theme regarding schools are rectified, there will continue to be the ongoing story of how the secondary school teaching of DS is negatively impacting how DS is taught within colleges.

8.2 Theme 2: A Whole New World

This overarching theme encapsulates participants awareness and reflections on change, and what has ultimately resulted in a whole new world to be living in. The theme 'Evolution of technology' captures two facets of how innovation and technological developments have impacted teaching practices. First, how technological advances has created a culture of cat and mouse between industry practice and taught curriculum, with the latter lagging behind. Second, how new technology provides opportunities, but causes existing teaching practices to become outdated quickly. Meanwhile, the theme 'Post-pandemic life' implies a before and after, and refers to how the teaching and learning environment has altered as a result of COVID-19. Within this theme, COVID-19 was situated as being a domineering presence which demanded a change in teaching practices, which is viewed as both a challenge, but also a benefit, as described in the sub-theme 'Accelerated online capabilities'. The final theme, 'T-levels - the future of technical education' centres around the perceptions about how the new T-Levels are viewed as progressive and innovative as a qualification, and how they represent the future teaching landscape, albeit with some potential pitfalls.

8.2.1 Evolution of Technology

'Evolution of technology' highlights how technology is constantly changing and impacting everyday life, while also playing a significant role in setting the direction of the educational landscape. Much like the meaning of evolution in nature, where the characteristics of organisms that remain or change are the ones that are successful for the survival of their species, if the education sector does not adapt to the evolution and changes in technology, they may not survive, or at best, be left behind. Therefore, while evolution can be seen as largely positive, it can result in two challenges for teaching and learning: curriculum lag, and outdated practices. Both are sub-themes identified through the coding and analysis process, and will now be explored.

Curriculum Lag

'Curriculum Lag' refers to the construct of how curricula cannot keep up to date with the latest technology, and so they are always lagging behind. This has a profound impact on DS related courses in particular due to being so intrinsically linked to technological developments. Interviewee comments concerning this issue was not surprising as it has been frequently discussed in literature and governmental reports (for instance see: House of Lords (2015) and ECORYS UK (2016)).

A primary reason for 'curriculum lag' is due to the processes that must be taken to deliver a new course. When topics for a new course are identified, there are stages of planning that must be taken such as course validation. After planning and approval for a new course is complete, academic years have standard start dates which is typically September of each year. Hence, new course delivery would have to wait until then. One senior leader discussed this process and explained how long planning processes can be of a larger detriment for DS courses:

> *"You could plan something for nine months, it goes through your approval process. If this were the case, you could then market it. That's another say another, that's to be a year cycle. And then you're delivering it, you could be delivering the things that in digital, nobody wants anymore. Yeah, when it, you know, is C++ the thing that people want? Or is it something else?" (Interviewee 12: Senior Leader, General FE College)*

This indicates that for new qualifications to be relevant, those designing new courses may have to try and predict what will be relevant in a few years. Furthermore, it suggests how often courses must be updated as otherwise they will fall behind. For lecturers in particular, there was a sense of despondence when discussing the evolution of technology. For example, Interviewee 29 (Lecturer, General FE College) stated that "The technology changes at such a rapid rate where there's no way to keep up", which demonstrates what is perceived as the almost impossibility of keeping up with technological changes. This teacher went to explain how what they are teaching is out of date, and ideally there would be a new course specification every couple of years. However, frequent updates in course specifications can impact on the other challenge that is a result of the evolution of technology, which is outdated practices.

Outdated Practices

Changes in curriculum suggest a need for a change in delivery practices (Aničić, Divjak, and Arbanas, 2017), and interviewee comments implied that this impacts the need for new resources and the need to up-skill one's self. Regarding resources, one senior leader discussed how there is an expectation from industry in that education providers should be using the latest technologies. However, identifying what these are, and putting in place appropriate funding to support these new resources can be a challenging task.

> *"From an industry point of view, there's the expectation, that's what people now want to be using. If you're going to work in that field. That's what you need to be comfortable to engage with. We have to try and work incredibly hard to future proof the decisions that we make when it comes to spend, and making sure that we have a framework in place that can support that change". (Interviewee 22: Senior Leader, General FE College)*

As previously mentioned, budgets are often limited and spread across a college, not just a single department. However, DS courses require more frequent resource updates and so unless computing departments are allocated what could be considered as a more biased allocation of funding, they may not have the resources to effectively deliver curricula aligned to changes in technology. As well as physical resources, there are also course materials and plans that require updating, which can result in lecturers having to create things themselves:

> *"When syllabuses change, and they change, and there's a lot of new technical stuff, that's the, that's the difficult, that's the*

big big one, that's the one because you've probably got nothing that you could use, and you've got to totally reinvent the wheel. And I'm sure you know, lecturers up and down the country are reinventing the wheel. Because there's no, there's nowhere to go". (Interviewee 19: Lecturer, General FE College)

This particular quote also highlights the isolation that some teachers feel, either from being in a very small department, or being disconnected from those in other computing departments at other institutions. Furthermore, having to create new content may require teachers having to learn new things, with technological changes demanding the need to up-skill. Some interviewees acknowledged that this is just part of the job:

"I think it's just the nature of computing, you cant say that's it, no one sort of goes, 'oh I've learned that'. Because, you don't, do you." (Interviewee 9: Head of Department, General FE College)

Similarly, another head of department explained how they are planning for the future by getting a colleague to learn different software due to the identification that what they currently teach and use will shortly be out of date:

"I know that 3ds max by Autodesk has probably only got about another four or five years left in it. I think once that happens, I've already got another team member training themselves up on the Unity drag and drop game development system." (Interviewee 14: Head of Department, General FE College)

A potential problem that may occur in situations like this is whether it is possible to always recognise that something will become out of date, what is a suitable replacement, and having someone willing to learn something new.

8.2.2 Post-Pandemic Life

This theme explores the reality of the world that everyone now lives in as a result of the COVID-19 pandemic and how it has influenced the teaching and learning environment. Within 'Post-pandemic life' are two sub themes: the first relates to how COVID-19 necessitated a shift to online learning and as a result, accelerated online capabilities. The second theme emphasises how COVID-19 has influenced an overall change in teaching practices.

Accelerated Online Capabilities

The majority of interviewees in some way or another discussed the COVID-19 pandemic and how it caused a paradigm shift to teaching and learning online. Online learning itself is not a new concept, but to suddenly shift from a traditional classroom to an online classroom affected each college. Each college reacted differently to the same situation, with some more prepared than others, some viewing it as largely negative, and some as an opportunity for developing online learning capabilities. COVID-19 accelerated progress in this area, as exemplified by one senior leader:

> *"There was some inherent problems around online learning which, you know, included, perhaps safeguarding issues, perhaps in included the technical issues, perhaps, around how do you deliver high quality teaching and learning through that way. And I just think we might not be perfect at it. But, but lots of solutions to those problems have got better. And because they've had to, it's not like it's not been moved from being a nice to have, to actually, it's essential that we do this. So that's really accelerated those changes." (Interviewee 28: Senior Leader, Sixth-Form College)*

Not only does this show that there are problems that were always there with online learning, having to teach online caused an adaption of learning how to address these problems effectively. This adaption varied from college to college with what seemed to be based on college culture, and an individuals mindset. Interviewee 10 (Lecturer, General FE College) stated how "No school or college was prepared for online learning", while Interviewee 17 (Head of Department, General FE College), stated "with obviously the lockdown we were then shoved online and we just took to it like a duck to water". These are vastly differing views and stem from a college's overall preparedness. Interviewee 17 (Head of Department, General FE College) discussed how they were already embedding Microsoft Teams and testing online learning capabilities before COVID-19, and so it is not surprising their view is more positive. Similarly, Interviewee 22 (Senior Leader, General FE College) explained how their whole college viewed the shift as bringing positives, stating that the "change of mindset for people has been a catalyst for us. So there have been people that have been innovating, people that have been trying to, to push things". Trying new things, innovating and experimenting can cause a more productive teaching and learning environment than simply viewing the negatives of having to shift teaching online. As more experience is gained and other benefits can be realised, this in turn increases the adoption rate of different online teaching techniques and the overall acceleration of online capabilities, as this practice is shared. For instance, one head of department discussed how teaching programming online allowed an educator to gauge how learners have progressed over time:

> *"So they put materials online as they progress, and the best case with that is looking at for example, development of coding skill, over a period of time. You can see the code in September, and it gives you the coding as they progress through the quality of the code improves, then actually the link between sort of coding, commercial coding starts to come through, we start seeing that it gets refined for a better word." (Interviewee 9: Head of Department, General FE College)*

This highlights just one aspect of online delivery, as more so than in the traditional classroom, other functionalities can potentially be realised. Meanwhile, there is also the greater possibility and emphasis on asynchronous learning. This brings to attention a similar but distinct sub-theme, of how COVID-19 changed teaching practices in what is now our post-pandemic life.

Changes in Teaching Practices

A major change in teaching practices highlighted by interviewees were the different ways colleges dealt with the increase in online learning and to account for social distancing. There appeared to be five different ways:

- A blended approach, where there is a combination of in class delivery and online learning.
- A hybrid delivery method which involved having some students in the classroom, with others getting involved virtually simultaneously.

- A blended-hybrid method as described by Interviewee 12: "we've gone for a blended hybrid delivery. So the learners who are self isolating, have some learning that they can do, but also the design of the curriculum delivery, and minimises the numbers that we have to self isolate".

- Only teaching online.

- Putting students on a rota where different students could attend college physically at set times.

These changes in delivery method can create logistical challenges for a college overall, in addition to specific challenges for those teaching. One specific challenge was regarding helping students with practical work when teaching online:

> *"It sounds that it ought to be self evident in that IT would be really nice, easy thing to teach remotely. But actually, if somebody's writing an accessor, Microsoft access application, and it doesn't work, then the leaning over your shoulder and saying, ie, 'you've got a comma there and not a dot' is a lot easier leaning over their shoulder than it is trying to do it on a chat box or on the forums." (Interviewee 21: Head of Department, General FE College)*

This 'leaning over the shoulder' was something highlighted by other interviewees too, most often in reference to teaching programming. In a face-to-face environment it is very simple and easy for an educator to look at a student's screen and identify an issue whereas, online, it can disrupt the session more, and requires students to share their screen or explain over some chat functionality. As put by other interviewees, in a classroom there are extra facilities such as whiteboards, tables, walls, and the ability to move around, but this is somewhat constricted online. This leads to another issue which is the ability of students to be much more passive, and not visible. In an online environment, students can much more easily disengage, by turning off their cameras and microphones, and this can be problematic for those teaching them. One head of department explained how this is a problem with regards to gauging student understanding, but this was a concern shared by other interviewees:

> *"You know by being in a classroom, you teach them something, you see that look on their face. That 'Oh, yeah', that kind of the pennies dropped that, that bit of knowledge they never knew before actually now all makes sense. Online we don't get that. That's the hardest thing. That's the biggest challenge that we've got to face". (Interviewee 17: Head of Department, General FE College)*

Another significant change in teaching practices as a results of the pandemic was regarding assessments, particularly when specialist software was required. Typically this would not be a concern but with many students learning online or not being able to attend college, they would not be able to gain access to what they require. One lecturer explained how they suffered from this issue but managed to overcome it by setting up remote access servers:

> *"So there are lab based modules with assessment in the lab that we had absolutely no way to do back in March [2020]. So what we've had to do is we've had to be quite quite creative and how to overcome that. Our lab technician has set up a bunch of remote access servers at the college and students can now log in with their college credentials remotely, and they can set up the server configuration." (Interviewee 29: Lecturer, General FE College)*

While this was done in response to COVID, this is just one example of how colleges have started building up the infrastructure and resources required for online teaching and learning. Therefore, creating the possibilities for different course designs, the increased possibility of having 'distance learners', and the ability to cater for if individuals can no longer attend college physically. As such, it is unlikely that teaching and learning will go back 100% to how it was before the pandemic, and hence post-pandemic, it is now a whole new world and environment to teach in. While some other challenges of COVID identified by interviewees are likely to diminish over time, such as the initial reduction in external speakers, others may still remain so long as there is a combination of traditional and online teaching. There is the problem of finding the right balance, and identifying best practice, particularly as different students will want different delivery methods. There is also what is perceived as an increased workload, which in many cases seems to be an accurate perception. One senior leader talked about how they wanted their staff to have two plans, one for face-to-face learning and one for online, but they acknowledge how this causes more work for teaching staff:

> *"We say to educators, you need to have a digital curriculum alongside your in person curriculum... So some of them create learning that can be done asynchronously, and they create a separate route and then they've got their in person bit and people switch switch tracks as they wish. That creates a capacity problem because you're essentially asking them to do two jobs." (Interviewee 12: Senior Leader, General FE College)*

Longer term, this is not sustainable and not an attractive proposition for current and prospective teachers, where staff recruitment is already an ongoing concern. Hence, there is likely to be the increased need for effective course planning and design moving forward. It is important to recognise that COVID-19 was an extraordinary situation that no one would have planned for, and so much of what was initially done in response to the pandemic was reactionary as opposed to proactive. Moving forward in this post-pandemic life, colleges can and should be more proactive in teaching in what is now considered the 'new normal'.

8.2.3 T-Levels - The Future of Technical Education

This theme explores the T-Level, one of the latest developments in qualification reforms. With recent government publicity surrounding T-Levels and their potential impact on existing qualifications, it was likely many interviewees would make some comment about them. While generally viewed as positive, and earmarked as the potential future of technical education, many interviewees discussed the benefits and challenges that T-Levels are currently, or will provide. This is reflected in the following five sub-themes.

Availability of Work Placements

The main aspect of T-Levels which all interviewees (who were digital T-Level providers) talked about, were work placements. They all perceived the work placement as beneficial, yet highlighted concerns about how it was working in practice and how there is a limited availability of work placements for digital. A cited reason for this was due to the nature of digital companies and how many are freelance, are remote working or that they have different jobs at different times. Furthermore, digital employers may be unwilling to allow 16-18 learners admin rights, particularly where there is sensitive data or when dealing with areas such as cyber security. This is synonymous with existing literature that reports how members of the 'digital' industry offered few entry-level roles, and were reluctant to host under 18s due to health and safety concerns, and not wanting young people accessing sensitive data (Williams, Newton, Takala, Gloster, and Alexander, 2020). As a result, for some interviewees it appears as if securing student work placements is seen as an almost impossible task. For example, one course leader for the digital T-Level questioned:

> *"Where are we going to get the employers from, just because they simply don't exist. And if they do exist, they haven't got time or the money to offer a free student for 45 days, it's a substantial amount of time. So they have, just haven't got that to put in place." (Interviewee 26: Lecturer, General FE College)*

This quote highlights other issues that if an employer was willing to host under-18s, there could be other barriers preventing them to take part in a T-Level program. It is clear that employee engagement for digital is a problem, and so offering T-Level placements is something that has to work and fit in with them. This may not always be possible given how three parties (student, employer, and college provider) must be in agreement. For instance, Interviewee 3 (Senior Leader, Sixth-Form College) explained how the biggest problem for work placements is not securing the placements themselves, but actually getting students to work due to limited transport links or willingness of students to travel. This concern about rurality and travel is not new; it has already been highlighted how industry placements may be limited in a provider's location should they be from either a rural or coastal location. This can impact on the number of employers available, or meaning students would have to travel where there are limited transport links (Association of Colleges, 2018c; Department for Education, 2018b; Straw and Sims, 2019). The same interviewee also explained how securing work placements is likely to only get more difficult over time due to increased competitiveness:

> *"Most of the other colleges are not starting T-Levels until next year. So at the moment, we you know, we're going out to IT companies and making all these connections. And they're like, you know, 'yeah, fine love to work with it really interested'. I think when they have six colleges coming to the firm saying, 'Can you give my student a placement', then that will become a lot more competitive." (Interviewee 3: Senior Leader, Sixth-Form College)*

Securing placements on a national scale will become more difficult as more providers start trying to source placements for their learners and competing in the same space (Department for Education, 2018b; Straw and Sims, 2019; Williams *et al.*, 2020). This causes problems for the wider roll-out of T-Levels and can cause some students to be placed in placements that are not entirely suitable. This resulted in one provider having to send their first cohort of T-Level students on placements that are not as aligned to the curriculum focus of software design and development as they would have liked. While the work placement aspect of the T-Level was overall viewed as positive by interviewees, there appears to be problems with its implementation, even with low student numbers. In fact, one head of department at a college who does not offer the digital T-Level explained that due to problems with student work placements in their local area, offering the T-Level would simply not be possible:

> *"We find it incredibly difficult to get IT/computing companies to pay students on work placements, it really is a tough challenge, I think, you know, to put it into perspective, that of 257 learners that studied computing last year, we only had five students go on work placements, and that was just a week." (Interviewee 31: Head of Department, General FE College)*

With such difficulties that occur surrounding work placements, it is difficult to envisage how it will be possible to provide enough work placements should T-Level enrolments rise to a similar level to that of A-Levels or BTECs.

Appropriateness of Curriculum and Assessment

Interviewees demonstrated mixed views on the appropriateness of the digital T-Level curriculum and assessment. Many interviewees liked the idea of the workplace component and how this makes students more employable and the taught content more relevant, albeit with some implementation concerns. Importantly though, some interviewees were very clear that both parties (student and employer) should benefit and the student should provide value for a business while on placement. Interviewees also stated how it is good how the specification is up to date, and how T-Levels should help overcome some of the concerns of grade inflation that has previously plagued vocational qualifications such as BTECs:

> *"The T-Levels are really scenario based and have competency as well as knowledge. There's a lot of real-world scenarios which are involved in the teaching. But it just makes it much more real, both for the staff and the student. It's much more relevant". (Interviewee 3: Senior Leader, Sixth-Form College)*

However, there were two main concerns with the assessment that were discussed. The first is that the exam-based components are inappropriate and not relevant to a workplace environment. One lecturer angrily expressed their views on this:

> *"For one of their exams, they have to do a Python program, basically from scratch without the internet assistance. And it's just like, in the real world, it doesn't work like that. So why, why are you making them sit the exam in that way." (Interviewee 26: Lecturer, General FE College)*

Exams are rarely required in the world of work and so could be considered as inappropriate, with project briefs, presentations and reports being described as a more suitable method of assessment (Association of Colleges, 2018c). Furthermore, many students choose a technical route as they have not enjoyed an exam-based education system pre-16, and by having exams as part of the digital T-Level, this may put some students off applying for the qualification (Straw and Sims, 2019). The other concern is regarding the Maths and English requirements where students need to achieve a minimum level of attainment in Maths and English in order to achieve the T-Level qualification (Foster, 2019a). Interviewees had reservations about how this would lead to some students not applying to the T-Level due to struggling in these areas, or that if students failed their Maths or English as part of the T-Level, they would fail the whole qualification. As a result, in some cases, this meant that delivering only the T-level was impractical, since from a college point of view and an overall pass rate, it would be classified as a fail.

Too Cutting Edge

One of the main benefits of the digital T-Level is the specification being up to date and relevant to industry needs. However, this appears to be causing some issues for colleges regarding staff expertise and resource availability due to having higher demands than other qualifications. Interviewee 10 (Lecturer, General FE College) went as far as saying that some parts of the specification are so advanced that "companies aren't even employing some of those technologies yet, because they're so cutting edge". This, in turn, has an impact on teaching such an advanced curriculum. For instance, Pearson, the exam board responsible for the digital T-Level, explains how lecturers delivering the qualification will need a variety of knowledge and skills including the knowledge of Python 3 and ideally two other programming languages (Pearson Education Limited, 2020b). Hence, given what was outlined in the theme 'Lack of experienced staff', it is not surprising there are concerns about having a stable workforce with the up to date knowledge and skills to deliver T-Levels effectively (Department for Education, 2018b; Straw and Sims, 2019; Williams *et al.*, 2020). Furthermore, in terms of resources, this has been cited as causing logistical issues for current T-Level providers due to the resources that are required. One head of department discussed this in terms of resources for assessment:

> *"They have to set up a small network, but that has to be retained. So they can go back to it because the assessment is over a period of time so it's a time controlled assessment. You know, if you got a class of 20, that's a little bit more challenging, having set hardware resource all put aside so there's some logistics challenges there". (Interviewee 9: Head of Department, General FE College)*

This resource issue naturally has some financial implications, but for those colleges offering the T-Level in 2020-2021, there was funding support available, which was cited by those interviewees that were offering the digital T-Level.

Government Support

Funding support came from government and it is evident that this substantially helped some colleges in getting ready for offering T-Levels, whether that be for equipment or training. The initial T-Level providers received extensive government funding to offer T-Levels, such as £30,000 per T-Level pathway delivered, and £8 million across all providers to help with the professional development required to teach T-Level specifications (Department for Education, 2019c). From many interviewees perspective, this staff training in particular, known as industry insights, was seen as a major benefit because the costs of covering staff were covered, while staff could gain industry expertise:

> *"They [staff] can take a one, two, three, or five day placement back out in industry. And it's funded back to the college. So the funding comes back to the college to actually back-fill in terms of any staff cover that's required, support with travel, so just, just a pot of money there that's able to actually facilitate that updating happening at a time when it suits that member of staff." (Interviewee 22: Senior Leader, General FE College)*

The vast sums of money that some providers received was, in some cases, still perceived as not enough due to the nature of qualification being so 'cutting edge'. Interviewee 10 (Lecturer, General FE College) stated, "there's never going to be enough for teaching that kind of qualification". However, the Department for Education has previously stated how T-Level payments will be phased out over time (Department for Education, 2019c). Regardless of whether funding will continue, technology will keep evolving and this will necessitate further changes in resources and staff expertise to ensure that the teaching can remain relevant to industry needs - one of the main purposes of the T-Level. But if funding is not there to support these ongoing changes, T-Levels may fail to be adopted more widely, while T-Level awareness was another cited concern.

Needs Time to Become Established

A main concern mentioned by interviewees was how T-Levels will need time to become established. T-Levels are only a small part of post-16 education with an estimated 2000 learners across all T-Levels in the academic year 2020-2021. Therefore, it is not surprising that it has been suggested that steps need to be taken to increase the awareness of T-Levels, particularly for employers (Foster, 2019a). This existing literature is supported with interviewee comments. For example, one senior leader of a college offering T-Levels stated:

> *"It needs time to bed itself in, it needs time to become part of the lexicon that we're using, and the employers are aware of and that universities are aware of... if we can do that, it will quickly kind of supersede any other level three vocational or technical route that is, is within digital very quickly." (Interviewee 22: Senior Leader, General FE College)*

As a qualification, colleges and students are also largely unaware of what T-Levels are and the benefits they can provide. An analysis of T-Level recruitment which included eleven college providers who offered the digital T-Level, revealed that nine failed to meet their modest recruitment targets (Camden, 2020). This could be due to a lack of awareness but raises concerns about the longer-term adoption of T-Levels.

To summarise, many interviewees were optimistic about T-Levels, and clear benefits were identified. However, there are concerns about how this qualification will overcome the long-standing problems that plague new qualifications which include significant work-place components. Still, should these problems be overcome, the consensus opinion is that T-Levels could become the future the technical education.

8.3 Theme 3: Choice of Curriculum

Building upon the previous theme of 'A whole new world', and in particular 'T-Levels - the future of technical education', this overarching theme discusses a colleges choice of curriculum, and the particular factors that influence what qualifications are taught, and why. The first theme; 'Curriculum control', explores which stakeholders have influence over curriculum decisions, and ultimately who has control over what is taught within a college. 'Perception of BTECs' outlines the many varied views which interviewees possess regarding this AGQ, while the final theme, 'Industry relevance', discusses the importance that is placed on ensuring curricula are aligned to industry needs, and how this impacts on overall curriculum choice and design.

8.3.1 Curriculum Control

Given research question 1 of this thesis, 'How do colleges decide what 'digital skills' qualifications and units of study to teach their post-16 level 3 students?', interviewees were explicitly asked about how this decision-making process works within their college. This theme explores interviewees' responses to this in respect to outlining who makes the decisions. The responsibility of who has curriculum control and who influences curriculum design varied from college to college. For some colleges it is a holistic process that considers the views of learners, the teachers, the overall department and senior leadership. For instance, one senior leader explained the process comprehensively but concisely stated:

> *"When you ask me who's dictating the curriculum, it's, it's the reviews from our learners. It's the study program managers that teach it themselves. And they have direct access to the labour market data and the employers to inform their curriculum at that level. But it then goes through a process of being moderated by their manager, and then the leadership team." (Interviewee 15: Senior Leader, General FE College)*

This process was echoed by interviewees of other colleges too, and particularly by senior leaders. For instance, Interviewee 12 (Senior Leader, General FE College) explained how the decision-making process has a 'bottom-up bit' where teachers and departments can put forward ideas and proposals, but also a 'top-down foresight' to ensure that what is proposed aligns with overall college strategy. Similarly, Interviewee 20 (Head of Department, General FE College) explained how the ultimate decision sits with senior leadership, and in particular the vice-principal for curriculum, but predominantly the role of senior leadership is to be consultative and make recommendations with overall curriculum choice and design stemming from teachers and departments.

While this aspect of curriculum control centres on the involvement of senior leaders, it was interesting to hear the differences of how in some colleges teachers were very involved in the process, whereas in others, the head of department alone had curriculum control. One head of department discussed the importance of involving their team in the decision making process since they would ultimately be the ones teaching on what curricula is chosen:

> *"You can't make that choice from one person, you kind of have to look at the skill sets that everyone has, and see what they're comfortable delivering. Because there's no point giving someone a unit that they've never heard of and have no idea about. Because it just won't work, it will fall flat on it's face. So you have to make that kind of collective decision." (Interviewee 17: Head of Department, General FE College)*

This experience was not shared by all interviewees. For some teachers, they have very little input, and what they teach is dictated to them. In some cases there is an illusion of choice, in that the overall qualification is already decided, but there is some freedom for choosing out of minimal options. For example, as explained by one lecturer:

> *"I don't get a lot of input... I don't think I have any choice. In terms of the units, over the course of the year, I am delivering maybe 12 units, I probably get freedom to choose maybe three out of those 12. And it's a binary choice. Either you take a or b." (Interviewee 16: Lecturer, General FE College)*

Clearly, colleges have very different strategies on who to involve in the decision making process regarding curriculum, which likely tie in to either overall college processes and policies, college culture, or management styles.

8.3.2 Perceptions of BTECs

Just like how interviewees had perspectives on T-Levels, many made comments regarding the longstanding qualification of BTECs. The majority of comments were largely negative, yet the BTEC was cited as an almost necessary qualification that was just part of an overall curriculum offer. Many interviewees discussed how overall, the BTEC has a relatively poor value, in that it does not prepare students for the workforce effectively:

> *"the curriculum does not meet the requirements of industry routinely. So for example, if you take I don't know, if you take the BTEC level three, which is a, a traditional product, you know, or A-Level computing, these are the two traditional products, I would say they are definitely not meeting the needs of industry as a level three product." (Interviewee 15: Senior Leader, General FE College)*

While this interviewee in particular highlights the issue of industry relevance, they highlight how this is similar to other level 3 qualifications such as A-Levels. Other interviewees focused more on the shortcomings of the BTEC qualification though. Another senior leader (Interviewee 3), from a sixth form college explained how students with BTECs who go into the workplace still need in-house training as they are not suitably qualified. However, as put by one of the teachers at this same college (Interviewee 25), they stated how "the [BTEC] IT is good for learners that perhaps haven't quite got the grades they'd hoped at GCSE". This shows how the BTEC is perhaps perceived as lower-level academically, and offers alternatives for students that can not get onto courses such as A-Level computing.

While the issue of level 3 students being able to get a relevant job straight after level 3 was cited as an issue, this could be due to the specification being out of date and not relevant to current industry practice. One lecturer cited the BTECs shortcomings in this regard:

> *"Courses are five years out of date when they're written, that the people at BTEC don't understand where industry is. What they do is they give an overview of a topic rather than industry specifics of a topic. So if I kind of extrapolate all of that out, the short answer is no, BTEC does not not not deliver what industry is requiring." (Interviewee 4: Lecturer, General FE College)*

This quote very much links to the issue of 'Curriculum Lag' as previously discussed so it is not surprising, with Interviewee 29 (Lecturer, General FE College) stating how the BTEC being out of date is 'the nature of [the] beast, unfortunately'. Other comments centred around the problems regarding BTEC assessment. Over time, BTECs have had more exams as part of their design, while issues of coursework for computing still remain, particularly in areas of assessing programming ability, as discussed by one lecturer:

> *"the evaluations tend to all be written. So a really, really good programmer will only achieve the pass grades with a really good program. It's all then about report writing on top of that. And in some ways, that's good, because like I said previously, the students who who aren't good at programming have a really good chance of getting a, a high grade. But in the other way, it's really frustrating, because you get students who write brilliant programs, but no interest whatsoever in report writing." (Interviewee 18: Lecturer, Sixth-Form College)*

This form of assessments relevance to industry is questionable, but it also shows the difficulty in understanding the ability of a programmer based on their BTEC grade alone. Finally, some interviewees commented on how they were not keen on Pearson, the exam board for the BTEC. Lecturer comments included how Pearson are "in it for the money" (Interviewee 19, General FE College), that they are "more concerned with the paperwork that we had in place, than they were with the students work" (Interviewee 23, Sixth-Form College), and that "the pressure that Pearson puts on submitting assignments on time is considerable" (Interviewee 16, General FE College). Neither of these factors contribute to an effective curriculum, but this is just the perspective of some of those who teach the qualification based on their lived experience.

8.3.3 Industry Relevance

The theme 'Industry relevance' explores the perspective of how important it is to have curricula aligned to industry. While as a concept this has been highlighted in the themes 'T-Levels - the future of technical education', and 'Perceptions of BTECs', this theme places this concept as an underpinning influencing factor in curriculum choice and design generally, without being tied to a specific qualification. Industry relevance was a feature discussed by almost every interviewee in some capacity. Some interviewees discussed the process of how industry relevance is considered before offering qualifications in the first place. Much like the Shadbolt (2016) and Wakeham (2016) reviews which indicate the usefulness of industry advisory boards (IABs) in their ability to better align the needs of industry with degree provision, some college interviewees explained how they go through a similar process for the design of college provision. For example, a senior leader explained how they consult with an IAB to identify what study programmes are not in their portfolio but in high demand:

> *"We have employer advisory boards that we consult about our programmes that we offer, and we ask about what's coming next in your, you know, your sector, and what we need to be thinking about for us our students. And so you get an intelligence that comes from employers. It also receives report, reports from labor market information, because we buy that. And so things that scrape live job advert data, and you can analyze that... So that informs whether if we haven't got a program in our portfolio, and it says, actually, nationally, there seems to be in high demand and is growing, we would then say to the faculty, right, you need to develop a proposal for this program." (Interviewee 12: Senior Leader, General FE College)*

In this situation curricula is demand-led, based on current industry information. However, this contributes to the issue of 'curriculum lag' as previously discussed due to being reactive to the current environment. This means students may finish their qualification and still be a year or two behind what is required. Ultimately, as recommended by the 'digital skills for the UK economy' report (ECORYS UK, 2016), FE curricula should be devised in partnership with industry so as to provide people with the skills they need for when they enter the workforce. There is merit behind predicting what the future industry needs will be and to devise curricula in line with this. This is perhaps one of the benefits of T-Levels being so 'cutting edge'. One head of department discussed how they consult with their IAB regarding what future DS demand will be in their local area so they can more effectively offer qualifications aligned to local industry needs, they stated:

> *"they [industry advisory board] think that about 18 months out, there will be quite an explosion for cyber in the area, for example. So that gets us thinking hold on, and what do we need to precede that explosion? So we started looking at our level three and level four provision." (Interviewee 9: Head of Department, General FE College)*

The problem with designing and developing curricula with the future in mind, is that ongoing issues regarding staff knowledge and funding remain and may be more burdensome for more advanced qualifications which require up to date knowledge and resources. Interviewee 22 (Senior Leader, General FE College) explained how the decision around curriculum is a "balancing act between the skills that we have, [and] the needs of industry". A problem about staying industry relevant was highlighted by a senior leader of a sixth-form college. They explained how regardless of developing new curricula in line employer demand, it is students who dictate the success of a new course as they are the ones applying for courses.

> *"When you come to creating new curriculum, there is a point where you almost have to take a leap of faith and go, 'well, we're going to run this and hopefully people will apply'... it's actually driven by demand from an individual perspective of what a 15-16 year old or maybe an adult student really wants to do, or they see as being an important and valuable qualification." (Interviewee 28: Senior Leader, Sixth-Form College)*

This quote shows the importance of considering student demand, and the importance of effective outreach initiatives in encouraging students to apply for newly developed courses.

Overall, this overarching theme of 'choice of curriculum' highlights the complex nature of curriculum choice and the individuals involved in this process. Each college may have a different process, with different cultural and individual perspectives on the qualifications themselves. Meanwhile, each college will be situated in their own local context containing different employers and students, where all have the potential to influence curriculum choice.

8.4 Theme 4: Environmental Strain

This overarching theme represents the nature of the landscape that college employees operate in. The theme 'The kids aren't alright' constitutes how students can be a challenge, but not necessarily of their own fault, due to the lived experiences and pressures that cause them to not be okay. Meanwhile, the theme 'Competing workplace demands' describes the burdens of the college workplace, with a particular emphasis on the multitude of activities that teaching staff must incorporate into their day-to-day roles. The final theme, 'The bare necessities', outlines concerns regarding resources, with the insinuation that colleges have just the sufficient resources to provide a basic teaching and learning experience, with nothing to spare to make teaching more progressive. Contextually, it should be recognised that many of the factors discussed within 'Environmental strain' appear to be influenced by factors contained within the three aforementioned overarching themes.

8.4.1 The Kids Aren't Alright

This theme reflects on how students can be a challenging aspect of teaching, with the reasons cited by interviewees falling into two main areas. The first relates to a lack of student motivation, and the second relates to issues arising due to their background experiences educationally or personally.

Student Motivation

Motivation can be described as being the driving force for action, willingness, and achieving goals. Motivation can give a reason for the way one behaves, and because the majority of level 3 college education is compulsory since the school leaving age is 18 (Education and Skills Act 2008), students are not necessarily choosing to be there. This can potentially lead to a lack of motivation as students did not make this choice themselves, or that it was just the best choice out of some options available, or that they need to be there, not because they want to be. This issue was highlighted by a number of interviewees, such as Interviewee 5:

> *"We do get students in who, who have to be here... they've got to pick a program. And a lot of them pick a computing program, because that's what they know. And actually, I mean, the other day I was just in a BTEC lesson. And one of the, one of the guys was misbehaving and I said, you know, 'do you want to be, you want, you want to be doing this, don't you? And, you know, you enjoy computing and all that sort of stuff'. And he said, 'No, I'm really bored. I hate it'." (Interviewee 5: Lecturer, General FE College)*

This lack of motivation can cause a lack of engagement, and potentially cause some students to misbehave as highlighted above. This does not help create a prosperous teaching and learning environment and makes classroom management even more challenging in a subject where keeping all students engaged can be difficult due to its student-centred nature (Yadav *et al.*, 2016). Some interviewees made comments about students misbehaving and how getting distracted is more of a problem in courses such as computing as distractions are just 'a click of a button away', while other interviewees cited issues regarding students' expectations of computing courses. It was cited how some students appeared to apply for computing courses because they liked playing computer games, and thinking they could just waste time and sit on their phones. While this is an issue of expectations and perhaps links to schools' careers guidance and students' own research into what a course involves, this influences the teaching within a college. However, as put by one lecturer, just because students have to be there, they do not have to participate effectively:

> *"They're there because if they're not there, they might not be getting social security or the parents ((inaudible)) housing allowance. There are financial reasons why they have to be present, but there are very few financial reasons why they have to be successful." (Interviewee 16: Lecturer, General FE College)*

This quote highlights both the concern of student motivation but also the prevalence of personal circumstances that may be influencing students. Outside of the classroom, students have their own lives and background, and this background should be understood.

Student Background

Reflecting on Biggs (1993) 3P Model (Figure 2.4), students have prior knowledge, abilities, preferred ways of learning, values and expectations. These influence the teaching context and the execution of the curriculum (task processing), which, according to the model, influence overall student outcomes. Considering students' previous educational experience is vital for the success of a computing curriculum. What was clear from interviewees was how different these previous educational experiences seemed to be for students. For example one lecturer stated:

> *"We get learners that can be quite experienced from some schools, and then other schools that you find that they can be quite weak and struggle. So I think sometimes that jump from school to college is quite a big jump for some learners." (Interviewee 25: Lecturer, Sixth-Form College)*

It is not a surprise to hear of such differences as this has been discussed in the theme 'We don't need no (secondary) education', and cited in existing literature. For example, students' having very different experiences of programming prior to level 3 (Crick, 2017; Sentance and Csizmadia, 2017a). While these differences undoubtedly exist, this causes a challenge for educators in catering for such a wide variety of learners. For instance:

> *"Half of them will think they know everything, and half of them will have no confidence. And you have to simultaneously develop the content for those two groups of students equally, whilst making half of them understand their level and what they need to do to progress as people as well as computer science students. And the other half build confidence." (Interviewee 10: Lecturer, General FE College)*

This quote highlights the challenge of having mixed ability students in one class (The Royal Society, 2017), which can influence engagement. Teachers need to be aware of differences students have and the different perspectives and misconceptions they may be bring, and this should never be taken for granted.

Another aspect of a students background is the technology that they have at home, and it should not be assumed that students will have all the necessary equipment for a computing course. It was explained by many interviewees that some students may not be able to afford the hardware that a computing course necessitates. For example:

> *"So when it comes to like a distance learning thing, if we ever go back to that, it simply wouldn't be viable. And because a lot of our students come from poor backgrounds, they don't have the hardware technology at home." (Interviewee 26: Lecturer, General FE College)*

While this is an issue that has perhaps been highlighted and exacerbated as a result of COVID-19, it is not a new phenomenon, and influences the teaching and learning environment which teachers must try and deal with. All students should have the opportunity for studying a DS related course, regardless of their financial or other personal circumstances. However, this causes a strain on educators in finding suitable methods to cater for all.

8.4.2 Competing Workplace Demands

'Competing workplace demands' shows the wide variety of responsibilities that is placed upon those teaching in colleges. Whilst some demands such as lesson planning, teaching, and marking are obvious demands on a teachers time, and cited as causing teachers to suffer from a heavy workload (The Royal Society, 2017; Orr *et al.*, 2019; Consulting, 2020), interviewees illuminated other competing demands that they have experienced, which are summarised in Figure 8.1.

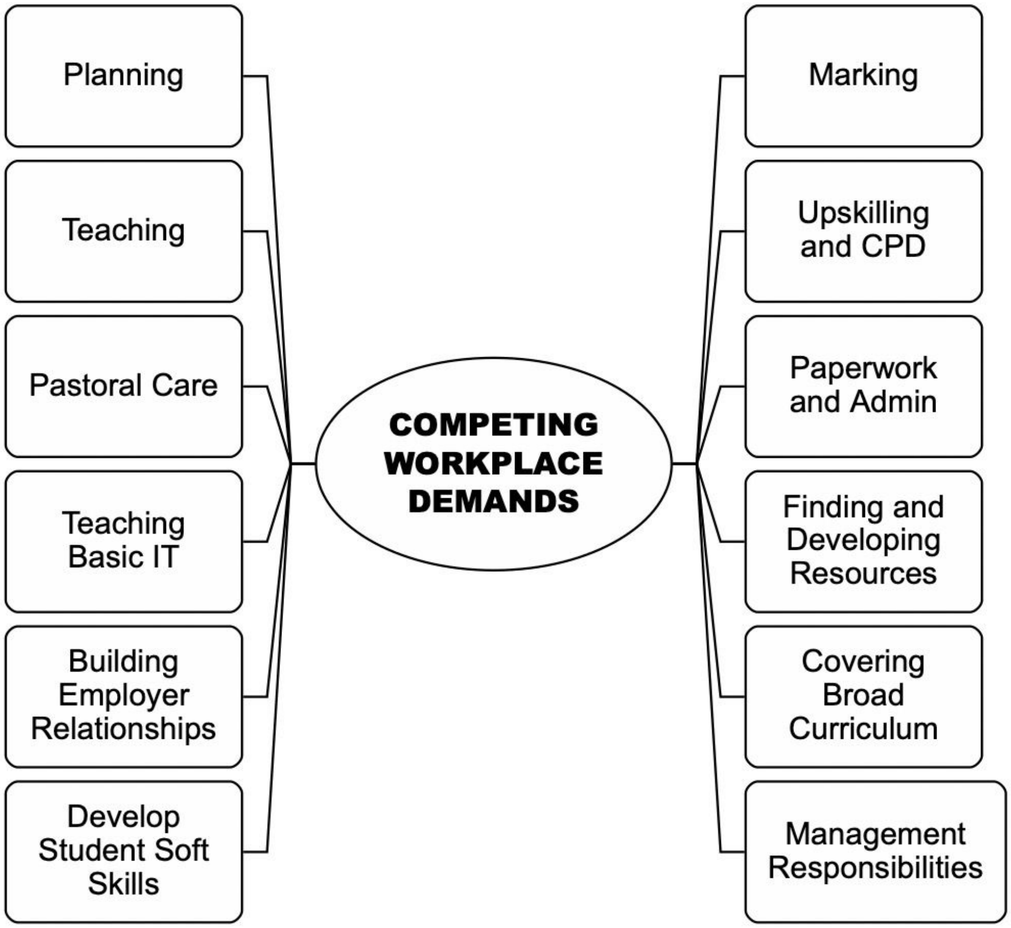

Figure 8.1: Competing Workplace Demands for Teaching Staff.

Not only does Figure 8.1 highlight the broad scope of tasks for lecturers, but if considering a typical working week, there is a limited amount of time available and so these tasks may bleed into a lecturers own time. For example:

> *"I'm on 25-26 hours a week, like doing weekly, like sessions like and they're not all the same session. They're like all different things. It could be from databases, Python programming, you know, all that type of stuff. And it's just finding that time to literally hone in on those skills." (Interviewee 8: Head of Department, General FE College)*

This shows how the majority of this teachers time is spent teaching, and if assuming a normal working week is approximately 40 hours, this leaves just 15 hours for all other tasks which may not be feasible, especially when delivering such a broad curriculum. Here, Interviewee 8 mentions about honing in on skills and essentially developing ones own knowledge. When referring back to the theme 'Evolution of technology', which can result in the need to create new content and learn new things, these impacts were felt as one of many workplace demands by interviewees:

> *"It takes, take time. Yeah, yeah. Yeah. And then I think particularly, particularly the case with, with computing, because it's a very technical subject. So you've got to get your head around it before you can create something at an appropriate level for the students to follow." (Interviewee 19: Lecturer, General FE College)*

Even when creating something at an appropriate level for students, time in class may not be enough. Some lecturers commented on how they do not teach the required amount of guided learning hours that courses require, often trying to compress teaching into a smaller time frame.

One interesting viewpoint was that of senior leaders with regards to competing workplace demands for lecturers. While one senior leader (Interviewee 28, Sixth Form College) stated how 'teachers should be slightly unshackled' another senior leader explained how their lecturers are educators, where:

> *"The role of an educator also develops new programmes, develops relationships with external businesses, wins new customers, either employer ones for apprentices or learners, is an advocate, is a mentor, is a manager of a project and your role as an educator is much bigger." (Interviewee 12: Senior Leader, General FE College)*

Interviewee 12 acknowledged the broad range of roles but clearly stated how all teaching hours are accounted for, and so was almost unsympathetic to these competing workplace demands being faced, as it is part of the job.

One final interesting role of the teaching job which interviewees themselves found surprising was that of the amount of time spent on pastoral care for students, and how this has increased over time. Many lecturers discussed how there are now more students that are 'higher-need', that students need more scaffolding, and more help with general progression for on their course and preparing for life after college. Interviewee 14 is one example of someone experiencing this:

> *"One thing that I noticed is that I spend more time now supporting the emotional development of my students as I do the curriculum level development...80% of my kids, I spend probably about half of my time, working with them as people as opposed to actually delivering any curriculum." (Interviewee 14: Head of Department, General FE College)*

It can be seen how there a range of competing workplace demands putting pressure on a teachers limited time and contributing to the environmental strain of working in a college.

8.4.3 The Bare Necessities

The final theme within 'Environmental strain' of 'The bare necessities' outlines interviewee concerns regarding resources. The general consensus from interviewees was that colleges have just enough resources available to provide a sufficient teaching and learning experience, but only the necessities, and nothing more. Within this theme are three main sub-themes which will now be explored.

Funding Required for High Quality Resources

The first sub-theme is that the resources required for DS courses are often highly specialist and require financing. Much like existing literature which highlights that many schools and colleges have insufficient funding for the equipment and software required to deliver computing qualifications successfully (for instance see: (Lucas, Spencer, and Claxton, 2012; The Royal Society, 2017; Augar *et al.*, 2019)), this was highlighted by a number of interviewees. For example:

> *"Resources are a big thing, especially in computing, because of the things that we have available, right, we don't have the highest spec machines, we don't have the best monitors, we don't have all the software that can be available, simply it comes down to money*

> *and availability of that money and where it goes." (Interviewee 26: Lecturer, General FE College)*

While this issue was brought to attention in the theme 'Please sir, I want some more (money)', a lack of funding is not only a 'tale as old as time' in the FE sector, but one that is causing severe environmental strain to those trying to deliver DS related qualifications. Therefore, teachers need to be supported and well equipped for this kind of curricula to be successful (Gal-Ezer and Stephenson, 2014; Department for Digital Culture Media and Sport, 2017). Admittedly, not every college is suffering, for example:

> *"The college have invested quite heavily into into computing and digital skills. We've got a specialist cyber-security lab. Invested close to 100K. We've got Microsoft dedicated Microsoft classroom. Yeah. We're very fortunate in comparison, to some other schools and colleges." (Interviewee 31: Head of Department, General FE College)*

There were only a few interviewees who discussed being in a similar beneficial situation, and, contextually, this was often cited by those interviewees at colleges that were offering the new digital T-Level, and so were recipients of government funding. As previously mentioned, this funding may not be sustainable, and as eloquently put by Interviewee 2 (Senior Leader, General FE College), colleges need to understand that there "is not a one-off procurement of IT and you're done, there needs to be a plan, a budget, and be long-term". This is easier said than done, with some interviewees explaining how they now only focus on the basics, as that is all that is possible given the circumstances. Regardless of the funding required for specialist resources, these circumstances frequently involved a general inadequacy of colleges' infrastructure and network.

Inadequate College Network

Existing literature has previously highlighted how in FE, there is the general unreliability of IT infrastructure (Armstrong, 2019), and this was further confirmed by interviewees. While perhaps amplified by COVID-19 and the shift to remote-learning, generally, the colleges' infrastructure and network were not sufficient. For instance:

> *"Big investments have to be made, I feel in infrastructure, especially now when we're seeing a lot of colleges really struggling with their network infrastructure that they have. Not being able to support remote delivery effectively, we spent a huge amount of money, I think, proportional to other colleges on that, and we, and we really, we really struggle." (Interviewee 10: Lecturer, General FE College)*

It is not just the general network for remote learning though, many interviewees cited how their resources are outdated, the software is basic, and so the teaching given to students is basic. College resources have been identified as being insufficient to meet the diverse and increasing needs now and moving forward (Consulting, 2020), and so it is no surprise that interviewees are trying to find alternative methods to bypass the college network. Interviewee 17 (Head of Department, General FE College) explained how he is finding that many staff are using their own laptops in classrooms in comparison to college computers as "they're just awful". Meanwhile, one lecturer explained how they have started using external resources where possible to account for the poor college infrastructure, stating:

> *"I think the infrastructure is a massive challenge, I have recently had the students tap into free azure accounts, so to spin up some virtual private servers, and because of a lack of infrastructure, so because we don't have infrastructure in the college, server technology," (Interviewee 20: Lecturer, General FE College)*

An inadequate college network is not the sole reason for interviewees taking these measures, as there is also internal college conflicts with IT teams and college IT policies.

Conflicts with IT Teams and Policies

This sub-theme explores a challenge that is severely impacting the ability for DS lecturers to teach curricula effectively, and it is focused on security. Cyber-security processes are in place for a colleges' benefit but teaching DS related qualifications often require access to software which typical college

IT teams and policies do not allow. For instance:

> *"When you want to run forensics, you need the right software, which means it's going to be running off a Linux box, you've got to be able to clone a hard disk, you've got to be able to have write protection... I understand these people have to protect their systems. But that protection makes it almost impossible for some of us to do our job. We need the kind of low level access that they don't want to give. And we see this with more and more of the software." (Interviewee 16: Lecturer, General FE College)*

This interviewee is not alone in stating how these procedures make it almost impossible to do their job. Interviewee 27 (Head of Department, General FE College) explained how their IT teams have blocked access for them to use certain aspects of Unreal, while Interviewee 17 (Head of Department, General FE College) stated how their system is so locked down, it's like 'Fort Knox', with the college not allowing the use of Oracle, as it is deemed unsafe. Equally, Interviewee 4 (Lecturer, General FE College) discussed how they have been battling with IT teams to allow students to use hardware for networking, but has just repeatedly been told to use Cisco Packet Tracer, as this is all that they should need to teach networking effectively. None of the above eludes to creating an effective teaching and learning environment, and puts the responsibility on lecturers to try figure out a way to effectively teach DS courses in such a constrained way. Interviewee 29 explained how they now just use their own devices to bypass the college regulations:

> *"I've actually just brought my gaming laptop from home and I and a really long HDMI cable, plugging that directly into the projector bypassing my college regulations, because it's the only way that I can actually teach the content they need to know." (Interviewee 29: Lecturer, General FE College)*

There there is a discrepancy between college security and allowing access for the effective teaching of DS courses, with an end-solution currently unclear. This is something that is placing a strain on college lecturers to do their job effectively, which influences a students development and ability to enter the workforce with the right up to date skills in digital.

8.5 Theme 5: It's a Hard-Knock Life

With subtle references implying notions of under-appreciation and exploitation, this overarching theme explains how interview participants constructed the nature of working in a college environment as a picture of struggle and hardship. The theme 'Difficulty of work-life balance' explores how college professionals contend with the challenge of separating their professional and personal lives. Meanwhile, the theme 'Mental well-being' captures the unmitigated influence of how working in a college can affect both emotions and attitudes. Across both themes, there is the moral tension of doing the right thing for students, with interview participants showcasing how this is often done at the sacrifice of themselves. Both themes identified within 'It's a hard-knock life' seem to be influenced by other concepts discussed within the aforementioned overarching themes of 'Tales as old as time' and 'Environmental strain'.

8.5.1 Difficulty of Work-Life Balance

Directly influenced by the concepts discussed in the theme 'competing workplace demands', this theme highlights how many interviewees are facing difficulties in separating their professional and personal lives and struggling to achieve a suitable work-life balance. Many interviewees highlighted how certain tasks such as marking are completed in their own time, often citing how it is just part of the teaching job and is expected from them. For example, one lecturer stated:

> *"So I teach, what 23 or 24 hours a week with planning, you can't fit that all in, that's part of the teaching job, you know that there's always going to be a proportion of your outside time which you spend planning or marking or whatever." (Interviewee 10: Lecturer, General FE College)*

Due to having such a broad range of competing workplace demands which appear to bleed into teachers own lives, this naturally appeared to lead to many teachers having to choose which tasks are priorities. Teaching, planning lessons and marking appeared to be priority tasks with others such as CPD being pushed aside in some instances, and having to be done in a teachers own time, if at all. This corresponds with previous literature stating how the majority of teacher CPD is undertaken in their own time (The Royal Society, 2017; Sentance and Csizmadia, 2017b), and as stated by Interviewee 27 (Head of Department, General FE College), "It's like another, another job". Some interviewees discussed how due to demands of being a teacher, they are not able to effectively live their own lives. For example:

> *"We're all human beings, we'd like to live our lives as well. And not, you know, so Sunday, Sunday evening, you know, after tea, it's just going up to the study or whatever, turn on the machine." (Interviewee 5: Lecturer, General FE College)*

Meanwhile, one lecturer who works part time exclaimed how they will not consider working full time as a teacher due to the problems of achieving a good work-life balance:

> *"One reason why I haven't I haven't ever worked full time is because I thought, if I do that, then I will lose one day, every weekend. And with having my own family, I didn't think that was reasonable." (Interviewee 23: Lecturer, Sixth-Form College)*

These interviewee comments clearly show the environmental strain placed on lecturers, with competing workplace demands in particular negatively affecting a lecturer's ability to achieve a suitable work-life balance. Not only could this influence prospective lecturers wanting to enter the profession, but could also cause existing lecturers to want to leave. Besides, a college workforce survey highlighted how 20% of those who resigned from college teaching stated it was because of the heavy workload (Association of Colleges, 2018b).

8.5.2 Mental Well-being

Linking on from the theme of 'Competing workplace demands', and the aspects highlighted in 'Environmental strain', this theme captures how employees have suffered as a result of these circumstances within colleges, and how they have had a negative effect on mental well-being. Here, interviewees commented on stress, anxiety and depression, which can be caused as a result of trying to do the right for their students at the expense of their own time and health. For example, Interviewee 27 (Head of Department, General FE College) explained about this in the context of making sure their skills were up to date so they could effectively teach their students. However, even though they do enjoy the subject themselves, it is not actually in their best interests. They stated:

> *"You know, it's okay, doing these things in your own time. That's brilliant. Done that all my life. But it doesn't actually help your health or your fitness, or your well being, even though you love doing it. I do it because I love doing it, it still wipes you out." (Interviewee 27: Head of Department, General FE College)*

Being 'wiped out' was an occurrence mentioned by other interviewees too, and for some, the demands placed upon them became too much. For instance in the case of Interviewee 6:

> *"[I] became slightly depressed, I just couldn't, I'd lost all my motivation, kind of lost, lost my drive to do anything. So I was always working, never unwinding. And I've had to have had to step back because I joked about doing the whole like 25 hours a day. But like my manager and other people saying, 'Oh, you burn the candle at both ends', and it was seen as a thing that you really should be doing for the kids. And I've had to learn the hard way that the, as good as it is for the students. I can't do it. It, it very nearly broke me." (Interviewee 6: Lecturer, General FE College)*

This interviewee went on to explain how they are feeling a lot better now they have had a reallocation of workload and expectations, and help from their partner. However, they could have easily left the profession as a result of this impact on their mental well-being. Some interviewees discussed how having situations in teaching that do not go as planned should be expected, and that their will be poor performances, or student difficulties. Some mentioned how the key thing is to have the right mindset, to plan effectively, and just try and learn from any experiences. For example one lecturer stated:

> *"You have to understand there'll be sort of good sessions and bad*

> *sessions, hopefully more good than bad, but they are sort of, that sort of system. So you want to try and ensure that you're having that sort of, sort of expectation when you walk in, and sort of. I'm not really sure what else to add really to that. I would just say, yeah, just make sure that you don't dwell on sort of your poor performances, just try and react to them and be better." (Interviewee 8: Lecturer, General FE College)*

Clearly, college lecturers are under a tremendous amount of pressure. This only highlights the importance of identifying and sharing best practice regarding the teaching of DS to make the impact on lecturers mental well-being less burdensome.

8.6 Theme 6: Critical Success Factors

Wide in variation, yet key for addressing the DS gap, this overarching theme features the scope of factors that are deemed important for overcoming the challenges that influence the teaching of DS and related courses. The theme 'Collaborative digital culture', which was predominantly created from statements from senior leadership, highlights the importance of colleges all being on the same page and being digitally forward thinking. Meanwhile, the theme 'Having the right staff' emphasises the value of having both passionate and knowledgeable staff. 'Professional development' discusses the variety of factors that are important for CPD programmes, as well as calling attention to the need for CPD in the first place, while the theme 'Working together' accentuates the significance of building relationships with a variety of parties. Finally, the theme 'Pedagogy (approaches to teaching)' expresses the variety of pedagogical techniques used by educators that are deemed to be successful in their own practice.

8.6.1 Collaborative Digital Culture

This theme refers to the notion that an effective college culture is important for student success. More specifically, a collaborative digital culture that is built upon the foundations of being digitally adept and forward thinking, having a willingness to learn, and working collaboratively with one another.

Much like a jigsaw containing many individual pieces, this theme should be viewed as a completed jigsaw. The individual jigsaw pieces which contribute to this overall culture such as 'Working together' are themes later discussed in their own right. While it is viewed that culture is influenced by those other aspects, unless all of the pieces are there, the jigsaw is never complete, and this theme explores the importance and emphasis on having all those pieces together. For instance, one senior leader referred to the importance of their college culture frequently, and how it dominates everything that is done within the college. They stated:

> *"I've already mentioned in terms of that that culture we have of aligning ourselves with industry... We are always challenging our curriculum teams to make sure their curriculum remains relevant, and it remains current and it gives people what they are looking for from a program... So it has to be that cultural shift. And if you come and work at [this college], if you come and work with us, you need to buy into that culture... And therefore, culturally, there is a drive for staff to want to better themselves and want to move forward. And I think one of the things we've been able to do is to put in place opportunities for staff to do that, and also reasons for them to do it as well." (Interviewee 22: Senior Leader, General FE College)*

Here, there are mentions of working collaboratively, whether with industry or internally within the college, challenging staff to keep relevant and continue learning, and an overall underpinning of being forward-thinking. All are under the basis of how the college operates, i.e, its culture, and its way of doing things. Similarly, Interviewee 3 discussed the culture within their college and how there is a large focus on sharing ideas, resources and teaching one another. They said:

> *"We have a good good sort of culture of sharing stuff here... if you have teachers teaching teachers, rather than bosses, teaching teachers or whatever, it's, there's less it's, it's, I guess, probably perceived less as a kind of like a management telling you what to do. It's like, 'I teach the same lesson, the same kids you teach, you know, lets look at how I go about working with this particular*

> *issue' or, you know, and it just creates that collaborative culture." (Interviewee 3: Senior Leader, Sixth-Form College)*

While the emphasis on culture was profound during the interviews with Interviewees 3 and 22, not every interviewee who discussed culture was experiencing the collaborative digital culture they would have liked. One Interviewee 11 (Lecturer, Sixth-Form College) explained how their college had went through some changes but they have never reviewed their IT provision, and explained how it is just the culture that exists within the college. Meanwhile, a senior leader who described themselves as a 'technology advocate', discussed how they want to have a culture that exists where their staff are coming to them asking for resources or opportunities to learn and to share ideas, but it is not happening:

> *"We've got the opportunity for additional equipment for T-Levels, we've got the opportunity for capital investment, with the IoT in terms of equipment budget for the 3 million pound build that we're doing. There are not that many educators in the relevant disciplines who are going 'if only I had a, a network switching things, so I could create a dirty lab for my cyber thing we could bring companies in' and you know that they're not asking for anything. And so which worries me." (Interviewee 12: Senior Leader, General FE College)*

While this issue could be because of the motivation and inclination of staff working for the college, it could also be as a result of expectations and not having a clear understanding of college goals. It is evident how an effective collaborative digital culture is viewed positively, but culture is a jigsaw with many pieces. One of the fundamental aspects of culture is the people who reside within that culture, and hence, having the right people (staff) is of the utmost importance if a collaborative digital culture is to be achieved. This aspect will now be explored in greater detail.

8.6.2 Having the Right Staff

Given the challenges emphasised in the theme 'Lack of experienced staff', this theme explores how having the right staff is a critical factor for success in terms of being able to offer industry relevant curricula, and to achieve positive pupil factors. This theme is closely linked to and influences the theme ‘Collaborative digital culture’ since any culture is made of the people who are within it.

To achieve positive student outcomes, a key characteristic of the right staff are those individuals who are in the teaching job because they truly care about the students. By having student interests at heart, teachers will take action to ensure that students succeed. The by-product of helping students and seeing their success was frequently described as a satisfying and rewarding experience. For instance, one lecturer explained how this is one of the main reasons they are in the teaching profession:

> *“I feel like ethically they [students] are they’re better off because I’m here... I don’t do it for the hours, I don’t do it for the pay. I don’t do it as everyone keeps thinking for the holiday. I do it because like the students need somebody who is caring and passionate about the subject.” (Interviewee 6: Lecturer, General FE College)*

The concept of ‘passion’ was another frequently cited comment by interviewees. This was not exclusively in relation to the passion and desire for helping young people, but also that of the passion for technology and computing. Some interviewees explained how if you do not have the passion for working with and helping young people, and the passion for the subject matter, then you are in the wrong job. Interviewee 20 (Lecturer, General FE College) for instance, explained how you need to be enthusiastic about technology and computing for success as a DS teacher, because if not, the students will probably find the subject very boring, which could lead to a lack of engagement, and subsequently, poorer student outcomes. Consequently, it is not surprising to see that this passion for the subject was reflected in the perspectives of senior leaders and heads of departments as a trait of what they want for their teaching teams. One example of this was by Interviewee 9 who discussed how as a department they can always buy new hardware or upgrade existing equipment, but it is having the right teachers that will influence whether a student will stay on the course or go elsewhere. They stated:

> *"It's that passion about the subject. It's not about teaching computing, its about wanting to share the passion of computing... So I think if someone's coming in new, I'd be saying, you know, you need, if you are doing web, I want to see that you are doing web outside of the classroom, you, you know, you have a genuine passion for web." (Interviewee 9: Head of Department, General FE College)*

Having this passion for the subject and teachers learning in their own time not only acts as form of professional development but it can ensure teachers stay relevant with industry changes which they can incorporate into their teaching. That being said, one lecturer discussed how one of the reasons they enjoy teaching is because they can work in partnership with students and learn from them too:

> *"So I absolutely love this job [teaching]. And one of the reasons is because you can pass you can, you can work and the study of the same time, you can learn. And IT and computing, you can learn from students as well, because computing is changing every day, quickly growing up, and [they] can capture all the information so, and very often I teach I learned from students, this is brilliant, it's absolutely amazing. When you, when you teach a young people, and when you see when they got started with passion in computing, this is the best place." (Interviewee 7: Lecturer, General FE College)*

By having lecturers that create and have co-constructed learning environments with their students, this should facilitate a better student experience. Having lecturers (and more widely college staff) with the passion and knowledge for helping students develop, for teaching, and for the subject area of computing and technology is likely to be a critical factor for success and positive student outcomes.

8.6.3 Professional Development

This theme centres on professional development. In some respects, this can provide a solution to the one of the issues already highlighted in the theme

'Lack of experienced staff', since it is not only recruitment of qualified staff that is a concern for colleges, but that existing college staff may not have the suitable experience for teaching DS related courses. Within this theme are indicators as to what is required for effective CPD as revealed by interviewees. It is not just what CPD covers that is important (i.e. the content) but also how professional development is structured, and what requirements must be in place for it to be successful.

It has already been discussed how the most effective CPD would cover both pedagogy and also meeting the requirements of a teachers dual professionalism, in addition to recent sector developments (McCrone *et al.*, 2015), and these different aspects were all highlighted by interviewees. For instance, Interviewee 18 explained how CPD has two main aspects to it:

> *"I mean, CPD is kind of a, it's kind of got a dual meaning really, isn't it? I mean, there's, there's, there's college CPD ((inaudible)) that's kind of different. And there's, there's keeping up to date with current advances." (Interviewee 18: Lecturer, Sixth-Form College)*

Interviewees cited a wide range of content that CPD should cover including; content knowledge, pedagogy knowledge, how their college operates, policies and practices, safeguarding, using digital teaching tools, and aligning what is covered in any sort of professional development with what is being delivered to students. However, it became evident that there are requirements that must be in place in order to facilitate the ability for teachers to take part in professional development activities, particularly if during normal work hours.

Requirements for Professional Development

A key requirement is to have support from leadership. In alignment with existing reports on the subject (e.g. (Cordingley *et al.*, 2015)), interviewees discussed how if they are taking part in professional development during work hours, it is as a result of the college and senior leadership supporting them to do so, and if not, it is often because of the college not supporting them. One senior leader was very keen on embedding professional development and conversations about it as a normal procedure and how it should be no different than the actual teaching itself due to its importance. They stated:

> *"We identify in that five ways of working and digitally enabled is one, and continuous learning and improvement is another. And so we'll be driving that down into the expectations in personal objectives and professional development and review meetings. And so we really say okay, 'well, what are your learning goals for you this year?', and this is a, not a, it would be nice if I could do some CPD, but no you're required to in order to remain competent." (Interviewee 12: Senior Leader, General FE College)*

This interviewee acknowledged how if teachers are up to date then this could lead to better student outcomes, and they were not alone in this thought. Another senior leader (Interviewee 1, General FE College) expressed his recommendation that any college needs to have somebody at a senior level with support from the principal (or equivalent) in driving a college strategy forward.

Time was another requirement cited by interviewees. The vast amount of responsibilities has already been discussed and how CPD can be an afterthought so again, this factor is mentioned within this theme. A key quote that highlights a number of requirement issues was from Interviewee 25:

> *"I think that the time pressure is always difficult within education, but they (senior leadership) are supportive, and in respect they're happy to fund and allocate, cover lessons where needed for CPD. Obviously, it's always pressure in further education. But I think the college does a good job of, of supporting us." (Interviewee 25: Lecturer, Sixth-Form College)*

Not only does this quote highlight the support given by senior leadership, but it also indicates how time is an issue, as is funding. Even if some professional development is free, there is still the cost to the college of having to cover that lecturers lessons. If given the time and funding to take part in professional development, due to the vast array of topics to learn, and how fast technology changes, some interviewees explained how they still need to do some learning in their own time.

The final requirement is regarding awareness. Due to external developments taking place at the same time as teaching and completing other responsibilities, some lecturers may not be aware of what they should be updating themselves on in the first place, and hence, what opportunities may be available. One lecturer (Interviewee 11, Sixth-Form College) simply stated that "opportunities don't arise", while another lecturer explained this issue in much more depth:

> *"If you don't know what you don't know, then you don't know what you need to know if you know what I'm saying. So because they've [teacher colleagues] both taught at FE for so long and don't really understand where industry is at. Well I'm just you know, five years out of industry now so I'm kind of, not on cutting edge anymore. If you don't know where industry is at it's very difficult to know what you need to learn in order to go out get into industry." (Interviewee 4: Lecturer, General FE College)*

Teacher Engagement

An interesting aspect of professional development is the engagement of those in the process. If a teacher wants to learn and develop, they will likely be more willing to engage in CPD, and to seek out opportunities. One interviewee was very close to retirement at the time of the interview so they were not keen on taking part in any professional development. However, those earlier into their careers were generally more keen on learning new things and keeping up to date with industry changes. In fact, three interviewees stated how they would like to pursue a PhD. This personal interest is likely a driving factor in whether any form of professional development is successful, as otherwise a teacher may not be as engaged. That said, some interviewees discussed how professional development that has awards and accreditation's attached to them tend to lead to increased engagement as the opportunity has a meaningful personal benefit to those taking part. For example one senior leader stated:

> *"We worked at looking at how we develop their [teachers] CPD,*

> *some of like the online training packages. So Microsoft has a suite of badges and looking at how we can empower them to say, 'Well, you know, if you ever left here, if you ever went on to somewhere else, you could say that you're certified Microsoft teacher'." (Interviewee 13: Senior Leader, Sixth-Form College)*

Having an additional qualification benefits that individual, but also likely benefits the students they are teaching and as a result, the college overall. However, CPD that has an award or accreditation attached to it tends to be a longer commitment, and have associated costs. The college would therefore have to decide whether that development opportunity is worth it or not.

Structure of Professional Development

A key aspect of professional development was the wide variety of methods in which it took place, and how different each type of CPD was structured. Some interviewees discussed how they have attended formal face-to-face training courses with mixed reviews. Some made reference to taking online courses such as those from Udemy or Code Academy, while some stated how watching videos on YouTube, reading class textbooks or asking questions on forums are their ways of professional development. While online sources were deemed the most accessible, they were not always considered that beneficial, especially if outdated, or if they did not adequately cover how to teach a certain topic. However, interviewees made reference to how useful online sources are to gain content knowledge. A small minority of interviewees discussed reflection as a form of professional development. One lecturer explained how it is a key component of their teaching practice, where they watch their own recorded sessions to see what went well (or not), and combine that with student feedback so they could improve:

> *"Reflection is is the fundamental part of it. It's all well and good identifying all the needs of the students and planning your curriculum. But if you can't reflect, you know, in action while you're delivering or after the session, to figure out what went well, what went badly, you're not actually improving your own teaching, you're just delivering the same content over and over again." (Interviewee 29: Lecturer, General FE College)*

A key point raised here is how any professional development should ultimately feed back into improving the teaching so it benefits the students. Without that, there seems little benefit in professional development if that knowledge cannot be passed on. On a similar vein to reflection, some interviewees discussed how they have benefited from observations, both in terms of gaining feedback on their own practice, or observing other colleagues lectures. Furthermore, observing colleagues who teach other subjects than those related to DS to gain a wider perspective on pedagogical approaches. This cross-curricula approach was favoured by a small number of interviewees. For instance, Interviewee 29 further stated:

> *"Observe as many possible lessons from many different lecturers, regardless of whether they're actually in your sector or not... I found that it was more beneficial to try and get those different perspectives... so that I can then again, reflect on that, and try and incorporate it in my own my own practice." (Interviewee 29: Lecturer, General FE College)*

Working with other people was also discussed more generally, particularly in terms of networking and collaboration with other teachers from other institutions. Learning with others is an essential part of developing workplace expertise (Ertmer and Ottenbreit-Leftwich, 2010; Lahiff, 2015), and it has previously been recommended how professional learning support networks should be established where teachers can engage with peers in their subject (Derrick, Laurillard, and Doel, 2016; Cutts *et al.*, 2017). While this literature is now outdated, it is evident from interviewees that these recommendations have not been acted upon effectively for colleges. For example, one lecturer highlighted how these networks are what teachers need:

> *"Building a community of people that teaches similar things together, I think is really important. ((inaudible)) , something funded perhaps by the ETF, where we can meet every quarter, for example, somewhere neutral, have a few talks about some of the pedagogical developments... we need teachers to get together and be able to experience the different opinions, beyond chain resources and things. So if that's an online platform, if that is something created by central government, or contracted out to*

develop, I think we need something that brings computer science and computing teachers together." (Interviewee 10: Lecturer, General FE College)

These networks are crucial in sharing best practice, and not having an opportunity to develop these networks can have a detrimental impact on teacher engagement in CPD (Broad, 2015). Networks can also mean industry links, with some interviewees at all levels discussing how teachers obtaining industry experience and building links with employers is important. Some discussed the benefits of being able to work in industry for a short while during the academic year. These interviewees in particular were predominantly teachers who worked at a college offering T-Levels so they benefited from government funding to allow this opportunity for them to up-skill. However, even those colleges not offering T-Levels tried to ensure staff had the opportunity in some capacity, even if minimal. For instance, one senior leader explained:

"It's mandatory for every single teaching member of staff in the [college] to have a back into industry day, you're not allowed to not to, we encourage more than the absolute minimum in all instances." (Interviewee 15: Senior Leader, General FE College)

This could be interpreted as being part of having a 'collaborative digital culture' within that college, but even so, it shows the importance placed on building networks.

Regardless of the structure and content of any professional development, a key issue highlighted by a small number of interviewees was that it is difficult to gauge the effectiveness of CPD, since it is hard to measure. While metrics such as hours or days spent can be used, these are simplistic measures that just show the amount of time someone spent on professional development, not on whether that time spent was actually worthwhile, or whether that leads to improved classroom teaching. To neglect professional development based on it's difficulty to measure would be naive, and not taking into account the benefits that it can provide. Professional development can happen in many different ways, but it needs certain requirements to be in place, and what works for one individual and college may not be suitable for someone else.

8.6.4 Working Together

This theme collates and emphasises the importance that was placed by interviewees on working together, and building relationships of mutual benefit, based on trust and understanding of one another. This in itself is divided into three different but equally important relationships: the relationship between senior leaders and computing departments, the relationship between colleges overall and industry, and the relationship between students and the staff teaching them.

Senior Leadership and Computing Departments

The relationship between senior leadership and computing departments was cited as an important component for success, especially regarding the understanding of the needs of a computing department from a senior leadership perspective. Generally those senior leaders who were understanding and not digitally naive, seemed to have computing departments with greater resources and facilities, and were early adopters of T-Levels. However, any discrepancy in senior leaders' understanding to what it should be was more frequently cited by teachers than senior leaders, with teachers discussing the issues they have faced due to senior leadership lacking in an understanding of their needs. For example, one head of department stated:

> *"But there are things that senior management team want me to look at. So adult courses for example or gap offers, they want to run a BTEC, a vocational course late start, starting from January, but they've not potentially thought about the controlled assessments and the exams, and the time to deliver that to equip students with the necessary skills and knowledge." (Interviewee 31: Head of Department, General FE College)*

Here, the issue is regarding the components of what the curriculum involves and while the above quote could arguably be in reference to many other subjects, other interviewees expressed their concerns more explicitly. For example, one lecturer exclaimed that while the senior leadership at their current place of work have a good understanding of the needs of a computing department, the same cannot be said for their previous college:

"SLT at that time didn't know that computing or computer science and IT are completely different subjects. You know, there is a degree of overlap, but essentially that completely different subject... SLT have no understanding of what computer science is." (Interviewee 23: Lecturer, Sixth-Form College)

These comments indicate how senior leadership teams and computing departments need to understand one another. While senior leaders are battling with college wide issues such as funding concerns, they need to understand that computing departments may need more frequent updating. At the same time, computing departments need to understand how they are just one department of many, all of which may be crying out for support. That being said, one senior leader (Interviewee 2, General FE College) explained how generally across colleges, there needs to be an understanding from SLT about what digital skills are, and digital skills needs.

Colleges and Industry

The next important relationship is that of between colleges and industry. While colleges are preparing students to enter the workforce as future employees, industry can provide guidance to colleges with regards to curriculum design, offer work placements, and act as guest speakers. These relationships were identified as being crucial by interviewees, but they must be of mutual benefit. With regards to this relationship, one senior leader commented:

"The placements have got to have a, it's got to be transactional in the sense that the students have got to be able to give something back to that employer, if they're going to actually be with them for a period of time, the students need to be equipped with the skills from the college, when they drop into that placement, they are ready to be adding some value." (Interviewee 22: Senior Leader, General FE College)

This emphasis on how students must be able to add value was frequently mentioned by a number of interviewees. One lecturer declared how the usefulness of students in the workplace indicates to employers how valuable the qualification they have is, and whether the college they came from is good to work with. They stated:

> *"The bigger issue is that educating employers by the students coming out. So if we can get enough students coming in, who are all tooled up and ready to go, it will become better because if those employees go we had BTEC student and they were awesome, that organization will then view them and go, 'Well, that's good'. And vice versa, then you have a BTEC student who is under-performing or doesn't quite fit into what they wanted, then they will take a negative view of that." (Interviewee 30: Head of Department, Sixth-Form College)*

However, one difficulty is that many colleges find getting work experience for students difficult in the first place, which coincides with the concerns previously mentioned with regards to T-levels. To alleviate this issue, some colleges have dedicated work experience teams, and while they can help address the issue of teachers having to deal with this issue, even they can find it a challenge. Consequently, some interviews also discussed about embedding work experience alongside the curriculum where students can work on real life projects set by employers but in the classroom. Again, this requires that relationship to exist between the college and employers, and just provides a more easily achievable method for both parties to gain a mutual benefit than work placements. A similar alternative to this is having external speakers come in as guest lecturers. Many interviewees explained how they desire more external speakers as they can help teachers with their teaching, inspire students, while also acting as a form of professional development for teaching staff; for instance, one lecturer commented:

> *"External speakers and engagement, stakeholder engagement, that's something which would, yeah, would really help us. Because if, if I'm standing there, talking about, you know, a digital marketing campaign to 20 students. That's, you know, one thing but if they have a person come in from a local agency who does that on a daily basis, that's an entirely different thing. So that's where I think we should be pushing ourselves." (Interviewee 11: Lecturer, Sixth-Form College)*

While external speakers can make class topics more 'real' and relevant for students, COVID-19 had a negative impact on the frequency of external speakers being able to deliver guest sessions. While this issue should subside over time, Interviewee 6 (Lecturer, General FE College) explained how their college has made it difficult for external speakers due to the college having such a rigorous vetting process. This can not only effect teaching and learning opportunities but also the relationships between colleges and industry partners, especially if an external speaker was deemed as not appropriate to come into the college.

Staff and Students

The final relationship is the one between staff and students. Interviewees cited the importance of understanding individual students needs, being honest and transparent with students, and to work in partnership with them. It was claimed that by doing this, this leads to a more productive teaching and learning environment. With regards to understanding student needs, this can stem back to Biggs' 3P model (Figure 2.4). In this model, there is a relationship between teachers and students where they each have perceptions of one another. If teachers build relationships with students and understand the students prior knowledge, abilities, preferred ways of learning, and expectations, then they can adapt the teaching context to be more appropriate for those learners. For example Interviewee 26 said:

> *"You have to get on their level, you have to, you have to understand why that student individually wants to do that course, and where they want to progress to... And as soon as you gain like their trust, you can you can basically get them to do pretty much whatever you want within the classroom environment." (Interviewee 26: Lecturer, General FE College)*

This emphasis on understanding students was often deemed more important than the teaching of the subject itself with comments such as: "The computing side of it is not the biggest part of this job. Yeah, it's a very minor part of the role. The, the students are central." (Interviewee 16: Lecturer, General FE College). As previously highlighted in literature in the context of programming, a students' prior knowledge can influence the difficulties they face and the misconceptions they have (Qian and Lehman, 2017). If there is not the student-teacher relationship where the teacher understands this, or the student is unwilling to share their troubles, then the student may continue to have misconceptions and difficulties. As a result, comments such as those by Interviewee 25 are understandable:

> *"Having the technology and the skills to understand technology is a is a is an important part of it. But it's not the essential part of it, I think, being able to understand learners, how to communicate, and how to identify, really, and be able to be proactive when they've got a problem, how to intercept that and help them. So I think really having those sort of skills and be able to plan your lessons effectively, is really important." (Interviewee 25: Lecturer, Sixth-Form College)*

A related aspect of the relationship that should be built between teachers and students centres on working in partnership with students as opposed to trying to be too much of a teacher. Here, interviewees mentioned how in some cases the students may know more than they do, but that is okay as it means bringing extra knowledge and discussion to the teaching environment, where they (the teacher) can act as a facilitator to the learning. This could be considered as being aligned to constructivism, which contends that teachers should not be seen as knowledge transmitters, but instead as mediators who assist students in constructing their own knowledge (Armoni, 2011). Arguably, this is more important in a continually evolving subjects such as computing and having this student-centered approach was seen as beneficial to both parties. For instance, one head of department explained:

> *"I think as soon as I stop treating them, like students and I'm their teacher, and I started being, I'm a, I'm a senior producer and you are my production team. It completely changed the way my philosophy about how I approach teaching when, and actually made the relation with students that much better." (Interviewee 14: Head of Department, General FE College)*

Dispelling the role of student and teacher not only seemed to help both parties, but is more akin to that of the workplace and has the potential to increase career-readiness in students. Interviewee 6 (Lecturer, General FE College) further described themselves as taking the role of a "more knowledgeable learner" under the context of social constructivism, and they are very happy to do this as it benefits the learners but also the teachers in keeping up to date with the latest technological developments.

8.6.5 Pedagogy (Approaches to Teaching)

This theme refers to different aspects of pedagogy; the method and practice of teaching, which was cited by interviewees as being important for a successful teaching and learning environment and overall student success. Pedagogy itself is broad, and within this theme are five sub-themes showing the variety of pedagogical aspects that resulted from the interview process.

Develop Student Soft Skills

A key area of pedagogy which many interviewees talked about was developing students' 'soft skills'. As a concept this can be defined in numerous ways, but for the purpose of this theme it refers to those skills that are considered important in employment such as communication, teamwork, leadership, work ethic, etc. It does not include skills such as programming ability as these are more technical skills. Crucially, interviewees cited the development of soft skills as just as important, if not more so, than the technical skills being taught on DS courses. For example, Interviewee 10 explained:

> *"Developing those [soft] skills is important outside of so making sure the student is becoming developed rather than just teaching them the thing, which is what a lot of people in this space develop. They think the content is first and foremost, and then forget that we teach kids though. Kids need help." (Interviewee 10: Lecturer, General FE College)*

This concept of making sure students are developed goes beyond the typical dissemination of knowledge that is associated with outdated teaching practices, and it also goes beyond teachers having just pedagogical knowledge. To develop student soft skills in a manner truly appropriate for the workplace in the digital sector, teachers must understand policy changes, local context, employment options, and general changes within the sector (McCrone *et al.*, 2015; Passey, 2017) as outlined in Figure 4.1. One lecturer (Interviewee 16, General FE College) stated how developing soft skills is "the biggest part" of the teaching job, while another lecturer (Interviewee 32, General FE College) explained how they are not teaching students content, but instead "teaching people how to learn". The concept of teaching students how to learn was also cited by other interviewees, as not only does this prepare them for an ever changing digital world, but also changes their mindset in finding things out for themselves as opposed to asking teachers for help. A further interesting point raised by a small number of interviewees was regarding what their typical computing student is like, and it is because of these characteristics that a greater emphasis is placed on developing student soft skills. For example, Interviewee 31 expressed one way they develop student soft skills, and their reasoning for doing so:

> *"We've been in every single [e-sports] tournament and the whole point of the tournament is to grow, or to get students to improve their soft skills, communication to work resilience, problem solving... So getting students to sort of build those softer skills and communication, teamwork, networking with their peers, we find really useful." (Interviewee 31: Head of Department, General FE College)*

Evidently, developing soft skills is seen as important, but the constraints of curriculum and typical ways of teaching can sometimes hinder progress being made in this area. Consequently, some interviewees described the ways in which they try to overcome this by challenging current practice.

Challenge Current Practice

Building upon the sub-theme of developing student soft skills, this sub-theme outlines ways in which interviewees are challenging the usual ways of doing things. Interviewees from one college in particular highlighted how they have implemented a large scale practical student project to help develop their students. Interviewee 14 discussed this project in great detail explaining how it works for their Games Design students:

"I say literally, 'you know, you've got to turn around, we've got a full board game, 3D printed pieces, all cards, all counters, rule books, you know, game art, 20 minute presentation, 25 minutes making a documentary, four social media platforms. I want you know, the entire campus sorted out, I want full catering, run a mini bar here, the venue presented, question and answer, everything set up', and they look at me like I'm absolutely having a laugh. And you know what that is, I think that is my favorite module on the course, it's that one where I get a whole bunch of 16 year olds that literally are still wiping the placenta off themselves. And say in nine days time, you're going to be launching a full product... that I think is the thing that turns them from 16 year old kids into a into FE game students." (Interviewee 14: Head of Department, General FE College)

To allow for such a comprehensive project, this college has had to condense their traditional teaching patterns by compacting their curriculum to allow for this two week project. While this was described as causing challenges for the teaching team, the staff enjoy working on the project, as do the learners, who benefit greatly. In fact, a senior leader at this college commented:

"I think it's fantastic for our learners, though, because there's nothing that prepares you more for real life than working on a real life project." (Interviewee 15: Senior Leader, General FE College)

This was a large scale example of challenging current practice which shows that with support from everyone in the college, new models for student success can be created. Trying new things and taking risks was commended by some interviewees. One head of department explained that without risks, teaching will get boring and will never improve. They stated:

"Look, don't be afraid to take risks. Yeah, it might not work right? But if you haven't tried it how do you know?'. Yeah. You know, cus again, ((inaudible)) if someone comes in and said it didn't work at least I know they've tried. Yeah, if you say 'well, that will always work' it becomes really stale." (Interviewee 9:

Head of Department, General FE College)

Importantly, to take risks you need to have the right staff who are willing to do so, but you also need a college culture that is supportive of taking such risks. Hence, challenging current practice is intrinsically linked and influenced by some of the preceding themes already discussed.

Put Emphasis on Students

One pedagogical approach cited by many interviewees was to put an emphasis on students. Here, some interviewees referred to the constructivist teaching approach of using a flipped classroom, which has been shown to increased student performance in areas such as maths for computing (Bradford, Muntean, and Pathak, 2014). For example, Interviewee 24 explained how they have used a flipped classroom approach:

> *"I've got videos and notes, and they've got textbooks and it's, do all the learning at home, come into the classroom we'll do the consolidation and assessments in the classroom environment itself. And I found that's been really beneficial...they can take as long as they need, they're not relying on on my pace of delivery in order to get that understanding, come into the classroom, give them a little mini sort of pop quiz, very quickly work out who has understood and how much they've understood. And then you can tackle the, the specifics very, very easily." (Interviewee 24: Lecturer, Sixth-Form College)*

While this has been extremely beneficial for this interviewee, not all teachers who have tried using a flipped classroom approach have had much success. Interviewee 16 (Lecturer, General FE College) explained how they have tried to get students to prepare in advance for in class sessions but students do not always comply. This could be because of student expectations or the link between the in class and out of class activities, a key factor for success in a flipped classroom approach (Healey, Flint, and Harrington, 2014). Equally, some students may simply dislike the approach as they cannot passively receive information (Berrett, 2012), and given some students may have to be there, they may not wish to put extra time and work into their studies. It is not a surprise to hear of some failings of the flipped classroom approach since it has been highlighted as challenging for both students and educators (Cook and Babon, 2017).

Interviewee 21 took a different approach. Instead of using the flipped classroom as a compulsory part of teaching, they provided an opportunity for students in a less structured way:

> *"I went out and bought, bought a ((inaudible)) introductory Arduino box, gave those and said 'there yours, just play with them'. There's no work set, but go home and play with them. And for about half of them, it sort of that got them over the step... within a day, I had one of them and it's all plugged together an LCD and have his name scrolling as a marquee across it, somebody else had built some traffic lights, somebody else had built a reaction testing, mostly from from online tutorials, but the idea that they they go away, find out stuff. And then when they didn't, when they got stuck in the run, sit there, sit there and ask me, they'd go online and start to solve their own problems." (Interviewee 21: Head of Department, General FE College)*

By not being compulsory, and simply allowing students to be creative and learn things themselves, this put the emphasis on them if they want to learn. Further, as noted by Interviewee 21, students started to solve their own problems, instead of asking for help. This of which coincides with the importance of teaching students how to learn for themselves as highlighted in 'Develop student soft skills'.

Tools and Resources

A further aspect mentioned by almost every interviewee in some capacity was regarding tools and resources available for teaching DS courses. One communication tool that was consistently praised was Microsoft Teams, a tool that received a surge in usage due to COVID-19 and the need to teach online. Specific comments regarding Microsoft Teams included; "[teams] makes life so much easier" (Interviewee 17: Lecturer, General FE College), "In terms of best practice at the moment, one of the things I do is we use teams for everything" (Interviewee 29: Lecturer, General FE College), and "[teams] really helped share ideas very, very early on. Like, like a fever, almost, of learning. It was great. So you actually still felt connected" (Interviewee 27: Head of Department, General FE College). As well as the positivity surrounding Microsoft Teams, interviewees discussed more specific pieces of software and resources related to computing, especially those that were free. For example:

> *"So students can get office 365 for free, they can get Blender for free, Unreal Engine for free. So there's loads of really brilliant software, and for them to have a go at that isn't gonna cost them any money." (Interviewee 30: Head of Department, Sixth-Form College)*

Due to the contextual timing of the interviews in the midst of a pandemic that resulted in online learning, it is no surprise to hear comments about free resources that can be used by students when working at home and not in the classroom. Here, the emphasis on free resources is perhaps more important than usual, but with challenges regarding college funding and paying for new equipment and software, these free resources were cited as extremely important. However, free resources are sometimes only available for a certain period of time, such as in a free trial. Therefore, some interviewees discussed how they got students to sign up with different accounts to gain access:

> *"If you're running off free stuff, then you are limited to your what you can do. So for the, for the project, my solution is I have web based project management software. It has a 30 day license, I tell the students to use a college email, then I tell the students to go back and use their personal email that gives them 60 days. 60 days is enough time to cover this course... free stuff on the web exists and it's available and is good. But it doesn't always satisfy everybody's needs." (Interviewee 16: Lecturer, General FE College)*

While this is one way of gaining access to the software, it is not an ideal situation, and certainly not sustainable longer term, i.e. if students wanted to use that software after those allocated 10 weeks. Using freely available resources in this case does not deal with the root issue, but instead masks the issue of funding that exists.

Other Teaching Tips

This sub-theme could be described as a collection of other pedagogical approaches discussed by interviewees that do not 'fit' within the aforementioned sub-themes. That being said, to neglect mentioning them would be to neglect sharing other pedagogical best practice. Some interviewees made reference to the importance of a classroom set-up, with open plan computing labs with a large boardroom table in the centre being cited as preferable, as there can be the danger of "lecturing the back of people's heads" (Interviewee 20: Lecturer, General FE College). On this line of thought, the importance of pulling students away from the computer in a classroom setting is important to explain concepts and theory, and a centre boardroom style table can help minimise distractions that a computer can provide.

With regards to teaching online, one lecturer demonstrated his approach of using a stylus to be able to annotate the software shown on their screen and draw equations. They stated that:

> *"Delivering computing from just a PowerPoint, it doesn't make sense. You need to actually demonstrate to students how it works and how to design build, how to implement stuff." (Interviewee 7: Lecturer, General FE College)*

Finally, there were mentions of what worked best when teaching programming. One practice was getting students to debug others code as much as possible so that students learnt how to identify errors and see other versions of writing a program so they could learn more effective means of writing code in the first place.

8.7 Differing Perspectives

This section discusses how college stakeholders differed in what they discussed during the interview process, even though they were asked the same questions. This directly relates to research question 4, which is "How do college stakeholders differ regarding their perceptions on the challenges that influence the teaching of 'digital skills', and the practices used to overcome those challenges?". To guide the answering of this research question, objective 3 was proposed: "To carry out an analysis of how internal college stakeholders differ regarding their perceptions on the challenges that influence the teaching of digital skills and the practices employed to overcome them".

This analysis took place when the coding process was complete, and all themes were created. It required the use of NVivo queries which compared transcript metadata and the coded references. All interviewee transcripts had associated metadata attached to them which was created when adding interview transcripts to NVivo. This included interviewee information such as job type, and the type of college interviewees worked for. Once the coding process was fully complete, NVivo was used to run two sets of matrix queries, a feature of this CAQDAS. The first set of queries were to compare all coded elements via interviewee job type in terms of how many cases were coded. In other words, whether that code came up at all from that interviewee. The second query also compared codes against interviewee job type, but in terms of how many coded references there were in total. This reveals the total amount of coded references in total, but it should be noted how the coding process is subjective based on the researcher's interpretation, and that whether a code shows up in a case is more appropriate for drawing conclusions. This is because if measured by coded references, there is the potential for what could be 10 coded references for 10 interviewees, but only one interviewee could have referenced that code 10 times, while the others not at all. Therefore, both matrix queries were run with the results presented adjacent to each other so more effective comparisons can be drawn, as shown in Appendix F. Furthermore, this analysis revealed that in total, there were 1467 coded references in phase 5 of the coding process.

This analysis process was important to conduct since it could augment the findings outlined in the aforementioned themes by showcasing how stakeholders differed on their views, if at all. It has already been discussed how different stakeholders within an organisation may experience a different workplace reality (Saunders, Lewis, and Thornhill, 2019), and because of this, they could have different perspectives on the same topic due to their role and experience. This analysis allowed the opportunity to reveal any areas of disagreement from individual stakeholder types, but also consensus codes. Depending on the code, these findings can reveal important implications for DS teaching, and potential areas for future research. Differences and consensus in perspectives from the three stakeholder types will be described theme by theme.

8.7.1 Tales as Old as Time

For 'Tales as old as time', each stakeholder type referred to the issues of a lack of experienced staff, with the highest proportion mentioning this being head of departments. Funding concerns were also discussed by at least four interviewees of each stakeholder type, but for the theme 'We don't need no (secondary) education', only one senior leader referenced issues with secondary school teaching, as opposed to five of both head of departments and lecturers. This is not too much of a surprise given senior leaders are the most distant from the student body.

8.7.2 A Whole New World

At least half of all three types of stakeholders interviewed made some reference to how the evolution of technology has led or leads to issues such as curriculum lag and outdated practices, with a higher proportion of senior leaders citing the issue. Similarly, a small proportion of each stakeholder cited how COVID-19 has caused some sort of changing in teaching practices, but there were some differences in opinion regarding the benefits that have developed because of the pandemic. Half of senior leaders and head of departments discussed how there have been some benefits to teaching online, but only three out of 14 lecturers viewed there as being any sort of benefit in this.

Regarding T-Levels, only a small proportion of senior leaders and head of departments perceived any benefits in T-Levels, with a particular emphasis on developing employable students. There were general concerns from each stakeholder type regarding the qualification, with a higher proportion of senior leaders and head of departments discussing the problem of availability of work placements. Overall, not many interviewees discussed T-levels in much detail, but only 10 out of the 32 interviewees were working at institutions which were providers of the digital T-Level during the academic year of the interviews, so this is perhaps not surprising. Besides, T-levels were not the focus of the interviews. Nevertheless, due to their recent implementation, future research could investigate T-Levels more explicitly, and build on some of the preliminary findings revealed during these interviews.

8.7.3 Choice of Curriculum

For the choice of curriculum, the theme of curriculum choice contained a broad range of perspectives which explained how curriculum decisions were made. All stakeholders explained how the process worked in their organisation as this was a direct question asked in the interview process. However, it was not one that was very perspectival of challenges or best practice, as it was more factual, based on their college decision making process. However, there were some differences regarding the importance placed on different aspects of curriculum decision making. A higher proportion of senior leaders and head of departments discussed the importance of industry relevant qualifications than lecturers. This could be due to a more strategic view of their organisation compared to the 'on the ground' perspective of lecturers. Only a small proportion of senior leaders discussed their perceptions of BTEC qualifications, compared to head of departments and lecturers. These stakeholders largely discussed how the BTEC was out of date, had a poor specification, or there were problems with the assessment and/or exam board.

8.7.4 Environmental Strain

For 'Environmental Strain', this was an overarching theme where there was little consensus between stakeholders. It was only in regard to how 'funding is required for high quality resources' where there was a similar proportion of each stakeholder type. The different aspects of 'competing workplace demands' such as broad curriculum offer and less GLH, planning and marking, keeping skills up to date, and paperwork were predominantly only cited by lecturers. However, the issue of 'conflicts with IT teams and policies, and 'inadequate college network' was equally cited by around 50% of the head of departments and lecturers interviewed but only one senior leader. This is unsurprising given that the college network and policies are likely perfectly suitable for most college courses which senior leaders oversee. It is only in the case of DS related courses where this seems to be more of a pressing concern, so it makes sense for computing lecturers and head of computing departments to cite these issues. Furthermore, it is also not surprising how student related issues such as student background and student motivation was cited by a higher proportion of lecturers compared to other stakeholders due to being closer to the student cohort in their job role.

8.7.5 It's a Hard-Knock Life

Predictably, based on the stakeholders who cited issues of 'competing workplace demands', it was mainly lecturers (6), and some head of departments (3) who gave the impression they were suffering from the difficulty of maintaining an effective work-life balance. No senior leaders mentioned this at all. Likewise, the theme of 'mental wellbeing' had similar results, albeit with two more senior leaders and head of departments giving the impression of this issue.

8.7.6 Critical Success Factors

All but one of the senior leaders gave a perspective which led to the creation of the code 'Collaborative Digital Culture' as a factor for success. Comparatively, half of head of departments and just one lecturer referred to the same factor. It is likely that due to the strategic position of senior leaders who often influence and dictate college culture, they would be the ones citing its importance. However, this is clearly not reflected by those lower down in the organisational hierarchy with other factors taking precedence. A greater proportion of lecturers and head of departments emphasised the importance of having knowledgeable staff, with the importance of passion being proportionally even across all stakeholder types. Similarly, each stakeholder discussed pedagogy, and while some discussed different pedagogical approach's more than others, the spread was relatively even apart from 'putting the emphasis on students', which was predominantly mentioned by lecturers.

Regarding professional development, the cited areas of content and teacher engagement characteristics were equally mentioned by each stakeholder type, albeit in equally low numbers. However, only some senior leaders discussed how it is difficult to gauge the effectiveness of CPD, with senior leaders also being the predominant stakeholder to emphasise the importance of leadership support in implementing or allowing CPD programmes and opportunities. Meanwhile, in terms of structure, the importance of industry experience, employer connections, and networking and collaboration was mentioned by each stakeholder type, but it was mainly those closest to the teaching of students that cited the importance of online resources and applications.

Perhaps unsurprisingly, a greater proportion of senior leaders and head of departments discussed the importance and benefits of working together regarding colleges and industry. This was also the case for the relationship between seniors and computing departments, although the numbers of interviewees mentioning this was low overall (10 in total). For the relationship between staff and students, it was only head of departments and lecturers who discussed factors such as 'don't be a teacher', and the importance of honesty and transparency. Some stakeholders of each type emphasised the importance of understanding individual student needs, but it was predominantly senior leaders who mentioned about 'working in partnership' with students.

Overall, the biggest differences in perspectives appear to be between senior leadership teams and lecturers, with head of departments sometimes having the same perspective as one or another. This again should not come as a surprise given how the role of a head of department is situated in the middle of the organisational hierarchy. Furthermore, while this analysis of codes and themes gives some indication as to how college stakeholders differ regarding their perceptions on the challenges that influence the teaching of DS, and the practices used to overcome them, it is recommended that future research takes a more comprehensive approach now initial findings have been outlined by each stakeholder type. A Q-Methodology study for instance, which allows researchers to understand the complex viewpoints of stakeholders (Zabala, Sandbrook, and Mukherjee, 2018), through augmenting existing qualitative techniques such as interviews, (Shemmings, 2006) could take the findings from this study and re-contextualise them in a Q-Methodology Q-Sort. By doing this, it would be possible to group stakeholder perceptions by their belief systems or value positions, irrespective of surface characteristics such as gender, ethnicity, education or job role (Ramlo, 2012). Hence, allowing for the creation of 'personas' of those that work in colleges and their views on DS education. This is a potential area for future research.

8.8 Chapter Summary

Overall, this chapter has outlined the six overarching themes created during the analysis of interview data, and while subjective due to researcher interpretation, they provide the basis for further analysis and discussion. Hence, now that the main findings of the study have been presented, the following three chapters will discuss the interview data and themes in greater detail. This will be completed by considering them in relation to answering the first three research questions of the thesis respectively, and also in relation to existing academic literature.

Chapter 9

Choice of Curriculum

9.1 Chapter Context

This chapter discusses college curriculum choice and directly relates to research question 1 which is "How do colleges decide what 'digital skills' qualifications and units of study to teach their post-16 level 3 students?". To help guide answering this research question, research objective 1 was proposed which was "To investigate the decision-making processes that inform which digital skills qualifications and units of study are taught within colleges at level 3".

All interviewees were explicitly asked three main things regarding curriculum. First, how much influence they have on which qualifications and units of study are taught within their college. Second, to explain the process of how these curriculum decisions are made, whether that is by themselves, their team or other college stakeholders, and finally, why they offer the courses that they currently offer. These questions were important to ask based on the contextual information previously identified in the literature review. Colleges offer a wide variety of qualifications and have been identified as being pivotal in addressing the DS gap (House of Lords, 2015), but the array of level 3 qualifications and units of study available to choose from is vast with Davenport *et al.* (2019) contending that there is a lack of coherency in addressing the DS crisis. By gaining an understanding of how colleges choose their DS curricula, this can provide insights into the priorities when making curriculum decisions.

Each interview led down a very different path based on each interviewee's different experiences and situation regarding curriculum choice, with some being heavily involved in the process, and others not so much. This disparity was likely due to the combination of interviewing stakeholders from different colleges but also from different hierarchical levels. This disparity was important since educational institutions like colleges are complex and are comprised of many different systems (see figure 2.5) with each system influencing the layers adjacent to them (Biggs, 1993). To visualise the variation that exists between colleges, a cross-case analysis between colleges was conducted using information from a variety of sources. This cross-case analysis serves as a key contribution to knowledge in understanding curricula choice for colleges, and has been compiled into a tabular form as presented in Figure 9.1[1]. This included:

- The different types of qualifications offered by each of the 13 colleges in the academic year 2020/2021 (obtained from college websites and confirmed during the interview process).
- College information from both Ofsted (Department for Education, 2021b) and the Education and Skills Funding Agency (2021).
- Who makes curriculum decisions within colleges (obtained via analysis of interview data), consisting of both the overall curriculum and individual units of study.
- The factors which influence curriculum choice (obtained via analysis of interview data).
- Quotes from interviewees of each college relating to curriculum.

[1] *Where Ofsted Ratings are: 1-Outstanding, 2-Good, 3-Requires Improvement, 4-Inadequate, and **Student destinations are defined as students that left 16 to 18 study at this college in 2017, who either stayed in education or went into employment from October to March the following year, or stayed in an apprenticeship for at least 6 months.

	College ID	1	2	3	4	5	6	7	8	9	10	11	12	13	
College Information	College Type	FE	SFC	FE	FE	FE	FE	SFC	FE	SFC	FE	FE	FE	FE	
	Latest Ofsted Rating*	2	2	2	3	3	2	1	2	2	1	1	2	2	
	Student destinations (whole college)**	79%	88%	75%	74%	79%	80%	87%	81%	89%	81%	73%	78%	79%	
	Total 16-18 learners	>3000	>2000	>3000	>3000	>5000	>2500	>1500	>3500	>1500	>4500	>3500	>3000	>1000	
	FTE Teaching staff	>600	>100	>250	>350	>200	>250	<100	>250	<100	>350	>500	>300	>100	
	Average FTE Learners per Computer	7	4	3	4	8	3	2	4	2	3	7	3	8	
	Dependency on 16-19 income	37%	81%	43%	35%	48%	44%	71%	52%	94%	61%	29%	49%	44%	
	Dependency on HE income	8%	4%	12%	13%	16%	9%	0%	8%	0%	10%	10%	5%	7%	
Level 3 Courses Offered	Cambridge Technical IT									x					1
	BTEC IT		x		x		x	x	x		x		x	x	8
	BTEC Computing	x		x		x					x	x		x	6
	BTEC Games Development	x													1
	UAL Diploma in CMPT	x		x	x				x		x	x	x	x	8
	A-Level Computer Science	x	x			x	x	x	x	x	x	x	x	x	11
	T-Level - Digital	x	x								x	x			4
	Access to HE Computing			x			x				x			x	4
	Access to HE Games Development			x							x				2
	Data Technician	x												x	2
	Cyber Security Technician	x													1
	Infrastructure Technician	x		x		x	x		x		x	x	x		8
	Digital Support Technician		x		x									x	3
	IT Solutions Technician		x				x								2
	Software Development Technician		x			x						x		x	4
Overall Curriculum Decision	SLT		x							x	x				3
	SLT (but HoD can make suggestions)					x	x								2
	SLT and HoD	x										x			2
	Computing Department			x				x	x					x	4
	Computing Department (SLT signs off)				x								x		2
Units of Study Decision	SLT (but HoD can make suggestions)						x								1
	SLT and HoD	x										x			2
	Computing Department		x	x	x	x		x	x	x	x		x	x	10
Factors affecting curriculum choice	Labour market information	x		x	x		x				x	x			6
	Industry relevance	x	x	x	x		x		x	x	x	x	x	x	11
	Skillset of teaching staff	x	x	x		x		x	x		x	x	x	x	10
	Familiarity		x			x		x		x				x	5
	Variation/suitable for students	x	x						x					x	4
	Performance (student outputs)					x							x		2
	Curriculum funding available	x	x									x			3
	Student recruitment (demand)				x			x			x		x		4
	Aligned to college strategy						x		x						2
	Resources available			x			x		x	x					4
	Quotes from interviewees	SLT - "we've made it very, very important that we align our curriculum to what industry needs." Lecturer - " The college wants to be seen that they're running, that they can run everything."...	Lecturer - "I certainly wasn't consulted on whether we would be teaching the BTEC IT" SLT – "As each new T-level comes out, we are switching off the equivalent BTEC."	Lecturer - "if market demand is for web dev, and we have no one that can deliver the web dev, right? So hey there we can teach ourselves, okay, if we have a time and then we say 'Yes, okay, we can do the units' or we'll need to swap to different ones."	SLT - "[curriculum managers] have direct access to the labour market data and the employers to inform their curriculum at that level. But it then goes through a process of being moderated by their manager, and then the leadership team."	Lecturer – "if you've been teaching a unit that may be outdated or may not have a great deal of relevance to industry, you carry on teaching it because you're comfortable with it, and you know that you can get the outputs for it"	SLT – "Is there a market for this? What do potential customers say? Do employers want this qualification? What's the labour market look like?'" HoD – "it's quite tough to sort of bootstrap the whole concept when when there's no industry demand [locally]"	Lecturer - "because I'm familiar with the A-level computer science, I like to stick with what I'm familiar with". SLT - "it's actually driven by demand from an individual perspective of what a 15-16 year old or maybe an adult student really wants to do"	SLT - "curriculum team decide, and they obviously, try very hard to, to remain in line with, you know, the requirements of industry" HoD – "courses that we run was a departmental choice. So it wasn't solely made by one person, we all sat in a room as a team."	HoD - "One thing we haven't really ever done is review our IT revision. So I think you could put it down for lack of management, engagement"	Lecturer - "We do play it safe at times, just because of the amount of students we have to teach"	SLT - "Unit selection is based on careers, not courses. We choose units based on employability and skills" HoD – "as part of early adoption to the T levels, our first year through that also allowed us to sort of investing, specific capital"	HoD – "it's all about facts and figures now and meeting benchmarks and standardization. And it's less about what happens in the classroom."	Lecturer – "we sort of sat down together and knocked out what units would be best" Lecturer - "I just thought that the [BTEC] IT was a better fit with with the level two that we were teaching at the time and the kind of students that we get, and also what's needed locally, really."	

Figure 9.1: College Curriculum Choice Cross Case Analysis

9.2 What was Found

All but one college offered a BTEC in IT or Computing, with the exception offering the Cambridge Technical in IT. This college had their curriculum decided by senior leadership, yet interviewees in the computing department explained how there is a lack of management engagement with what they taught largely being based on resources and familiarity.

Eight of the 13 colleges offered the UAL Creative Media Production and Technology, which was typically used for courses related to games design / games programming and related courses. All but two colleges offered an A-Level Computer Science, and interestingly, these two colleges make curriculum decisions within the computing department (i.e., HoD and lecturers), where decisions are largely based on labour market information and industry relevance.

Four of the colleges offered the T-Level in Digital Production, Design and Development which focuses on software development. Only interviewees from colleges which offered the T-Level (3 out of 4) explained that one of the reasons influencing curriculum choice is the curriculum funding available. This is perhaps an unsurprising finding given that government funding is available for those that offer T-Levels.

Just three colleges offered an Access to HE course in computing, all of which were general FE colleges, where labour market information and industry relevance plays an important role in their curriculum decisions. Furthermore, there were six different types of level 3 apprenticeship on offer from the 13 colleges, the most common being the infrastructure technician apprenticeship offered by eight colleges. Only two colleges did not offer any type of apprenticeship where both were sixth-form colleges, who only offered two qualifications related to DS each.

Interviews with college stakeholders revealed that the choice of curriculum for DS qualifications, and the specific units of study within them is decided by different individuals within each college. In some colleges, curriculum decisions were made by senior leadership alone (n=3), in others by senior leadership but computing departments could make suggestions (n=2), and in a couple of cases the decision was made where both senior leadership and heads of departments played a deciding role (n=2). In other cases, the head of the computing department would make the decision and they may or may not include a consultation with the members of their team (n=6), where in some cases, curriculum choice would still need to be signed off by senior leadership (n=2).

Individual units of study tended to be decided by the lecturing team (n=10) but often in consultation with their head of department. However, it is important to note that in some cases, and particularly for the sixth-form colleges, a college computing department can be very small, with the smallest case having as little as two members of staff. In these cases, the head of department is very closely linked to the teaching team, often having many hours of teaching themselves. Whereas for larger colleges, or colleges with larger computing departments, the head of department may also be the head of department for other areas such as Business, or Engineering, and so they tended to be less involved with decisions around individual units of study.

There were several factors that influenced curriculum choice, and while there were three overall themes regarding curriculum choice that were explicitly identified in the previous chapter, to provide a more thorough overview of what curriculum decisions were based upon, Figure 9.1 divided the factors into ten main areas. Here, an 'x' was placed against that factor for a college if one of the interviewees of that college mentioned it during the interview process.

One of the key influencing factors for many providers were the two related factors of using labour market information (LMI), a factor for six colleges, and a qualifications relevance to industry needs, a factor important for 11 colleges. For both of these factors the key point was in offering qualifications that were based on demand, but also how appropriate the qualification was in terms of offering industry experience, having an up to date specification or whether the assessments were appropriate. Consequently, some colleges are focusing more on new qualifications such as the digital T-level or apprenticeships as these are more aligned to industry needs in comparison to A-Levels or BTEC qualifications (due to the workplace components). The interview findings and analysis suggest that those colleges who base curriculum decisions with a higher emphasis on industry relevance are more culturally proactive in the digital arena, often with senior leaders who are pro-digital and clearly understand the benefits that industry experience provides and the importance of using LMI to inform what is relevant to industry.

There are other factors that influence curriculum choice, with a major one being the colleges' staff skill set which was an important factor for 10 colleges. A similar factor is the availability of resources. Resources in this manner refer to a combination of funding, network infrastructure, and the equipment available for teaching, since these are important resources required for offering curricula with a high resource requirement. Other factors seem to be based on offering a broad curriculum to cater for the variety of learners that study at colleges. For instance, A-Levels and T-Levels were perceived by some interviewees to be more difficult qualifications and so not offering a course such as a BTEC was seen as not catering to all learners' needs. Overall, there are a variety of factors that influence how colleges decide what DS qualifications and units of study to teach their post-16 level 3 students, and these initial 10 factors have been grouped based on their similar characteristics into four main areas, as depicted in Figure 9.2, which shows the four pillars of curriculum choice.

These four mains areas (pillars) consist of labour market information, relevance of qualification to industry needs, qualification attractiveness, and current college resources. The model shows how the decision makers (which varies from college to college of which stakeholders this is), must choose from a pool of level 3 qualifications on offer. This pool of qualifications is considered against each of the four pillars, where the consideration given to each pillar varies from college to college. Some pillars are related, for instance LMI can inform how relevant a qualification is to industry needs. Meanwhile, the relevance of a qualification to industry needs may be something which influences how attractive the qualification appears to be. Similarly, current college resources can influence how attractive a qualification may seem. Nevertheless, regardless of the relationships between the pillars, consideration of these four pillars is what can help inform colleges on which curricula to offer, and serves as a key contribution to practice, since institutions can use this model to help inform their decision-making process and ensure it is inclusive of some key factors.

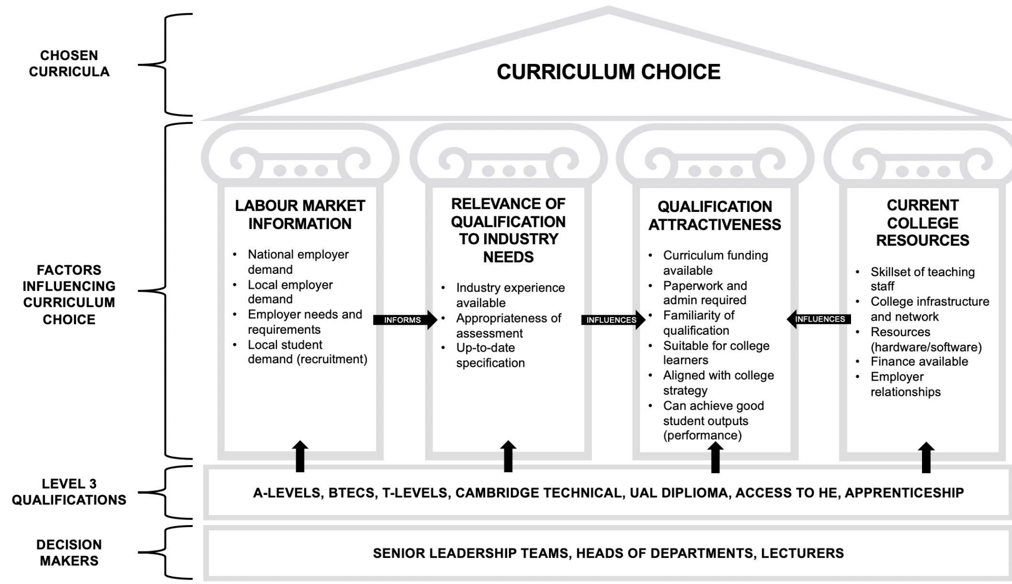

Figure 9.2: Four Pillars of Curriculum Choice

All curriculum decisions appear to be influenced by these four pillars, but it is the extent of how much emphasis a college places on each pillar which can influence their decisions regarding curriculum. For instance, one college placed a very high emphasis on LMI, and used this information to effectively identify what qualifications were most relevant to industry needs. Hence, one decision they made was to offer the digital T-Level and while they did not initially have the resources to offer this qualification, they used the T-Level funding that was available to help overcome this. For them, this qualification was very attractive from a strategic point of view, and the benefits they could obtain (i.e., curriculum funding). However, the priority pillar was LMI.

Alternatively, one sixth form college made their curriculum decisions based solely on what their current college resources were such as the skill-set of their teaching staff, and employer relationships. For this college the decision of curriculum was predominantly made by the computing department and what made a qualification attractive was their familiarity with it and not having to change too much. As a result, they continue to offer BTEC qualifications and at the time of interview, did not wish to change their offer to include any other qualifications, even though one lecturer acknowledged how what they are teaching is not necessarily relevant to industry, and so not very useful for their students. Here, this college's priority pillar was current college resources.

A colleges' culture, location (rural vs urban - especially for qualifications with a workplace component), and history (e.g. their traditional curriculum diet) may influence these pillars, and while Figure 9.2 could be argued as being a simplistic model of representing what are complex organisational decisions, it provides a model of understanding that identifies and separates key influencing factors of curriculum choice. It can also be seen from this figure, that the left two pillars are focused on factors external to a college, while the right two pillars are more geared towards factors internal to a college, whether that be perceptions regarding a qualifications attractiveness or more explicitly, the college itself. A factor not included in this model is routes to HE. It was surprising that this factor did not appear to be a driver of curriculum choice, with a greater focus being placed on industry relevance and employability generally, as opposed to preparing students explicitly for HE.

9.3 Relation to Literature

While there is limited research available regarding how colleges choose what DS curriculum to offer, there is research which indicates the need for computing and DS curricula generally in the education sector, and what those curricula should strive to achieve. While many of these aspects are individualistic, some of them can be mapped onto the Four Pillars model (Figure 9.2). A key piece of research that contains some of these aspects is by Passey (2017), whose article "Computer science (CS) in the compulsory education curriculum: Implications for future research" outlines six main arguments for a computer science curriculum, and while argued in the context of schools, some of the arguments are very relevant to colleges and how they could link to curriculum decisions.

The first argument presented is the 'economic argument', which is that education should be supporting learners to engage in a curriculum that will support a future economy, where they can meet the needs and skill requirements of current and future jobs (Passey, 2017). This argument is closely linked to the second pillar of the Four Pillars model (Figure 9.2) of choosing a curriculum based on whether the qualification is relevant to industry needs. This was the most commonly referenced factor by colleges of what is important in determining curriculum choice. Here, factors such as having an up to date specification, combined with industry experience and appropriate assessments are often deemed most relevant to industry needs. This is congruent with existing literature on the subject; employers are increasingly valuing students that have work experience (Shury *et al.*, 2017), in addition to having both technical and non-technical skills (Aničić, Divjak, and Arbanas, 2017) relevant to the workplace.

The government and key reviews have stated how FE should be providing learners with the opportunities and tools that are needed to progress into skilled employment (Augar *et al.*, 2019; HM Treasury, 2020), and ultimately these opportunities stem from having appropriate qualifications, which are relevant to industry needs. Hence, having up to date curricula, with varied assessments that replicate the 'real-world' alongside work experience were seen by interviewees as being more valuable qualifications. It was not a surprise to hear many interviewees discussing the new qualification of T-Levels that initially seems to meet many of those requirements, in addition to the general theme of 'Industry relevance' that was presented in the previous chapter. However, even T-Levels have their downfalls, and it can be argued that other than the industry placement, the T-Level does not appear to address occupational competencies such as teamwork, communication skills, and leadership, while the two written exams of the digital T-Level are not relevant and applicable to industry, as they do not go into any substantial depth or include any practical element (Association of Colleges, 2018c). Curricula is evolving over time, and while the T-Level may not be 100% relevant to industry needs, it may be closer to achieving this when compared to other level 3 DS qualifications, and for some colleges, this relevance to industry needs may be the most important pillar of curriculum choice.

Passey (2017) goes on to explain how in regard to the 'economic argument', to actually understand whether a qualification is relevant to industry needs, this implies that teachers must require an understanding of what is required in industry and how technology is changing the world of work. While this demonstrates the importance of teachers being a 'dual professional' as depicted in Figure 4.1, where they should be aware of policy and local context, it is logical to assume that in order to have this knowledge, they must gain it from somewhere. It is here where the first pillar of labour market information can be important for teachers and other college stakeholders in making curriculum decisions and understanding what qualifications are relevant to industry needs.

Whether to consider LMI from a national or local perspective is one of interesting debate. Colleges could take a view from a national perspective which is perhaps more forward looking to wider changes and trends, but ultimately each individual college will be operating in a specific local area, and so the local LMI may be more important. One interviewee explained how nationally there is demand for software engineers, but in their local area, there are limited workplace providers in this area, and so very few opportunities for students to either take part in work experience during their studies, or for them to progress into that as a career locally once they leave college. Hence, there is a decision for those choosing curricula based on the multiple insights that can be gleamed from LMI alone. Without considering LMI, and not looking to what may be required in the future, this can lead to 'Curriculum Lag' where curricula are lagging behind technology as identified both by interviewees and in existing reports (House of Lords, 2015; ECORYS UK, 2016). It is also here, where the next argument is brought in which is the educational argument, that is based on the premise that computing and technology will continue to develop, where it is not possible to see any endpoint in these developments. Therefore, education should include computer science and DS curricula that are aware, understand, and support these future societal needs (Passey, 2017). Implicitly, there are future needs that do not currently exist and so the educational argument is also concerned with lifelong learning and building the capacity to do so within students.

An ability to learn and adapt to change is what employers are looking for; the Shadbolt Review (2016) found that employers are looking for graduates who can learn, recognise and select a relevant programming language for a specific task, not that they have the knowledge of a specific programming language. While this implies the need for students to be taught how to learn and adapt to change, a characteristic which has historically been a shortfall of traditional education (Scepanović, 2019), a key question must be put forward for debate. If success in the arena of DS and ever-changing technology is predicated on an ability to engage in lifelong learning and being able to adapt to change and learn new things, then surely individual curriculum specifications do not matter that much in the grand scheme of a student's education. On the contrary, what matters most is pedagogy and what is actually happening in the classroom, and the influencing factors that affect this teaching and learning environment, as shown in Biggs (1993) 3P Model (Figure 2.4). Besides, as previously discussed, and highlighted by notable reports such as the Wolf Report (2011), what is on a qualification specification is just a small component in what is actually taught to students. Hence, it must be recognised that there is a difference between what is an intended curriculum, which can be defined by a given scheme or relevant standards, and the actual enacted or implemented curriculum that is experienced by students (Falkner *et al.*, 2019). Therefore, curricula can be argued as being simply guides to education, but education is not the curriculum. As a result, LMI is not, and should not be the only influencing pillar regarding curriculum choice.

Moving forward with the educational argument, if education is more than just the curriculum, then it reiterates why some interviewees and colleges place such as heavy importance on the third and fourth pillars of curriculum choice, (i.e., qualification attractiveness and current college resources), since these areas are internal to a college, the predominant place where students learn. This is especially the case for those aspects that have such a close link with students such as the teachers who teach them. When considering existing literature regarding teaching DS within colleges, it is even clearer why curriculum choice may be dictated by these factors. Not only has FE been dominated by continuous change (Norris and Adam, 2017), and a lack of investment (Department for Education, 2021d), but there is still a lack of appropriately qualified staff for teaching DS related courses which impedes any sort of change or curriculum innovation (Brown *et al.*, 2014; Webb *et al.*, 2017). This combination of external factors, all influence how a college can operate, and regardless of any considerations of LMI and what qualifications may be relevant to industry needs, there are some qualifications which colleges may find almost impossible to offer effectively, so curriculum decisions are made based on pillars three and four.

A prime example of the issues that can exist are with the new T-Level; they require a large workplace component but there may simply not be the employers in a colleges vicinity to offer this opportunity. Further to this, T-Levels have higher guided learning hours (GLH) than other level 3 qualifications and so this could result in issues regarding timetabling (Straw and Sims, 2019), especially with those with smaller computing departments. Finally, the awarding body of the digital T-Level, Pearson, explains how the lecturers delivering the qualification should have the skills and knowledge of three programming languages (Pearson Education Limited, 2020b), and for a college lacking this breadth of skill-set, they may be put off from offering this qualification. Interviewee findings showed that for some colleges, this was definitely the case, with 10 colleges citing staff skill set as an important factor which influences their curriculum choice, even though many acknowledged the benefits T-levels can provide.

9.4 Contributions and Implications

Initially it was surprising to see how each college had such a different structure and process regarding curriculum decisions, both in terms of who had influence on the decision, and also how the decision was made. However, on reflection, when considering how each college is so different in terms of structure, size, location, type and the demographic of those who work at colleges, it is logical to assume there would be some differentiation. The culmination of findings led to the creation of a cross case analysis of college curriculum choice (Figure 9.1), and using this table as part of the analysis led to the creation of the Four Pillars of Curriculum Choice model (Figure 9.2). While this model may not address every factor that influences curriculum decisions, it does provide some structure in answering the research question of 'How do colleges decide what 'digital skills' qualifications and units of study to teach their post-16 level 3 students?'.

The Four Pillars model, in addition to the general discussion surrounding research question 1 has some important implications for practice. First, advances in technology often necessitate changes in curriculum (Webb *et al.*, 2017), and LMI should be considered. However, it must be recognised that changes in curriculum often require changes in teaching and delivery methods (Aničić, Divjak, and Arbanas, 2017), and making these changes effectively can take many years (Sentance and Waite, 2018; Falkner *et al.*, 2019). Colleges should consider their own current situation and find a balance between offering curricula that are based on LMI and relevant to industry needs, but also that are feasible given their current resources and how much a qualification is aligned to their overall strategy, and overall comfort level in terms of qualification attractiveness. Furthermore, curricula should not define a student's education, but merely guide it. For instance, curricula does not indicate how to address individual student issues (Passey, 2017), as this is a pedagogy issue, and so a balance must be found. This is especially the case as the government is providing little guidance on how to implement curriculum changes, with educational institutions such as colleges being the ones who are playing the leading role (Crick, 2017). With this being the case, colleges should make curriculum decisions carefully and take into consideration a wide variety of factors.

A key contribution to practice is that based on the findings and analysis regarding curriculum choice, it is recommended that colleges use the Four Pillars model as a frame of reference when making curriculum decisions so they can appreciate the bigger picture of what should be considered in this process. Importantly, colleges should not focus on one singular pillar, as this is more likely to lead to a less prosperous teaching and learning environment for teaching DS courses. By considering all pillars, curriculum decisions can be made with the consideration of both internal and external factors to a college, while taking into account future societal needs.

There are also some contributions to research; not only do these findings provide an insight into how decisions regarding DS curricula are made, but they are provided in the context of further education, a typically neglected area of research interest (Augar *et al.*, 2019; Ofsted, 2019a). Additionally, the cross-case analysis of college curriculum choice in Figure 9.1 illustrates the variation that exists between colleges, and provides a fair reflection of level 3 DS curricula offered within colleges in the South West of England since 13 out of the 21 colleges (general FE and SFC) were represented in the sample. By triangulating evidence through interviewing different types of employees within a college (i.e. lecturers, head of departments and members of senior leadership), this allowed for a more comprehensive view of how curriculum decisions are made, and increases the validity of the model provided. This was important given how it was found that the process of curriculum decision differs from one college to the next, with different levels of the hierarchy having different levels of influence. This variation was only understood through speaking with stakeholders from multiple colleges. Furthermore, while the Four Pillars model is presented as a generic model of curriculum choice, caution should be applied if looking to generalise the model to contexts beyond that of DS related courses, or colleges outside of the South West. Curriculum decisions may be made in a similar way regarding other topic areas, but this is something which may require further research. Similarly, the model may or may not be applicable for DS related courses in other types of educational institutions such as schools, but again future research could investigate this. To further validate the model as accurate, future research could involve presenting college stakeholders with the model to decipher whether anything is missing or whether it is truly representative of the factors involved in making curriculum decisions from their perspective.

This research does have some limitations stemming from the nature of utilising a qualitative research approach. The analysis and interpretation of interview data is subjective, and what has been presented (including the Four Pillars model) is the researcher's interpretation. Consequently, what has been presented should not be stated as fact and generalisable to every college. However, what this research does present is the findings from 32 interviewees across 13 colleges in the South West, and this variation should provide confidence in what has been outlined. A greater sample of interviewees for each college may have provided further insight into how curriculum decisions are made, but beyond interviewing more than one person from each layer (lecturer, head of department, and senior leadership), this would likely have resulted in data saturation due to an already varied insight into college processes.

Gaining an insight into how colleges decide what DS qualifications and units of study to teach their level 3 students was just one aspect of this thesis, and spending a greater amount of time with interviewees discussing this area would have neglected the time available for considering the other research questions. Finally, this research took place during COVID-19, and it could be argued that the end of COVID-19 may influence how curriculum decisions are made in the future regarding qualification format and structure. Hence, qualification decisions may be made differently in the future.

9.5 Chapter Summary

Regardless of any curriculum decision that is made, it is the students who should be at the focus with their best interests in consideration. They are the ones who are most impacted by curriculum changes (Sentance and Waite, 2018), as it is their education at stake, and arguably their future too. Making the right curriculum decisions is extremely important, even though any curriculum is not the sole factor that influences a student's education. Moving forward, further curriculum reforms are likely to take place, while new qualifications such as T-Levels, like any new qualification, will take time to be embedded into the educational landscape. These qualifications should be given time, and colleges should be given time and the resources to appropriately integrate these types of new qualifications into their overall curriculum offer. Finally, research into this area should not stop here. When considering DS, change is omnipresent, and so is the need for new qualifications. Therefore, research that identifies how to simplify these complex organisational decisions surrounding curriculum choice, and what is considered best practice should be encouraged.

Chapter 10

Perceived Challenges and College Context

10.1 Chapter Context

While the previous chapter discussed curriculum choice in the context of research question 1, this chapter's attention is on college context and the challenges that exist for teaching DS. More specifically, this chapter focuses on the discussion of answering research question 2, which is "How does a college's specific context relate to the perceived challenges that influence the teaching of 'digital skills' at level 3?". Here, the key words are 'perceived' and 'challenges', and it should be recognised that in the context of this research question, there are important ontological and epistemological underpinnings.

What one individual may view as a challenge, for someone else it may not be a concern, since individuals will construct their own meaning to the same phenomenon in different ways (Crotty, 1998; Gray, 2017), resulting in all challenges being based on the perspective of the individual that 'challenge' relates to. To explicitly say something is a certain challenge for everyone neglects the variety that occurs from differing perspectives, which may be influenced by an individual's role, experience, or socio-economic background. Gaining a greater understanding of context where these challenges reside, and through multiple perspectives, the reality of the situation can be understood more effectively. Therefore, this research question aims to draw upon perceived challenges, to gain a greater understanding of college context, and see how the two are interconnected.

During the interview process, interviewees were first asked about their role and experience to provide some background context around each individual. Later they were questioned on what challenges influence the teaching of DS related qualifications and why from their perspective. In relation to their answers, interviewees were asked why those challenges were particular challenges for them, to ensure that the challenges were framed in their college context. Interviewees were also asked to identify what they viewed as the most significant challenge and why to further give clarity on their responses.

These questions were important to consider as the literature review highlighted how each college will have their own idiosyncrasies, history, agendas, and local context containing their own variation of stakeholders which can all influence DS provision where all provide a valuable contribution (Freeman, 1984). When combining this notion with Biggs (1993) systems model of tertiary education (Figure 2.5), it is clear how an understanding of context and different stakeholder views help generate a clearer picture of the educational challenges being faced. Without understanding why something is having the impact it is having, it is difficult to address the issue at its source, and therefore this understanding is required to make a meaningful contribution to practice (Collis and Hussey, 2014).

To deepen the understanding of what challenges influence DS, a cross-case analysis between colleges was conducted and produced in a tabular form (Figure 10.1 [1]). This included college information from both Ofsted (Department for Education, 2021b) and the Education and Skills Funding Agency (2021), and all the themes which signified challenges that influenced DS teaching. To create this table, a matrix coding query was used in NVivo which contained all interview data and themes. The matrix coding query combined selected themes which represented challenges and sorted them by college. Since themes were hierarchical with some much deeper than others

[1] *Where Ofsted Ratings are: 1-Outstanding, 2-Good, 3-Requires Improvement, 4-Inadequate, and **Student destinations are defined as students that left 16 to 18 study at this college in 2017, who either stayed in education or went into employment from October to March the following year, or stayed in an apprenticeship for at least 6 months.

(i.e., more layers), only the top three levels were considered (i.e., overarching theme, theme, and sub-themes), with anything further counted towards the higher level. This presented a table which counted how many times that theme was mentioned by interviewees of each college.

The purpose of the cross-case analysis was to identify whether a challenge was mentioned for each college, irrespective of how many times it was referenced during the interview process. Hence, the number of references was changed to a binary representation (i.e., whether that challenge was mentioned by at least one of the interviewees from that college or not). The result (Figure 10.1) allows readers to see what challenges were present for different colleges, how they compare, and how representative that challenge is in the region. Therefore, contributing to knowledge through showcasing the challenges being faced by colleges in the South West regarding the teaching of DS. While Figure 10.1 can provide a foundation for future research, and something to inform future hypothesis, it should be noted that Figure 10.1 is quantifying qualitative data and interpretation, so any conclusions drawn from it must be considered very carefully. For instance, just because something was not mentioned by interviewees of a college, this does not mean it is not a challenge which exists for them.

College ID	1	2	3	4	5	6	7	8	9	10	11	12	13	
College Type	FE	SFC	FE	FE	FE	FE	SFC	FE	SFC	FE	FE	FE	FE	
Latest Ofsted Rating*	2	2	2	3	3	2	1	2	2	1	1	2	2	
Student destinations (whole college)**	79%	88%	75%	74%	79%	80%	87%	81%	89%	81%	73%	78%	79%	
Total 16-18 learners	>3000	>2000	>3000	>3000	>5000	>2500	>1500	>3500	>1500	>4500	>3500	>3000	>1000	
FTE Teaching staff	>600	>100	>250	>350	>200	>250	<100	>250	<100	>350	>500	>300	>100	
Average FTE Learners per Computer	7	4	3	4	8	3	2	4	2	3	7	3	8	
Dependency on 16-19 income	37%	81%	43%	35%	48%	44%	71%	52%	94%	61%	29%	49%	44%	
Dependency on HE income	8%	4%	12%	13%	16%	9%	0%	8%	0%	10%	10%	5%	7%	
A Whole New World - > Evolution of Technology	x	x	x	x		x	x		x		x	x	x	10
A Whole New World - > Evolution of Technology -> Curriculum Lag	x	x	x	x	x	x	x	x	x		x		x	11
A Whole New World - > Evolution of Technology -> Outdated Practices	x	x		x	x	x	x	x			x	x	x	10
A Whole New World - > Post-Pandemic Life -> Change in Teaching Practices	x	x	x	x	x	x	x	x	x	x	x	x		12
Environmental Strain -> Competing Workplace Demands -> Broad Curriculum Offer & less GLH	x	x			x	x	x			x		x	x	8
Environmental Strain -> Competing Workplace Demands -> Building employer relationships	x	x		x	x	x								5
Environmental Strain -> Competing Workplace Demands -> Developing new resources	x				x				x				x	4
Environmental Strain -> Competing Workplace Demands -> General reference to lack of time	x	x	x		x		x	x	x	x	x			9
Environmental Strain -> Competing Workplace Demands -> Keeping skills up to date	x	x	x		x					x		x	x	7
Environmental Strain -> Competing Workplace Demands -> Management responsibilities	x				x	x								3
Environmental Strain -> Competing Workplace Demands -> Paperwork	x	x	x		x		x	x	x			x		8
Environmental Strain -> Competing Workplace Demands -> Pastoral Care				x	x			x	x			x		5
Environmental Strain -> Competing Workplace Demands -> Planning and Marking	x	x			x		x	x	x			x		7
Environmental Strain -> Competing Workplace Demands -> Results driven					x	x								2
Environmental Strain -> Competing Workplace Demands -> Teaching	x				x		x		x	x	x	x		7
Environmental Strain -> The Bare Necessities -> Conflicts with IT Teams and Policies	x		x	x	x		x	x		x	x	x		9
Environmental Strain -> The Bare Necessities -> Funding required for high quality resources	x		x	x	x	x	x	x			x			8
Environmental Strain -> The Bare Necessities -> General comments that resources are needed	x		x		x	x	x	x	x		x	x	x	10
Environmental Strain -> The Bare Necessities -> Inadequate college network (inc PCs)	x	x		x	x		x	x	x	x	x			9
Environmental Strain -> The Kids Aren't Alright -> Student Background	x	x		x	x	x	x	x	x			x	x	10
Environmental Strain -> The Kids Aren't Alright -> Student Motivation	x	x	x	x	x	x	x	x	x			x		10
It's a Hard-Knock Life -> Difficulty of Work-Life Balance	x	x	x		x				x	x		x	x	8
It's a Hard-Knock Life -> Mental Wellbeing	x	x			x	x		x	x	x		x		8
Tales as Old as Time -> Lack of Experienced Staff	x	x			x	x	x	x	x	x	x	x	x	11
Tales as Old as Time -> Lack of Experienced Staff -> Earn More in Industry	x	x		x				x		x	x			6
Tales as Old as Time -> Please Sir, I Want Some More (Money)	x			x	x	x	x	x						6
Tales as Old as Time -> We Don't Need no (Secondary) Education	x			x	x	x	x		x	x				7
Total challenges mentioned (i.e. total "x")	25	17	11	14	25	16	18	17	17	12	12	16	10	

Figure 10.1: College Challenge Themes Cross Case Analysis

10.2 What was Found

Figure 10.1 provides some interesting findings. Only one college had interviewees which did not mention how the 'Evolution of technology' causes any challenges. This college had the second largest amount of 16-18 learners and was one of just three colleges rated outstanding by Ofsted. Similarly, only one college had interviewees citing a change of teaching practices stemming from the COVID-19 pandemic. This college had the smallest number of 16-18 learners of all colleges in the sample, yet they had the equal greatest breadth of level 3 DS provision with eight different qualifications being offered. Unsurprisingly, all colleges' had interviewees who mentioned some challenge of competing workplace demands, with some colleges citing many more competing demands than others. Less common was the issue of 'conflicts with IT teams and policies' which was an issue cited by interviewees from nine out of 13 colleges. This shows the vast issue that exists for DS educators in being able to have the right software or equipment needed for teaching DS. An inadequate college network was also cited by interviewees from nine out of 13 colleges.

Only two colleges did not have any interviewees referring to the issue of 'The Kids Aren't Alright', and both were FE colleges rated outstanding by Ofsted, and interestingly, were two of the four providers in the sample who offered the Digital T-Level. Finally, a 'Lack of experienced staff' was mentioned by interviewees from all but two colleges, where both happened to have the second and third worst student destination statistics. This is interesting as skilled educators is not seemingly a problem for them, but learners are not obtaining good destination outcomes.

Interviews revealed that there is an interesting dichotomy between what can be considered a challenge for DS teaching, and what is simply wider context that itself is a challenge, because it influences and creates further challenges. There are macro-environment factors external to a college, but since a college operates under the context of these macro-environment factors, they are directly influenced by them, albeit in different ways depending on the internal environment of the college. This is best exemplified in the overarching theme 'Tales as old as time', which contains three themes that are wider macro challenges including a general lack of funding in the FE sector, a lack of experienced staff available for teaching DS related courses in the wider sector, and how there are issues with secondary schooling prior to FE. Colleges are susceptible to the influence of these external factors, but each can create further challenges for an individual college. Other macro-environment factors include those identified in the theme of 'A whole new world' which again contained three themes outlining change at an even wider level, especially when considering the impact of COVID-19 and general technological innovation. Both have a significant influence on colleges, and colleges cannot influence these factors.

On the contrary to having no influence on external macro-environmental context, colleges can influence how they can react, pre-empt, or deal with these wider influencing factors. This is perhaps most evident in a college's choice of curriculum. As expected and assumed in Figure 6.1 regarding case study theory, curriculum choice is a contextual factor in itself which can later influence the challenges a college may face. For instance, the challenge of finding suitable employers for the digital T-Level would not exist should a college decide not to offer the digital T-Level in the first place. Regardless of decisions that can be made by colleges, they can still not escape these wider contextual factors. For example, the overarching theme of 'Environmental Strain' contains the theme of 'Competing Workplace Demands' that outlines the struggle of the multiple tasks that come from working in a college. It is here, where the extent to this challenge can be influenced by a wide variety of contextual factors. An individual may be in this situation because there is a lack of staff. Alternatively, they may be in this situation due to the wide variation of qualifications their college is offering, or that they may not currently have the knowledge to teach their subject appropriately, so require more time for upskilling. The same can be said for the theme of 'The bare necessities' which outlines concerns regarding resources. The challenges may be due to a lack of funding, not knowing what is required, offering a new curriculum, or a lack of local employer support. To truly understand the perceived challenges for teaching DS, each college, and each individual would require an even greater analysis on a case-by-case basis further exploring each individual's lived experience which is greater than what can be gained from just one interview per individual. That said, the focus of this thesis is not one individual, but instead on colleges overall. Meanwhile, the research question at focus is concerned with how college context relates to the perceived challenges that influence the teaching of DS. Therefore, it is important to identify and collate what these contextual factors may be, and so this has been completed as shown in Figure 10.2

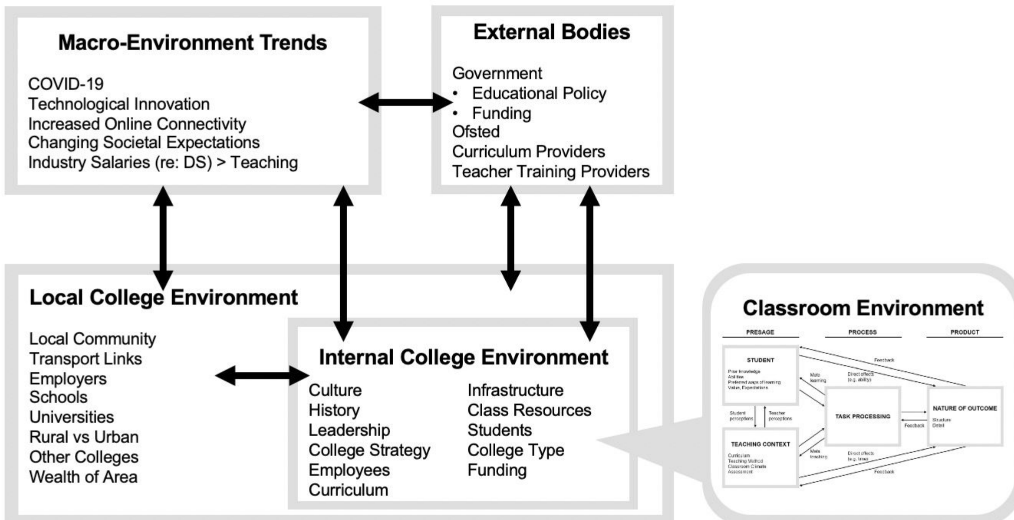

Figure 10.2: Contextual Factors that Influence the Teaching of DS. Source: Adapted from (Biggs, 1993).

In the top left, Figure 10.2 shows Macro-Environment Trends. These are external factors to a college on a very macro level. Colleges have little control of these trends but should take note of how they influence both colleges and society generally. In the top right there are external bodies such as government which creates education policy (including funding), Ofsted which monitors the standard of education practices, and curriculum providers such as Pearson who design the specification of what should be taught on individual qualifications, and how this should be assessed. Colleges are intrinsically linked to these external bodies but largely have to 'do as their told' in following their regulations and guidelines. Another inclusion in this section are teacher training providers, which can represent other colleges or universities. Collectively, these organisations try and help increase the number of individuals entering the teaching profession. The remaining three sections are layered. The largest is that of the local college environment. This consists of contextual factors that are geographically in the same area as an individual college. The combination or variation of the factors within a local college environment can have a severe impact on a college. For instance, a lack of employers, or poor transport links would have a large impact on a colleges ability to offer courses such as apprenticeships or T-levels. Equally if there are no schools in the local area, then there will not be students who want to progress into FE and hence enrolments are likely to be limited.

Next is the internal college environment, which refers to the characteristics of the college itself. Colleges have a much greater influence on these factors, such as setting the college strategy, or deciding on what curriculum to offer. However, the internal college environment is constrained to the limits placed upon it by the local college environment and more widely the external bodies and macro-environment trends. Finally, is the classroom environment, which has been modelled as the same as Biggs (1993) 3P Model (Figure 2.4). The classroom environment is just one part of the internal college environment and so is influenced by all the previously outlined contextual factors, as well as the internal college environment itself. This is important when considering how college context relates to the perceived challenges that influence the teaching of DS, since teaching happens at the bottom layer and can be influenced by a variety of factors.

Overall, what is important is which challenges are more generalist and related to contextual factors external to a college, and which are more internal to a college. Since a college can influence the internal college environment more effectively than the external environment, identifying how different challenges relate to different contexts allows a college to focus on the challenges they can have a direct impact upon, and henceforth try to mitigate or solve. Meanwhile, some of the external challenges are issues that should instead be the focus of government and policy makers to address.

10.3 Relation to Literature

When initially discussing colleges in the literature review of this thesis, one of the first aspects to be discussed was a timeline of events influencing the college sector (Figure 2.3), which outlined the frequent policy changes that have taken place over time. Education policy is a logical place to begin when discussing the context of education and the challenges that may stem as a result, since policy is all-encompassing and would influence every college. The problem that persists is not what one individual policy or governmental organisation seeks to achieve, but the frequency of how often they are changing. For instance, one senior leader discussed this issue in great depth:

> *"If you look back over time, a new government comes to power, whether that of some shape or form, and likes to start from a point where it's all broken, and we're going to fix it. And we're hope, funnily enough, we'll fix it just in time for the next general election... I've been around long enough to have seen in that time period, a whole range of qualifications that have been brought in and suggested launch, including diplomas, GNVQs to name but a few, all really high profile, really expensive and didn't last very long... If you look at the number of changes that they've [Germany] made in that time period, I think they've made two in 25 years, to what they do. And we've made nearly 25, or something ridiculous." (Interviewee 28: Senior Leader, Sixth-Form College)*

These views from interviewees augment existing literature which contend that due to FE receiving less attention than that of HE or schools, government has greater freedom and incentive to try and make changes in this sector (Thompson, 2014; Burnell, 2017; Ingleby and Tummons, 2017; Norris and Adam, 2017; Augar *et al.*, 2019). It is clear that governmental ministers are trying to make their mark, but they inevitably move on in just a few years, as outlined in Figure 2.3 showing the length of service for each secretary of state for Education. There is an overall lack of consistency, so colleges and teaching staff in particular will inevitably have struggles from these changes. Interviewee 28 further stated how due to qualifications being changed in how they are organised every two years or so, "all that kind of does is it just detracts the teacher or head of department whoever it is, from thinking about how they might improve the content delivery, into how they comply with what they need to do for delivering that qualification.". Some interviewees were even more cynical such as Interviewee 19 (Lecturer) who believed that frequent changes in syllabus are simply a money-making exercise as opposed to what would benefit students. The problem with these changes in policy and qualification reforms, is that colleges have historically not been communicated with effectively in how to deal with and implement such changes (Crick, 2017). Therefore, from an internal college environment point of view, it is difficult to ascertain what is appropriate or not, whether that be strategically, or in terms of resources etc.

Some macro-environmental factors such as technological innovation, and salaries in industry being better than teachers regarding computing were highlighted in existing literature and supported by interviewees. However, one aspect heavily discussed by interviewees but not so much in literature (historically) is the impact of COVID-19 on college teaching. Of course, this was a very contemporary issue at the time of the interviews, and due to being such a recent phenomenon, literature surrounding COVID-19 was in short supply. However, that which does exist echoes the view of interviewees. The Association of Colleges (2020d), reported on the impact of COVID-19 and explained that colleges had to incur extra costs such as supporting online teaching. Logically, due to interviewing during a time when teaching was primarily only being conducted online, many interviewees shared the concerns reported by the AOC. One paper in particular focused on the impact on computing teaching though, revealing how many practitioners had concerns about how certain concepts such as programming or group software projects can be taught online (Crick, Knight, Watermeyer, and Goodall, 2020). The interviewee findings support this existing literature, and while this is a teaching and learning issue, it shows how a contextual factor from a macro-environment level ultimately influences the teaching of DS.

With regards to the macro-environment, a PEST analysis was presented in the literature review (Figure 3.1), and this resulted in the identification of six main themes for exploration. Each of these challenges discussed in the literature review can be mapped to some of the themes identified through the analysis of interview data:

1. Lack of knowledge – ‘Lack of experienced staff’
2. Funding issues – ‘Please sir, I want some more, (money)’

3. Insufficient time – ‘Competing workplace demands’ and ‘Difficulty of work-life balance’

4. Curriculum concerns – ‘Evolution of technology’ and some aspects under ‘Choice of curriculum’

5. Inadequate resources – ‘The bare necessities’

6. Other teaching difficulties – ‘We don’t need no (secondary) education’, and ‘The kids aren’t alright’

Many of the challenges identified in the literature review were also identified through the interview process. However, while much of what was presented in the literature review was perhaps more generalist, and often also applicable to, or based upon research in a school environment, this research contributes to existing knowledge and research by demonstrating how the same challenges are also applicable in a college setting. Therefore, supporting much of what was presented in Figure 3.5, which showed the interconnection between challenges that ultimately lead to DS gaps. As identified previously, some challenges are unique to DS teaching while others are more applicable to any subject taught within a college such as a lack of funding. Caution should be applied when considering how these general contextual challenges may have more or less of an impact in some subjects than others.

10.3.1 Revisiting Biggs 3P Model

To consider some of the contextual factors that are more directly linked to the teaching and learning environment of DS, Biggs’ (1993) 3P Model will be revisited. By assessing the relation between interviewee comments, and existing literature, the model can be framed in the context of DS education within colleges more appropriately.

3P Model - Presage Factor - Student

This aspect of the 3P Model considers a student’s prior knowledge, abilities, preferred ways of learning, values, and expectations (Biggs, 1993). There are some key factors pertinent to computing education that were identified by interviewees and in literature, with the themes of ‘We don’t need no (secondary) education' and 'The kids aren't alright', being the most relevant. As identified in existing literature, colleges have learners with a multitude of different backgrounds and characteristics, and this diverse nature of students can cause some pedagogical challenges (Garneli, Giannakos, and Chorianopoulos, 2015; Greatbatch and Tate, 2018; Lucas, Spencer, and Claxton, 2012; Webb *et al.*, 2017). This literature is supported by interview data. Some interviewees identified issues with a student's motivation from having to be there, while others discussed how their students were more focused on earning money via a part time job.

The main aspect discussed by interviewees that leads to such a diverse nature of students was through the frequent discussion of how secondary schools in their local area may not offer a computing or related qualification at GCSE level. With some students studying computing before level 3, and others not doing so, this results in a vast range of student abilities and knowledge. Programming knowledge in particular was a contentious issue identified by interviewees and was perceived as one of the largest discrepancies in student ability. This supports existing literature which explains how students have different experiences of programming prior to level 3 at GCSE (Crick, 2017; Sentance and Csizmadia, 2017a). This can be viewed in two ways: first a binary interpretation of whether students have any programming knowledge or not, with the alternative view being that students may have knowledge, but this still differs because of the different programming languages they may have learnt. For instance, as previously stated, one survey revealed how 21% teach python, 19% teach Scratch, 10% teach JavaScript and the remaining 50% teach other programming languages (The Royal Society, 2017). It is not just whether a student has studied computing before level 3 though, as programming and the misconceptions surrounding programming can be influenced by their previous environmental factors such as their previous teachers (Qian and Lehman, 2017). An interesting concept linking to this identified by interviewees was that of 'over-scaffolding', where schools give too much structure to students. This results in students having the expectation that they will be told how to do things in a college environment, which college lecturers will have to manage.

3P Model - Presage Factor - Teaching Context

This aspect of the 3P Model considers the teaching context that includes factors such as curriculum, the teaching method used, the classroom climate and assessment (Biggs, 1993). This is rather broad, and is largely influenced by the internal college environment, local college environment, and macro-environment trends.

Curriculum has already been discussed so will not be explained here in great detail. However, it is worth mentioning how choice of curriculum will dictate assessment criteria, while curriculum also influences to some extent the teaching method used. What is important to discuss is the teaching method and classroom climate which stems from the knowledge, ability, attitude and approach of the teaching staff, and how they work together. Some key themes identified through interviews were the importance of 'Having the right staff', 'Working together' and having a 'Collaborative digital culture', and while these themes will be addressed in the next chapter as they are factors for success, the key issue in teaching context is when these factors are not in place, and a college is dealing with a 'Lack of experienced staff'. Teachers with a lack of computing knowledge or ability was cited by interviewees at all levels, including interviewees reflecting on their own knowledge and struggles of teaching the subject. For instance, one interviewee was a maths teacher, but moved to teaching computing even though they had no background in the subject. This is a prime example of where a teacher has to teach in areas outside of those they are knowledgeable in, an already cited issue (Ofsted, 2019a; Yadav and Berges, 2019). Hence, this changes how they approach teaching the subject and so greatly influences the teaching context. The issues of a lack of either PK, CK or PCK was extensively discussed in the literature review (for example see (Yadav, Gretter, and Hambrusch, 2015; Qian and Lehman, 2017)), and was evident as being applicable in a college setting through interviewee comments. Interviewees also supported the claims of the macro-environment issue for the sector that there is a lack of appropriately skilled staff for teaching generally (Association of Colleges, 2018b), but also more specifically for computing (Brown *et al.*, 2014; Moller and Crick, 2018; Department for Digital Culture Media and Sport, 2019; Yadav *et al.*, 2016; The Royal Society, 2017; Webb *et al.*, 2017; Yadav and Berges, 2019), with colleges not being an attractive job proposition for computing graduates due to limited salaries (Migration Advisory Committee, 2017). However, as expressed by some interviewees, salary is not why they teach, but because of wanting to help students or share the passion for computing.

3P Model - Process Factor - Task Processing

Task processing refers to the execution of the curriculum, and within this section, factors that affect the teaching and learning activities are those for discussion. Both presage factors influence task processing, but there are some key factors directly related to DS education that come in here. Some key themes identified by interviewees that can be mapped to this section include the more macro-environmental themes such as 'Evolution of technology' and 'Post-pandemic life', but also themes such as 'The bare necessities', and 'Competing workplace demands' since they deal with resources and time respectively. It is logical that the execution of a curriculum depends on the curriculum chosen, but resources and time in particular influence the execution of any curriculum. The availability of funding influences resources, but for computing related subjects which require up to date equipment and infrastructure, a lack of funding can influence the execution of the DS curriculum depending on the resources a college may have. Existing literature has highlighted how teachers need support with appropriate equipment and software to deliver computing curricula effectively (Gal-Ezer and Stephenson, 2014; Department for Digital Culture Media and Sport, 2017), but this is often not the case (Lucas, Spencer, and Claxton, 2012; The Royal Society, 2017; Augar *et al.*, 2019). Interviews supported these claims, with many teachers bringing in their own laptops/equipment to try and mitigate resource issues, whether that be from an equipment perspective, or due to the unreliability of college infrastructure that is an already cited issue (Armstrong, 2019). On a related note, there was the issue of 'Conflicts with IT Teams and Policies' which interviewees described as causing havoc in their ability to use specific tools or software required for their teaching. This has previously been outlined as a more pertinent issue for DS courses due to the nature of the subject (e.g. the inclusion of cyber security), with existing literature stating how the installation of software, technical difficulties with networks and the lack of flexibility by technicians as being challenges for the subject

(Sentance and Csizmadia, 2017a).

Resource issues should also give consideration for time (i.e 'Competing workplace demands'), and some teachers explained how they do not teach the required guided learning hours that qualifications require, which influences the execution of any curriculum. Similarly, there was the somewhat surprising find that lecturers are spending an increasing amount of time dealing with student pastoral issues. Still, the challenge of the multiple demands of a teacher is well-documented in existing literature, especially for computing teachers that often require more frequent upskilling, or a more continual need to create new resources. What is less reported in literature is the effect that these demands have on an individual. The overarching theme of 'It's a hard-knock life' focused on how college teaching is a struggle, often as a result of the issues within 'Environmental strain', but the result is teachers struggling with their work-life balance and in some cases affecting their mental well-being. While reports have provided statistics such as that 20% of new teachers leave the profession within 2 years, 33% leave within 5 years (Department for Education, 2019d), and 20% of those who resigned from college teaching stated it was because of the heavy workload (Association of Colleges, 2018b), they have not discussed how this influences those who are left teaching in the college. This is a key contribution to knowledge as it shows first hand how lecturers 'on the front line' are struggling in colleges. Staff leaving due to these issues further exacerbates the issues for those who remain, and teachers under stress, or feeling overworked, are likely to be less effective in the classroom, irrespective of what curriculum they are teaching.

3P Model - Product Factor - Nature of Outcome

For the nature of outcome, this refers to the desired outcome of the teaching and learning process, so based on the context of this thesis, to address the mismatch between the supply and demand of those people in society with the right DS and knowledge. Significantly, this is impacted by the other areas of the 3P Model, which is also influenced by all the other contextual factors as described in Figure 10.2. DS outcomes, or students with the knowledge and ability in the subject, whether that be technically such as programming knowledge, or with regards to 'soft' skills, all depend on these proceeding factors. Some interviewees expressed the importance of technical skills, others more on the employability skills such as teamwork and communication, while others mentioned the importance of students having the ability to learn and adapt to new things. The author considers all of these elements important for any learner on a DS related course, and these factors have been presented in one way or another in existing literature. While colleges inevitably play a large role in addressing the DS gap, the responsibility for this task should not lie solely with colleges, due to the range of contextual factors that influence a student's learning.

10.4 Contributions and Implications

The discussion surrounding the variety of contextual factors influencing DS teaching as identified in Figure 10.2, and how different challenges can be mapped onto Biggs (1993) 3P Model (Figure 2.4), have some implications for teaching practice. It must be recognised that the challenges which influence the teaching and learning environment within colleges vary in scale from macro-environment trends to misconceptions brought upon from an individual student's background. Consequently, it needs to be recognised how much variety there will be from one college to the next, and even within colleges, the difference between different teaching approaches, curricula, resources, and students. Overall, the education sector is extremely complex with political, social and economic factors (Ingleby and Tummons, 2017) all influencing teaching context, and therefore creating challenges in a multitude of different ways, which can be interpreted by individuals in different ways. Much of this may appear obvious, and to some extent it is, but what is important is how to deal with these challenges as a result of the contextual factors colleges and teachers specifically find themselves in when delivering DS courses. The most notable implication for practice is that there is not, and cannot be a one-size fits all approach for addressing many of the challenges identified. This is due to the unique characteristics that exist when teaching DS or related courses, whether that be for colleges specifically, or across educational institutions overall or at different levels (Crick *et al.*, 2020). Hence, for any college looking to address any challenge they have with regards to teaching DS, they should first identify what the root cause of the challenge is, and gain a greater understanding of the contextual factors that may be causing that challenge as then they will be better placed to address it.

There are also some implications and contributions to knowledge and research. The nature of this study addresses the lack of research that has traditionally existed for further education (Augar *et al.*, 2019; Ofsted, 2019a). Further to this, the interview findings augment existing literature that details the challenges of teaching computing, which have typically been focused in a school related context. The findings also collate the context factors that can influence DS teaching into one model, as opposed to them merely being discussed in an array of existing literature. These findings also lay the foundations for future studies that could investigate DS teaching under even more specific sub-contexts than that of colleges in the South West of England. For instance, solely focusing on Sixth-form colleges in rural locations. The importance of these contextual factors has a significant influence so if any inferences can be drawn and generalised elsewhere, this can only be done effectively if the context is as similar as possible.

Finally, it should be noted that speaking to students would have brought in another interesting viewpoint of the challenges of teaching DS. Students could have provided an insight into their perceptions of the teaching and learning environment, and their own personal goals (outcomes), which would have provided another element of contextual information.

10.5 Chapter Summary

The extent of the variation of context that influenced DS teaching was much larger than expected, and so the implications for practice are much less specific than hoped. It was expected that some key contextual factors would directly link to individual challenges alone, which would allow for the identification of addressing them specifically on a general level. However, the variation that exists is extremely complex and so the key contribution is that operating on a case-by-case basis is more effective. Furthermore, many different challenges have been identified, and by understanding the challenges that are faced, in combination with the context they reside in as showed in Figure 10.2, and as discussed in relation to the 3P Model, this allows researchers, practitioners, and policy makers to better identify what needs to be done to improve DS teaching moving forward.

Chapter 11

Best Practices Used

11.1 Chapter Context

This chapter discusses what could be considered as best practices for addressing the challenges that influence the teaching of DS, or general best practices for the teaching of DS and related courses irrespective of the challenges which exist. This chapter directly follows on from the previous chapter and relates to research question 3, which is "What practices do colleges currently employ to overcome the perceived challenges that influence the teaching of 'digital skills' at level 3 and why?"

All interviewees were asked what practices their college has implemented to try and overcome the challenges they had previously mentioned. They were also asked for their views on whether there are any 'best practices' when it comes to teaching DS and related courses. Finally, interviewees were also asked about CPD, which included whether lecturers take part in CPD, the general college perspectives on CPD, and the colleges needs for CPD to take place effectively.

These questions were asked as the FE sector has been identified as what should be at the forefront of providing education and skills training (Augar *et al.*, 2019; HM Treasury, 2020), with colleges being described as pivotal in addressing the DS gap (House of Lords, 2015; Independent Commission on the College of the Future, 2020). However, there are a number of challenges that exist for colleges and DS teaching, as identified in existing literature (e.g. see (Norris and Adam, 2017)), the challenges framework presented (Figure 3.5), and through the analysis of interview data. These factors combined with the shortage of research that currently exists for the FE sector (Ofsted, 2019a; Augar *et al.*, 2019) give emphasis to the importance of knowing how to address these challenges. Asking those interview questions provided an insight into how colleges overcome the challenges that influence DS teaching, and from the evaluation of these insights, it can become more plausible to create a set of best practices for the teaching of DS and share this practice with other colleges. Besides, existing literature has pinpointed the importance of how future research should explore the relative value of different approaches used within DS teaching (Garneli, Giannakos, and Chorianopoulos, 2015; Crick, 2017; Webb *et al.*, 2017; Derrick, Laurillard, and Doel, 2016).

11.2 What was Found

Interviews with college stakeholders revealed that the majority of factors which lead to the effective teaching of DS, or addressing the challenges that influence this, are not directly related to DS at all. Instead, most factors were all about people, and managing the relationships between different parties. Analysis of interview data led to the creation of the overarching theme 'Critical Success Factors', which itself contained five themes:

- Collaborative Digital Culture
- Working Together
- Having the Right Staff
- Pedagogy (Approaches to Teaching)
- Professional Development

'Collaborative Digital Culture', which can be described as a college's overall way of doing things, is logically important for DS teaching, but it can also be described as a product of the people within the organisation, in how they behave, interact, and contribute to any shared goals. As a phenomenon, culture is not something that can simply be changed or introduced overnight, as it instead evolves and develops over time from the combination of a variety of factors. Therefore, while for those with such a culture, its significance for effective DS teaching is recognised and it can be considered a critical success factor, what matters most are the factors which create this culture. One of these aspects identified was through the theme of 'Having the Right Staff'. This described the importance of having both knowledgeable staff (regarding DS concepts and topics, and pedagogy), and staff that are passionate and care about the subject and their students. If these factors were present in an individual, they are likely to be a more effective teacher than those that did not care or did not have sufficient expertise or teaching experience. With regards to teaching, there were several factors related to pedagogy that were identified from the interview data, as depicted in Figure 11.1.

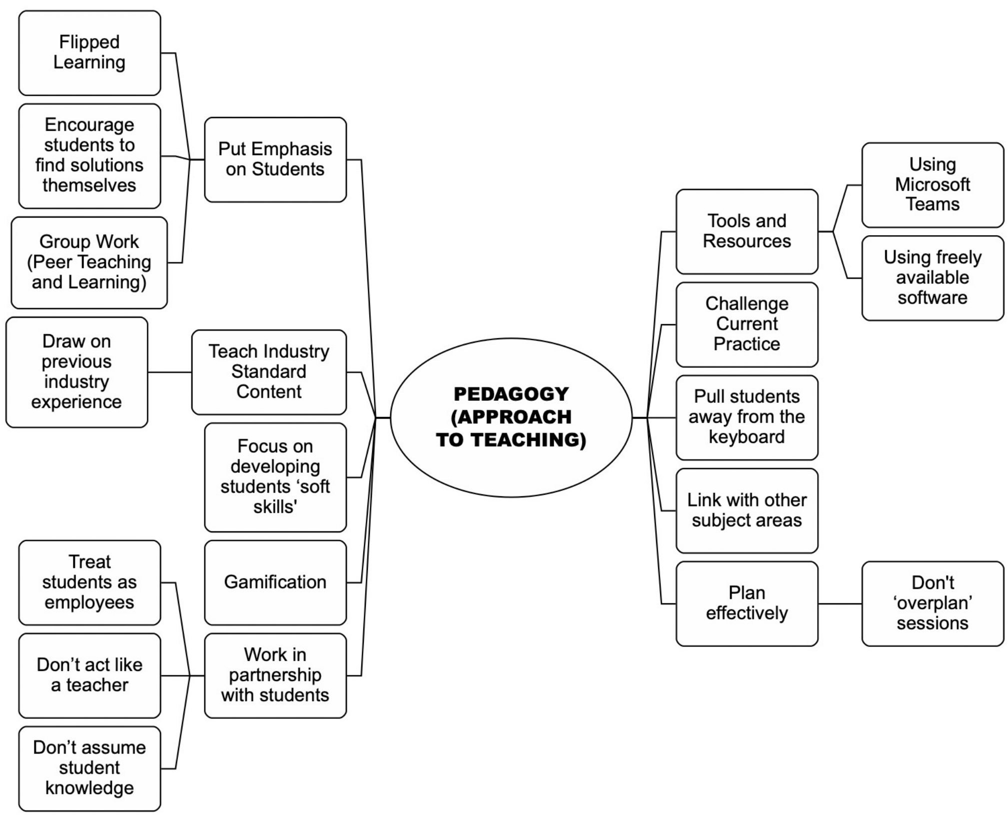

Figure 11.1: Approaches used for the Teaching of Computing (Pedagogical Factors).

A key pedagogical tip and implication for practice is to work in partnership with learners, and this pedagogical aspect bleeds into the other identified theme of 'Working Together' and more specifically the subtheme of 'Staff and Students'. Working in partnership with learners was found to take place in many ways; whether it was treating them as employees as opposed to students, not acting like a secondary school teacher, not assuming student knowledge, and ultimately ensuring there is an understanding of student needs. This last aspect was deemed more important that the actual delivery of DS and computing related content by many interviewees. By working in partnership with learners and understanding their needs, curriculum content and suitability of resources can be tailored more effectively, and students are more likely to ask for help and be engaged in lessons. This is irrespective of what infrastructure and resources each college has, but instead using what they have available to foster the best teaching and learning environment for their student cohort.

When considering the increased emphasis on teaching students how to learn so they can approach any given problem they may face moving forward, it becomes clear that having the most up to date resources and teaching the latest specification and topics are not as important as they may initially seem. Content should be applicable and relevant to industry as much as possible, but it should not be the predominant focus. Where possible, lecturers should draw on industry experience and use industry standard tools but focus on getting students to develop the ability to learn for themselves. This leads on to another pedagogical factor which is putting the emphasis on the students. This could be as simple as instead of giving students the answers to problems, direct them to where the answers could be. It could be using flipped learning as a teaching approach, which appeared to work particularly well for those lecturers who either have a lack of subject knowledge themselves or are dealing with a cohort of students which have very different abilities. Many interviewees mentioned how using freely available software is beneficial for two reasons. First, that it overcomes the challenge of a lack of funding and needing specific equipment, but also that students can use and access that software both at the college or in their home environment where they can explore and try new things. This removes barriers to learners, which again fosters a more productive teaching and learning environment. It is important to note that again, many of these pedagogical factors are context dependent, with a particular emphasis on a college's specific student cohort, and their associated backgrounds and experiences. Therefore, the main suggestion and implication for teachers, is that they should focus more on the needs of the students, and less on individual topics or software. Furthermore, they should take note of the variety of pedagogical techniques that can be used and experiment with them to find what works best for their own style of teaching and for their students.

While 'Working Together' has been explored in a student context, this concept was also described as important internally between SLT and computing departments. For instance, to ensure there is a fair and justified allocation of funding and resources, to minimise issues such as 'Conflict with IT Teams and Policies', and to ensure there is appropriate support, time and development opportunities afforded to computing lecturers. Communication between both parties is key, where clear roles and expectations should be discussed to minimise issues, and to more quickly address new ones which arise. Similarly, the importance of the relationship between colleges and industry was also discussed by almost every interviewee in how they can benefit the teaching of DS. Whether that is ensuring that curricula is more aligned to industry, providing work experience opportunities for students, providing external speakers to support classroom teaching, helping on setting student projects, or even acting as CPD for staff. The benefits are clear, but again communication and expectations between both parties must also be clear, where any actions should have a mutual benefit.

The final critical success factor was CPD. This concept was explicitly asked to interviewees and is a topic heavily discussed in the literature review. However, much of the literature was not directly related to the FE sector and colleges in particular, and while many CPD opportunities exist for DS, the potential of them to have a meaningful impact on college teachers is limited (Hanley *et al.*, 2018). Hence, exploring this concept with interviewees contributes to existing knowledge and research by contextualising how CPD should be framed in this setting. Besides, CPD serves as method to overcome the lack of knowledge of teaching staff and is even more important for those teaching DS and related topics as upskilling is consistently required.

Many lecturers explained that they spend a lot of their own time developing their own skills, going on training courses (subject to college approval), and watching and using online resources as it is beneficial to them in improving their own teaching. Many types of CPD were mentioned which all had different characteristics. A key factor of what seemed to be effective CPD, and is a key implication for practice, is that of building networks with other colleges and teachers to share best practice of what works well or not, so that they can apply this to their own teaching practice. It was clear that what was significant for CPD was an individual's personal interest and the passion of staff for teaching and for computing overall. Without this interest, it was described how any CPD would be ineffective due to a lack of teacher engagement. A lack of funding and competing workplace demands also constrained CPD opportunities in some cases, while in others, there appeared to be a reliance on staff to have a passion and interest to do things in their own time. This is not sustainable and can lead to, or exacerbate, the identified issues such as struggling to maintain a suitable work-life balance, or stress for teaching staff.

11.3 Relation to Literature

Due to the varied nature of the critical success factors, they will be discussed in three separate sections in how findings compare with existing literature.

11.3.1 Collaboration

There was an overall emphasis on collaboration, whether that was through the themes of 'Collaborative digital culture' or 'Working together', which influences the effectiveness of DS teaching. Through discussion groups with teachers, The Royal Society (2017) found that the support and attitude of senior leadership teams towards computing can have a significant influence on the culture of schools, which influences staff attitudes towards computing, the levels of interest in CPD, and other resources. The findings of this study contribute to existing knowledge and research by showing how this is also the case in a college setting too. It was clear from interviews with senior leaders whether they were pro-digital, as the actions they took were often focusing on staff development, and ensuring that curricula was relevant, and that the teaching and learning environment used the latest technologies where applicable. Equally, it was clear with interviewees where a digital collaborative culture was not in place, as these factors were not present, with teachers simply saying that it was just their college's way of doing things. This augments early literature which showed how this was true for schools, where each school, or team of teachers end up following a set of behaviours and practices which are considered the 'norm' (Ertmer and Ottenbreit-Leftwich, 2010). One individual alone cannot change this; as culture is a collective. However, a change in culture can start from a position of power (i.e. senior leaders), who can disseminate their vision to the rest of the college. Over a period of time, and through identifying and hiring staff who embody that shared vision, a culture may be changed. In fact, when asking a senior leader what other colleges should do when they do not have a member of senior leadership who is pro-digital, or someone being the figurehead for digital change and development, they responded:

> *"I'd say that they need to restructure and need to put somebody at SLT that has got that responsibility." (Interviewee 1: Senior Leader, General FE College)*

This quote emphasises the importance of senior leaders in driving a cultural change. A change in culture can provide the motivation for teachers to try things they otherwise would not, and this can include new methods of teaching, which could result in improved outcomes (Ertmer and Ottenbreit-Leftwich, 2010). This brings to question the need for staff and senior leaders to work together to understand each other's requirements as mixed messages from poor communication will only hinder DS teaching.

Working together is more prominent in existing literature when considering relationships between educational institutions, and with industry. The creation of Institutes of Technology (a combination of FE colleges, universities and industry) focusing on STEM (Augar *et al.*, 2019; Department for Education, 2021d), highlights how collaboration is being prioritised nationally, and not just perceived as beneficial from interviewees. Collaborating with industry has been reported as allowing colleges to better understand local demand, and shared benefits to be achieved (Derrick, Laurillard, and Doel, 2016; ECORYS UK, 2016), such as through a jointly developed curriculum to meet the needs of employers, work placements, or to allow greater development of students employability skills. The interview findings support these claims.

Service learning projects were discussed in the literature review, where students could engage in a project to serve the community, and apply what they learnt in the classroom (Salam *et al.*, 2019; Tan and Phillips, 2005). This was largely discussed in the context of university computing students supporting colleges, but this idea was not reflected or suggested by college interviewees. However, for their own students, some interviewees discussed the benefits of getting students to work on projects for businesses or client briefs, which itself is still a form of collaboration. Notwithstanding, many interviewees discussed the increased number of students taking part in apprenticeships or T-Levels, which by having a work-place component as compulsory, almost mitigates the need for extra student projects. Much like service learning projects which suffer from complicated logistics, and a commitment from all involved (Brooks, 2008; Venn-Wycherley and Kharrufa, 2019), these same factors apply to student work experience, so collaboration between colleges and industry is crucial. There needs to be mutual benefits for each party, otherwise there is little incentive for employers to provide these opportunities. Therefore, colleges and DS lecturers should be active with contacting employers to build relationships, but they must do so in a transparent, honest manner, and willing to enter a discussion of where mutual benefits can be achieved.

11.3.2 Approaches to Teaching

A study on computing education research found that the top questions which practitioners and researchers want answering relate to student behaviour, student understanding and pedagogy (general and computing specific) (Denny, Becker, Craig, Wilson, and Banaszkiewicz, 2019). This is not surprising as curriculum change, a common occurrence in the field of computing, gives precedence to an increased focus on how to teach (Sentance and Csizmadia, 2015), while it has been suggested that a renewed focus on pedagogy for teaching computer science should be embraced (Davenport, Hayes, Hourizi, and Crick, 2016). Teaching itself is a catalyst for learning' (Biggs, 2003), and therefore, the importance of pedagogy should not be understated as it significantly influences student outcomes.

This discussion on pedagogy will begin with the findings of a study that analysed qualitative statements about how to teach computing from over 300 in-service teachers, that also contributed to a larger survey (Sentance and Csizmadia, 2015; Sentance and Csizmadia, 2017a). The authors exclusively asked both what challenges do teachers report that they face, and what pedagogical strategies do teachers report work well for teaching computer science in school. Both questions are like that of this thesis and provide a good comparison for results. The authors identified challenges relating to teachers, students, and resources. Furthermore, issues such as a teacher's subject knowledge, technical problems in school, difficulties in trying to meet the disparity in student ability and needs, and a lack of time were frequently cited issues that are present in a school setting (Sentance and Csizmadia, 2017a). These challenges were also identified by college interviewees, and so contribute and augment existing literature on the subject, but for in a college setting. The pedagogical ways of dealing with these challenges are interesting to compare given the two different educational contexts. Sentance and Csizmadia (2017a) found that the individual pedagogical strategies used by teachers could be grouped into five themes, and these themes will be compared with interviewee findings.

Learning away from the computer (Unplugged activities)

Learning away from the computer, otherwise known as using unplugged activities was the highest coded pedagogical strategy in terms of number of cases in their study (Sentance and Csizmadia, 2017a). Unplugged activities do not use computers but are designed for learning computer science topics through kinaesthetic learning activities with an emphasis on understanding concepts without the need for tools or programming (Webb *et al.*, 2017). Some interviewees support using this approach, in the context of 'pulling students away from the keyboard' where they can engage in greater discussion and explain concepts in a different manner. Using unplugged activities can address the issue of a lack of resources in some cases (The Royal Society, 2017), depending on where it is used, and can help overcome some student issues if they are struggling with concepts. However, it can require some imagination on what is appropriate which emphasises the importance of a teacher's PCK in how to frame a topic in a different manner. It can be applied in a variety of topics. For instance, in the teaching of sorting algorithms, where some teachers have used puzzles or playing cards in an unplugged style of teaching (Nijenhuis-Voogt, Bayram-Jacobs, Meijer, and Barendsen, 2021), so could be a worthwhile strategy for college lecturers to implement more often.

Collaborative working

Collaborative working can also includes strategies such as team working, peer mentors, and paired programming (Sentance and Csizmadia, 2017a), and was definitely an aspect where interviewee findings augment existing literature. Much like other studies which emphasise students helping each other in peer support (Davenport *et al.*, 2016), some interviewees explained how creating group working strategies such as pairing students who have mixed abilities can help form a more prosperous teaching and learning environment. Another strategy used by interviewees was flipped classroom learning. This pedagogical technique involves creating content that students can use or complete out of class in their own time, so that class time can be used for more collaborative activities such as group work and class discussion (Bradford, Muntean, and Pathak, 2014). By putting the initial emphasis on students, this allows students to think for themselves and construct their own knowledge (a constructivist approach to teaching). This can help address the issues of mixed student abilities in one class, as students can spend as much or as little time as they need out of class before getting involved in the collaborative work in class.

The relationship between staff and students was particularly emphasised by interviewees, and it was accentuated how important it is to gain an understanding of student needs and attitudes, and to work in partnership with students. This concept of partnership in education has already been comprehensively explored by some authors who suggest that partnership can engage and empower students, and is an effective approach for more authentic student engagement and transformational learning experiences (Healey, Flint, and Harrington, 2014). It can be understood as staff and students working together to foster learning and enhance teaching (Healey, Flint, and Harrington, 2014), but this is easier said than done. Much like existing literature which explores the differences between novice and experienced teachers, where novices may fear to stray from their lesson plans but more experienced teachers may be characterised as showing more interactivity with students (Liberman, Kolikant, and Beeri, 2012), some indications of this was found through the interviews. Observations and evidence could verify this more effectively, but the lecturers with greater teaching experience (of DS) seemed to have a more relaxed view on their approaches to teaching, and encouraging more interactivity.

These aspects of collaboration regarding pedagogy link back to Biggs 3P model (Figure 2.4), and the interplay between the student and teaching context. There are both student and teacher perceptions, so gaining an understanding of these perceptions and working together can aid teaching and learning, making the process more enjoyable and effective for both parties. However, it is the role of the teacher to foster an environment where collaboration and partnership can take place, irrespective of whether a teacher is novice or experienced. This can take place in a variety of ways, but due to the variation that exists with students such as their needs and backgrounds, deciding what is most appropriate can be a complex decision (Garneli, Giannakos, and Chorianopoulos, 2015), and is context dependent based on that specific student cohort. Hence, good teaching requires a good knowledge of the learners (Yadav *et al.*, 2016).

Developing computational thinking

Developing computational thinking in students was one of the themes identified in a school setting from teachers (Sentance and Csizmadia, 2017a), but this was rarely discussed by the interviewees for in a college setting. There could be several reasons of why it was not exclusively mentioned by interviewees or highlighted in the analysis process. As interviewees were addressing a range of topics and how to deal with a range of both intrinsic and extrinsic challenges, not just a particular aspect of pedagogy, this is why it may not have been mentioned. As a concept, computational thinking is perceived as a more challenging topic to teach and assess, and this may partly be down to the lack of clarity of what it is (Crick, 2017). It can be described as a method of problem solving, using analytical thinking and abstraction to arrive at an optimal or best answer (Bort and Brylow, 2013), with Sentance and Csizmadia (2017a) predominantly discussing how the pedagogical techniques to use regarding this is simply breaking down problems, but little is explained as to the actual techniques on how to develop computational thinking skills, and what the best way to break down problems actually are. It has been suggested how future work should explore how to teach computational thinking effectively (Crick, 2017). It has been framed as something that is already developed when learning computing as a subject or programming more specifically, yet it has also been stated how it should not be defined as thinking like a computer (Bort and Brylow, 2013). Nevertheless, developing computational thinking skills is important for DS students, as evidenced by its frequent mention in curriculum programmes, and using a variety of techniques are likely to be the most effective way to ensure students develop these skills.

Contextualisation of learning

Contextualisation of learning refers to relating computing content to other aspects of the curriculum. This includes referring to other subjects or relating to real-life (Sentance and Csizmadia, 2017a). This pedagogical strategy helps students see the value in what they are learning and is a strategy shared by college interviewees. Interviewees referred to how content should be linked with other subject areas such as using Python to support taught Maths concepts, or how generally there should be more crossover between subjects. Many interviewees discussed how they teach industry standard content, and use their previous industry experience to make concepts and topics more relevant and 'real' to the students. This approach supplements other studies that investigated computing teachers pedagogical strategies, where relevant lessons where students can see where they can apply their knowledge being especially important for abstract topics such as algorithms (Nijenhuis-Voogt *et al.*, 2021). Besides, a students future employment will be based on real-life contexts so contextualisation of the learning is important, but this also requires teachers to have an understanding of local context, employment options and any changes in the sector (McCrone *et al.*, 2015; Passey, 2017).

Scaffolding programming tasks

Reviews of pedagogy have identified scaffolding of learning and assessment as a key component for effective pedagogy (Hanley *et al.*, 2018). Scaffolding can be provided to students through the provision of regular practical exercises with the opportunity for good quality formative feedback (Davenport *et al.*, 2016). Often used in topics such as programming and algorithms (Nijenhuis-Voogt *et al.*, 2021), this pedagogical strategy refers to how teachers can help students understand program code, with teachers emphasising good practice where they give students part of a program to extend, and programs to debug (Sentance and Csizmadia, 2017a). Interviewees did not explicitly mention the term scaffolding in terms of a pedagogical strategy to help students, most likely as the interviews were not exclusively focused on programming pedagogy. However, some interviewees mentioned putting frameworks in place, or giving students programs that are working, and those with errors to fix or debug. This was described as being able to help overcome the problems that tend to exist with their students regarding programming, such as students having such a variety of backgrounds and experience. Other problems with programming can include insecurity among learners (Davenport *et al.*, 2016), inaccurate mental models of programming concepts and general misconceptions (Qian and Lehman, 2017), and scaffolding programming tasks can alleviate these issues. Methods such as scaffolding have been shown to be of an increased importance in the FE sector when teaching in an online or blended fashion (Hamer and Smith, 2021). Interviewee findings support this, and mentioned how teaching online compared to face-to-face during the pandemic meant that they could not simply look over a student's shoulder to help address any issues with their code, so putting in place more structure (scaffolding) helps when teaching online.

A small number of interviewees also mentioned about getting students to experiment and have a bit of fun to find solutions for themselves, while one pedagogical strategy used was to get students to debug each other's code. This allows them to identify errors and see other methods and approaches of writing the same program. This has already been cited as important as lecturers should emphasise that there are a number of 'correct' solutions when writing a program, but some may be more optimal than others (Davenport *et al.*, 2016).

Overall, there are several pedagogical strategies used by interviewees that are also mentioned in existing literature, and it appears that using a variety of strategies is most effective due to the variety of students and contextual factors that can influence the teaching and learning environment. However, what was commonly cited by interviewees and less so in literature was the extent to how teachers need to focus on the needs of the students, and understanding them better, as opposed to focusing on specific topics or software.

11.3.3 Knowledge and Professional Development

Having the right staff that are knowledgeable and passionate for teaching and technology were identified as key factors for success by many interviewees. However, a main challenge was that of a lack of knowledge of staff and keeping up to date with innovation and change to computing topics. CPD can help address these issues, and interviewees discussed a wide variety of aspects related to CPD. Through these discussions, in combination with existing literature, a CPD framework has been created (Figure 11.2) that identifies the barriers for CPD to take place, the characteristics CPD opportunities should have to be effective, and how 'effective' can be characterised.

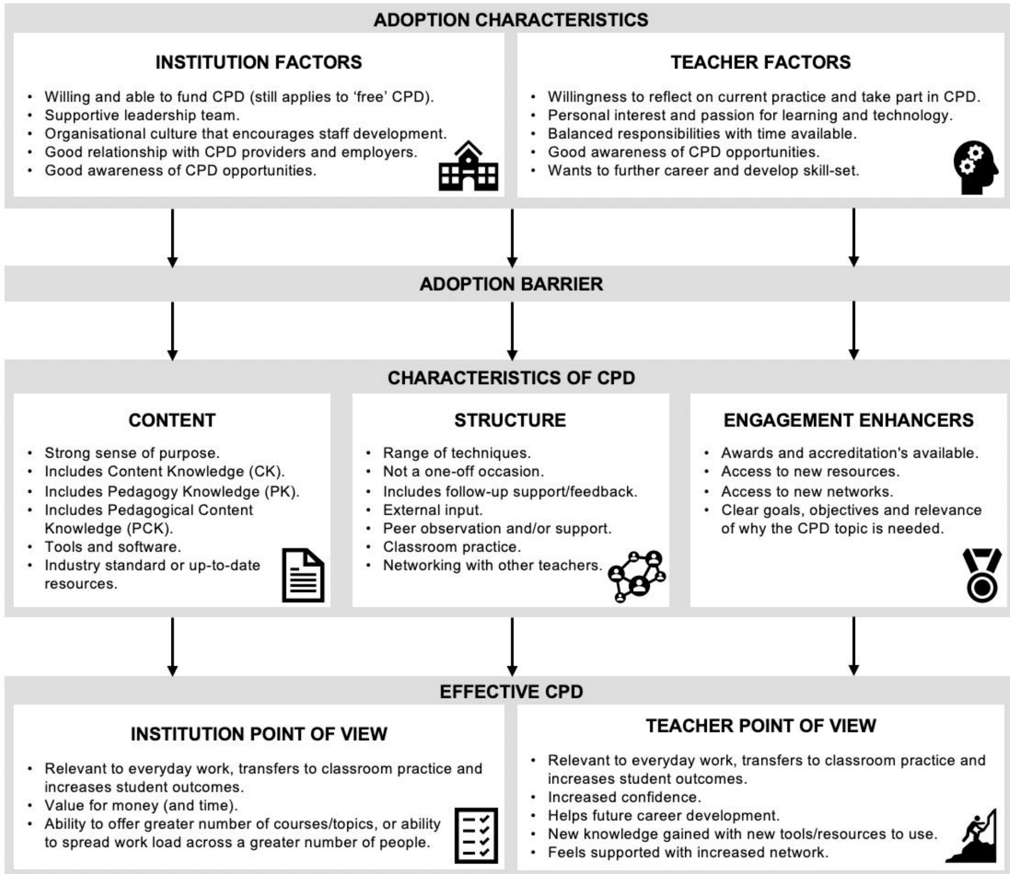

Figure 11.2: Requirements for Effective CPD in Colleges.

Adoption Characteristics

It has been identified how there are barriers for computing teachers to take part in CPD, both through interviews and in existing literature. These have been defined as 'adoption characteristics', and these are factors that must be present for CPD to take place, regardless of how beneficial the CPD may be. These adoption characteristics are divided into two separate sections: institution factors, and teacher factors. Institution factors refer to how a colleges context influences whether CPD will take place. Other authors have recognised these institutional factors such as the importance of college culture and senior leadership (Ertmer and Ottenbreit-Leftwich, 2010; Cordingley *et al.*, 2015; Sentance and Csizmadia, 2017b; The Royal Society, 2017; Ofsted, 2019a), with interviewees supplementing this literature by stating how if the college does not support them taking part in CPD, they will not be afforded the time and/or funding to do so. Speaking of funding, interviewees explained that even if CPD is advertised as 'free', this does not necessarily mean it is free to their place of work. This is due to having to identify and pay cover teachers, which is difficult to achieve in an environment with an already existing deficit of qualified staff to teach computing nationally. A common problem for both institutions and teachers is awareness of opportunities that exist; some interviewees explained how although they would like to take part in CPD, they do not know where to start and where to go, which is a significant barrier.

Teacher factors included contextual factors such as a teacher's personal interest to take part in CPD (passion), their willingness to reflect on their own teaching practice, their pedagogical beliefs and career goals, or simply how many responsibilities they had and their time available. Many interviewees declared how either themselves or their staff wanted to take part in CPD, and those that do things in their own time have a passion and desire to learn, with some even wanting to pursue further study such as a PhD in the future. Passion for teaching and development has been cited as a characteristic of good teachers (Learning and Skills Improvement Service, 2010), and without this, teachers taking part in CPD will likely only show superficial engagement(Beetham and Sharpe, 2013). However, as identified by some interviewees, some teachers may be close to retirement, so are unlikely to be interested in CPD. Equally with the challenge of so many 'competing workplace demands', there may simply not be enough time for CPD, or opportunities may not be at the right time of the academic year for teachers, with lengthy CPD opportunities reported as impractical (Haden *et al.*, 2016).

If 'adoption characteristics' are present, the barriers of taking part in CPD is broken, which is shown as getting passed the 'adoption barrier'. In other words, the college is in a position where they are willing and happy to consider having staff take part in CPD, and the teachers themselves are also willing to do so. As a clear implication for practice from a CPD opportunity perspective, CPD providers must consider these adoption characteristics in the design of CPD above everything else, as otherwise colleges and teachers are unlikely to take part in the CPD opportunity at all. Due to the challenges already outlined, to break through the adoption barrier, the cost of the CPD will likely to have be extremely minimal, or free, while also being at a time that fits in perfectly amongst the college teacher's many other responsibilities. Furthermore, if adoption characteristics are present, then CPD must meet three other criteria to be successful; it must have various content, structure, and engagement enhancer characteristics.

Content Characteristics

Content characteristics refer to what must be present within the CPD in terms of topics and content. CPD should cover computing content knowledge (CK). This has been reported as needed for good teaching (Lucas, Spencer, and Claxton, 2012), as teachers that are lacking in this have the added challenge of not being able to explore concepts in any depth (Yadav *et al.*, 2016). In line with this literature, the most frequently cited content areas desired by lecturers in FE included programming, cyber security, and artificial intelligence/machine learning, alongside training on the tools and software they are unfamiliar with. Interviewees mentioned the importance of pedagogy knowledge, but more importantly pedagogy content knowledge (PCK). Some discussed how they know and are confident with a particular topic area but are unsure on the best ways to teach that topic. Existing literature explains how this can often be the case with more novice computing teachers (Liberman, Kolikant, and Beeri, 2012), but emphasises that CPD which covers PCK is desired. Existing literature also highlights the importance of how CPD should cover both CK and PCK (Cordingley *et al.*, 2015; Crawley, 2012; Qian and Lehman, 2017; Moller and Crick, 2018), and outlines the importance of keeping up to date with the sector and what industry is doing (McCrone *et al.*, 2015), combined with policy updates and local context (Learning and Skills Improvement Service, 2010; Passey, 2017). These factors were also found to be the case by the collective sample of interviewees.

It has been stated how tying CPD to curriculum needs is an effective way to increase a DS teachers PCK (Yadav *et al.*, 2016), and this also makes the CPD more relevant for teachers. Interviewees implied how any CPD should have a strong sense of purpose, regardless of what is being covered with the CPD so that the development can have a later impact on what is being delivered to students. Finally, given the nature of how student perceptions and student backgrounds influence the teaching and learning environment (see Figure 2.4), this also emphasises the importance of CPD that shares best practice on how to gain a better student understanding. This can include different approaches to learning, activities that are difficult or easy to learn, and what elements or methods of study that students are likely to be more or less engaged by (Nijenhuis-Voogt *et al.*, 2021).

Structure Characteristics

Structure characteristics refer to how the CPD is delivered. Many interviewees believed that for DS and computing more generally, "CPD has to be part of the job", due to the ever-changing nature of the subject area. It was evident though, that there was not a one size fits all approach and taking part in many different types of CPD were to be more beneficial. This is not a surprise, as mix of both online CPD and face-to-face learning has been described as being more appropriate (Greatbatch and Tate, 2018), with CPD that uses a range of techniques and opportunities to reflect as more effective (Villeneuve-Smith, Bhinder, and West, 2009). Some interviewees explained how online CPD is predominantly more useful to quickly learn subject content (content knowledge), while it is also more accessible (a key factor given the challenges teachers face), but more structured programmes that are face-to-face are generally more effective for learning aspects of pedagogy such as through classroom practice. Classroom practice ensures teachers can more effectively apply what they learn to their own practice and for their own students (Cordingley *et al.*, 2015; Hanley *et al.*, 2018), and allows teachers to make mistakes in an environment where they can more quickly be acted upon.

Gaining external input from industry was also highlighted by interviewees as something that would be very beneficial, both for staff as a form of CPD but also for their students to gain a wider awareness of industry needs and current practice. Interviewees explained how practical training sessions where they can collaborate with others, share best practice, and build their networks would be particularly useful, for example through using peer observation, support, and feedback. This emphasis on networks or a community of practice is frequently mentioned as something computing teachers wish to have and is seen as very beneficial for the design of CPD (Lahiff, 2015; Broad, 2015;

Greatbatch and Tate, 2018). Benefits include the sharing of best practice and developing opportunities for collaboration (Derrick, Laurillard, and Doel, 2016; Yadav *et al.*, 2016; Cutts *et al.*, 2017), and avoiding feelings of isolation (Yadav, Gretter, and Hambrusch, 2015). Hence, this finding augments current literature and serves as a key implication for practice, in that a greater emphasis should be placed on building and maintaining collaborative networking opportunities.

The final aspect of structure is regarding time. One off short courses can be useful but longer term, CPD should not be a one-off occasion. Teachers need structured ongoing engagement with a continuous range of CPD opportunities (Yadav *et al.*, 2016). CPD should be part of a teachers weekly activities (Learning and Skills Improvement Service, 2010), which is easier said than done. However, CPD providers should develop opportunities that fit in with teachers needs more effectively. Besides, teachers require time to develop their practice (Lahiff, 2015; Moller and Powell, 2019b), and without the opportunity to act and reflect on their own learning, and how they have implemented their own learning in the classroom, CPD will not be as effective, so there needs to be ongoing support and feedback.

Engagement Enhancers

Engagement enhancers are factors of CPD which are likely to increase the likelihood of teachers wanting to take part in CPD, but also, their engagement during the process. Some interviewees commented that if teachers are not engaged, then they are unlikely to realise the potential of what the opportunity is presenting to them. One of these engagement enhancers is that CPD should have clear goals and objectives (Cordingley *et al.*, 2015), since if teachers are going to adopt new beliefs or methods of teaching into their practice, they need to understand how these translate into classroom practice (Ertmer and Ottenbreit-Leftwich, 2010). If the goals are not clear, this can just lead to confusion, and a misalignment of the messages being delivered.

Another aspect that enhances engagement is the opportunity for new networks, tools, and resources which teachers can take away and use. This is often the resemblance of a tangible product for teachers so they may feel as if they are ‘getting something’ from the opportunity in addition to the learning.

However, some interviewees explained how while learning new software is a good thing, if that software is not allowed where they work, or they do not have the resources to run that specific software effectively (e.g. due to conflicts with IT teams, or poor infrastructure), this can result in them feeling less engaged in the CPD as they cannot apply it to their teaching. Finally, CPD which has awards or accreditation's attached to them such as Cisco or becoming a certified Microsoft teacher appeared more appealing to teachers that were interviewed. Most likely as they would get something tangible that could help them in their future career or becoming qualified for teaching something new.

Defining Effective CPD

All three characteristics of CPD (content, structure, and engagement enhancers) should be met for CPD to be effective. For example, CPD could have the most relevant content and be structured in the most perfect way but if a teacher does not engage in the CPD or they are forced to engage in it, they are unlikely to learn as much as they could have, thus rendering the CPD a wasted endeavour. Equally, if a teacher is really engaged in the CPD and it is structured well, but the content is not relevant to DS or it is unlikely that it can be applied in the classroom effectively, then this form of CPD will not be applicable. Therefore, it would not help overcome the challenge of teachers having a lack of knowledge regarding DS. Hence, effective CPD should be relevant to everyday work, transfer to classroom practice, and increase student outcomes. These were factors raised by colleges generally and the interviewed teachers specifically, and are characteristics that have already been shown to be a product of good CPD (Sentance *et al.*, 2012; Cordingley *et al.*, 2015; Haden *et al.*, 2016; Qian *et al.*, 2018; Ofsted, 2019a).

Some interviewees raised a key point in how to measure, or gauge the effectiveness of CPD, and while a conclusive answer to this question was not identified from interviewees, there are some important considerations. What a college generally defines as effective CPD may be different to that of individual teachers who may have their own personal goals or measures of effectiveness. For example, if a teacher cannot apply what they learnt from CPD into the classroom, but they now feel more confident, have established collaborative networks, or increased their future career prospects, they may still view the CPD as effective. On the other hand, colleges as an institution may be more inclined to view CPD effectiveness as its impact on student grades, the value for money for the CPD, and whether they can now distribute staff more effectively or offer new courses or units of study. Regardless, teachers should be awarded the opportunity to experiment and succeed from what they have learnt from CPD, and just like schools, colleges could support this by having an effective culture in place (Ertmer and Ottenbreit-Leftwich, 2010).

The model in Figure 11.2 provides guidelines of what should be covered within CPD in order for it to be effective in colleges, irrespective of what type of CPD it could be categorised as, such as those outlined by Kennedy (2005). This is a key contribution to knowledge and practice, as it augments current literature on what is required for effective CPD, and what 'effective' CPD can be categorised as, whilst also being useful for CPD providers, as they could use this model to inform the design and development of future CPD opportunities.

Professional development can happen in a variety of forms, and its effectiveness measured in a variety of ways, but either way, CPD needs certain requirements to be in place (adoption characteristics), as well as covering a range of content, structure, and engagement enhancing characteristics. While it is suggested that the more factors that are present, the more effective the CPD will be, this does not mean that every characteristic shown must be present. For example, each college, course, and teacher will differ and therefore there is not a one-size fits all approach to CPD, and this is a clear implication for practice. Nevertheless, the model acts as a useful tool for those designing CPD for college teachers, as it indicates what factors must be considered for CPD to be a success. Still, this model could be improved, future research could investigate which characteristics and particular elements are the most important in specific circumstances, and for specific topics. Interviewees placed a much greater reference on how CPD should be structured, and what kind of content should be covered in CPD such as PCK, as opposed to specific content areas (e.g., python programming, cyber security etc). Therefore, the model created provides a more generalist view of what CPD is required in a college setting, as opposed to DS specifically.

However, it was created in the context of DS and computing, so future research would be required to verify whether this model is valid in other subject areas. Future research should look into these areas in addition to the general approaches taken for CPD and effective pedagogy (Webb *et al.*, 2017), so computing education can be improved.

11.4 Contributions and Implications

Many of the findings regarding best practices all seemed to link back to teacher development and teacher knowledge. Most likely as this often dictates pedagogy and the teaching context, and subsequently student outcomes. There was much less of a focus on how to address and deal with the more macro-environment or general challenges. This is presumably as teachers and colleges generally have much less power to influence them. However, what colleges can do is react to the situation they are in, and best practices such as working together, implementing a variety of pedagogical techniques based on the resources available, and teachers taking part in what professional development they can, are all methods which can be implemented, albeit to different degrees of effectiveness.

This chapter considered the practices which colleges employ or could use to overcome the challenges which influence the teaching of DS. This is where the most insight can be gleamed in addressing the 'digital skills gap', and has clear implications for practice. Due to the resource-intensive nature of digital as a subject area, there is often a focus on resources and equipment, whether that is having an expensive cyber security lab, up to date PCs, or the best industry standard software for teaching. However, there seems to be an increasingly forgotten element, which is pedagogy, the actual teaching of the subject itself and what is most effective for learners. Students on college courses will be studying to become employable for jobs that may not currently exist. Therefore, an implication for practice is that there should be an increased focus on 'soft skills' such as communication, problem solving, and developing the ability to learn new things quickly that will be important longer term. As part of this, putting the emphasis on students such as using a flipped learning approach may be preferred, while highlighting online tools that students can readily use. This is not to say that curriculum content and college equipment and resources are not important, as they are, but a key issue often seems to be access to resources and knowing what works best and what does not.

The next contribution is the recommendation that a network should be set up where college lecturers can share best practice and resources. Relying on the goodwill of lecturers already under massive time constraints to start the creation of this though is unlikely. There needs to be an external body to set this up and to start populating this with relevant resources for level 3, so a wider adoption can take place. Awareness is a key issue in regard to resources and places to seek advice and guidance, and while Computing at School (CAS) is one establishment which exists, the very name may put off college lecturers. There are wider bodies such as the Association of Colleges who focus on colleges, but this does not have a computing/digital focus, and with digital being very different to other subject areas, something new may be required. Even if a new body was not set-up, encouraging collaboration and sharing knowledge and resources should be a priority, and this should start by targeting senior leadership teams within institutions. Those colleges which seem to have better resources and a more positive outlook on digital education tended to have senior leaders who are pro-digital. There is certainly an element of college culture that has an impact on the effectiveness of digital skills teaching but culture is not something that is easy to change in a short-time span. However, future research could investigate what factors contribute to a successful 'digital' culture, including the best methods to foster and build relationships, both in terms of relationships between students and lecturers, but also between colleges and industry.

The CPD framework presented in Figure 11.2, should prove particularly useful for those designing computer science teacher CPD for those in a college setting, as if followed, created CPD opportunities should be more aligned with the needs of those teachers within FE. At the very least, the framework provides some guidance on the factors that may be important for FE DS teachers, so that these factors can be taken into consideration in the design process. It is plausible that the framework presented could be applicable to other subject areas, especially those areas related to computing such as mathematics and engineering. These subject areas are often combined within the same faculty as computing within FE, and so it could be assumed that CPD requirements may be similar. However, future research would be required to investigate whether the proposed framework is applicable to these other subject areas.

Once more, these findings together contribute to a greater insight into the lagging area of research considering computing education within colleges (Augar *et al.*, 2019; Ofsted, 2019a), and give particular insights into the aspects of pedagogy and professional development. However, these findings were only those generated from colleges in the South West of England, and so their applicability to elsewhere may be limited due to local contextual factors. Furthermore, best practice for addressing any challenges in DS teaching may change once the COVID-19 pandemic has subsided, as there will likely be key lessons learnt from 'emergency remote teaching' that can be applied to what becomes the 'new normal' of educational practice.

11.5 Chapter Summary

Regardless of the challenges which exist that influence the teaching of DS within colleges, teachers and other employees within colleges need to work together to create environments where students can be successful. This can involve building relationships with other institutions and industry, but, more importantly, gaining a good understanding of the students themselves and what they need. Each college will vary, as will each teacher, and each student, regardless of the wider context they are situated in. Hence, teachers need to have an arsenal of pedagogical techniques at their disposal for a variety of situations, and sharing best practice and professional development can help improve this. However, this necessitates certain requirements to be in place such as a supportive senior leadership team, and teachers with a passion for teaching and technology.

Part IV

Research Outcomes and Conclusions

Part III presented the overview and analysis of themes identified as part of the research process, and this was followed by three chapters where each provided a discussion of these findings in relation to both existing literature, and the research questions. Now this discussion has taken place, Part IV presents the culmination of the research, through revisiting the research questions, outlining how they have been achieved, and detailing how they contribute to research, practice, and how they are or will be disseminated. Following this, Part IV will outline the limitations of the research, and intended areas for future research.

Part IV contains one singular chapter:

12) Conclusions and Recommendations

Chapter 12

Conclusions and Recommendations

12.1 Introduction

Following the report on the study's findings, and the discussion with regards to the first three research questions, this chapter presents the conclusions. This chapter also considers how the findings contribute to existing theory, knowledge and practice with regards to the teaching of DS related courses. Finally, this chapter presents limitations of the study before making recommendations for future research.

12.2 Answering of Research Questions

The aim of this study was to investigate stakeholder perceptions regarding how colleges can overcome the challenges that influence the teaching of 'digital skills' courses (e.g. Computing), with a particular focus on post-16 level 3 education. To achieve this, this thesis proposed four research questions, and this section will summarise these research questions in relation to the key findings.

12.2.1 Research Question 1

How do colleges decide what 'digital skills' qualifications and units of study to teach their post-16 level 3 students?

> *'Curriculum does not meet the requirements of industry routinely' (Interviewee 15: Senior Leader, General FE College)*

Colleges in the South West of England are deciding on their overall curricula for level 3 DS courses in a variety of ways. Who decides on curricula differed across the sample of colleges, with five different variations of which stakeholders were involved. For individual units of study however, the decision was largely made by the computing department and lecturing team.

A cross-case analysis of colleges was also created (Figure 9.1) detailing college contextual information, level 3 courses offered, who makes curricula decisions, and the factors which influence curriculum choice. Ten main factors were identified across the sample for influencing curriculum choice, and this serves a key contribution to knowledge on who and how makes curricula decisions. Utilising this information, the 'Four Pillars of Curriculum Choice' model was created (Figure 9.2), which indicates and describes the key factors which colleges should consider when making curricula decisions.

12.2.2 Research Question 2

How does a college's specific context relate to the perceived challenges that influence the teaching of 'digital skills' at level 3?

> *'I'm glad this is being recorded, you can, you can sort of go down the list slowly. I think that there's a lot of challenges.' (Interviewee 20: Head of Department, General FE College)*

Analysing interview data led to the creation of a variety of themes indicating the perceived challenges that influence DS teaching. To view how colleges compared on these themes, a cross case analysis of colleges and challenge themes was produced (Figure 10.1). This provided a brief overview of some contextual factors in relation to challenges faced before a greater discussion analysed the themes in greater detail. The cross case analysis and discussion of themes led to a variety of contextual factors being identified and summarised in Figure 10.2. The key implication from this is that there are a multitude of contextual factors that relate to the perceived challenges which influence the teaching of DS, and therefore, the context of each college must be considered in depth if assessing any challenges faced and how to overcome them.

One of the most significant findings is that while one of the largest contextual factors that influences any challenges faced is curriculum, curriculum is often chosen based on the challenges faced, which itself, can be based on college context. This only emphasises the importance of understanding curriculum choice and ensuring that colleges choose the right curricula. However, defining what the right curricula is for a given college is a complex topic for debate.

12.2.3 Research Question 3

What practices do colleges currently employ to overcome the perceived challenges that influence the teaching of 'digital skills' at level 3 and why?

> *'The computing side of it is not the biggest part of this job. Yeah, it's a very minor part of the role. The, the students are central.' (Interviewee 16: Lecturer, General FE College)*

Colleges overcome the perceived challenges that influence the teaching of DS in three main ways: collaboration, approaches to teaching, and knowledge development. Regarding collaboration, by working together and gaining a mutual understanding of each other's needs and constraints, more effective relationships can be created, which can help minimise challenges occurring, or the creation of synergies. However, a key implication for practice is that there needs to be clear communication and collaboration to ensure mutually beneficial outcomes for both parties involved. It is therefore suggested that college employees actively engage in practices that enable collaborative working, and take action to communicate where problems exist, so potential solutions can be acted upon.

Approaches to teaching or pedagogical factors was another way to overcome some of the challenges faced, and these factors varied extensively. However, a key contribution found from interviewees is that an important need was to focus on the students and developing them as learners, as opposed to rigorously delivering a specification, or a specific topic. Hence, understanding student needs, and working with them, as opposed to simply disseminating knowledge was seen as a key factor for success, irrespective of what curricula was being taught, or programming language or software used. This calls to question what the goals or 'nature of outcome' of DS education should be. Without defining what the nature of outcome is and should be, any practice used cannot be fully evaluated effectively unless the intended goals are also defined explicitly.

The third area is knowledge development, or CPD, since a main challenge identified was a lack of knowledge. Through discussing with interviewees their knowledge levels, and their methods used to keep their knowledge up to date, a CPD framework was created (Figure 11.2), which outlines what is needed for effective CPD based on the different factors outlined by interviewees in combination with existing literature. Overall, the framework provides guidelines for what CPD providers should consider when creating CPD, but also for colleges or individual lecturers in deciding what CPD prospects may be best as effective developmental opportunities.

12.2.4 Research Question 4

How do college stakeholders differ regarding their perceptions on the challenges that influence the teaching of 'digital skills', and the practices used to overcome those challenges?

Issues regarding a lack of experienced staff, funding concerns, evolution of technology leading to curriculum lag and outdated practices, and COVID-19 impacting teaching practices were discussed by all stakeholder types. Similarly, regarding overcoming challenges, each stakeholder discussed some form of pedagogic approaches that are beneficial, with lecturers generally discussing a wider breadth of approaches than other stakeholder types. Equally, stakeholders of each type stressed the importance of understanding individual student needs. Furthermore, each stakeholder type discussed some aspect of professional development. Interviewees from each type mentioned the importance of industry experience, networking, and collaboration while the areas of content and teacher engagement characteristics were also discussed by each role, albeit in equally low numbers.

'Competing workplace demands', and student issues such as student background and student motivation were issues predominantly only cited by lecturers, with the latter to be expected given the nature of their role. It was primarily heads of departments and lecturers who perceived how many problems occur in secondary schooling that ultimately impact their students once at college. Similarly, it was lecturers and head of departments who raised concerns that led to the themes of 'conflicts with IT teams and policies, and 'inadequate college network'. No senior leaders mentioned anything to give the impression of suffering from the difficulty of work-life balance, yet lecturers and some head of departments did. Regarding overcoming challenges, it was heads of departments and lecturers who emphasised the importance of having knowledgeable staff, while for the relationship between staff and students, it was only these stakeholders who discussed factors like 'don't be a teacher', and the importance of honesty and transparency with students. The best practice of 'collaborative digital culture' was cited from those in more senior positions; almost all interviewees that were senior leaders, and some head of departments. Correspondingly, the related theme of the importance of colleges working together with industry was also predominantly cited by these two groups.

12.3 Contributions

12.3.1 Contribution to Knowledge

This project contributes to knowledge in several ways. On a general level, this research makes an empirical contribution to knowledge through exploring digital skills teaching at level 3 within colleges in the South West of England. Although there have been studies which consider English education regarding computing, this has typically focused on schools, whereas the further education sector has typically been an area of neglect both as a topic of research (Augar *et al.*, 2019; Ofsted, 2019a), but also politically, with the sector being subject to a multitude of changes (Norris and Adam, 2017; Burnell, 2017) and a lack of funding (Orr, 2020; Department for Education, 2021d). It is these challenges which only emphasised the importance of focusing on colleges as the subject of enquiry. Besides, with literature identifying how there is a shortage of employees with appropriate digital skills (Taylor-Smith *et al.*, 2019), this places an emphasis on understanding what is happening in educational institutions since education should support students in engaging in curricula that is best placed to support the needs of the workforce (Aničić, Divjak, and Arbanas, 2017; Passey, 2017). Colleges have been earmarked by the UK government as being crucial in addressing these skills gaps (House of Lords, 2015; Augar *et al.*, 2019; HM Treasury, 2020; Department for Education, 2021d), and this research provides important contributions to knowledge by detailing how colleges in particular are dealing with the challenge of developing the future workforce with the necessary DS.

The British Computer Society has identified that understanding the complex DS ecosystem across the UK is a critically important activity (British Computer Society, 2022), and this research directly addresses this need and contributes to knowledge by providing a comparative analysis of what level 3 DS qualifications are offered by colleges in the South West of England, who makes these decisions, and what these decisions are based upon, as presented in Figure 9.1. This has rarely been explicitly outlined in literature under this specific context before. Overall, this led to the creation of the Four Pillars model (Figure 9.2) which provides an insight into the drivers of curriculum choice that should be considered within colleges for DS courses. This model therefore serves as a key implication for practice. The key factors for curriculum choice within colleges has not previously been documented effectively and given the recent contemporary changes in the educational and macro-environment landscape such as the introduction of T-Levels and COVID-19 respectively, earlier literature would likely now be outdated, as it does not consider this recent context.

Thirdly, this research contributes to knowledge regarding the challenges that influence the teaching of DS by building upon existing literature such as that by Yadav *et al.* (2016) and The Royal Society (2017) by exclusively focusing on colleges, and creating a conceptual framework from literature of what factors lead to DS gaps (see Figure 3.5). By augmenting this literature with the findings of the primary research, it was possible to identify the range of contextual factors that influence these challenges (see Figure 10.2). Together, this information allowed college context and challenges to be framed under the theoretical representation of teaching context as outlined in Biggs (1993) 3P Model, and therefore augmenting the models use in the contemporary landscape.

Given the complex DS ecosystem within the UK, and particularly within England with regards to vocational and technical qualifications, the 2022 BCS landscape review indicates how a key aim of the BCS Curriculum and Assessment Committee is to help teachers understand how they should teach computing (British Computer Society, 2022). The findings of this research directly address this issue but in the context of the FE sector, with this research contributing to knowledge on what could be considered as best practice in delivering DS courses within colleges in the South West, such as the different pedagogical techniques utilised, and collaboration. Much like the governmental suggestion that industry and HE should work more closely with colleges (Medhat, 2014; ECORYS UK, 2016), this was also identified in the findings, with interviewees explaining how this is required to enable successful DS curricula and development. This work built upon the findings of pedagogical best practice and supports the findings of (Sentance and Csizmadia, 2015; Sentance and Csizmadia, 2017a), but within the FE sector. Furthermore, this research provides the important contribution to knowledge on how focusing on student needs as opposed to the curriculum or other factors is one of the most important aspects in developing learners.

The created CPD framework (Figure 11.2) contextualises and combines the plethora of work identified through both interview data and literature. This framework builds upon findings from both grey literature such as that by Villeneuve-Smith, Bhinder, and West (2009), Learning and Skills Improvement Service (2010), Derrick, Laurillard, and Doel (2016), and the review of reviews of effective CPD in 2015 (Cordingley *et al.*, 2015), and more academic literature such as that by Armoni (2011), Broad (2015), Cutts *et al.* (2017), or that of by Kennedy (2005) and Kennedy (2014) who provided a spectrum of nine different CPD models. As stated by Webb *et al.*

(2017), the approaches available for professional development for computing education is an important area for research. Through this study, and the creation of the CPD framework which combines factors such as barriers to CPD, the different aspects of what CPD can and should entail, and how its effectiveness can be defined, it is hoped that this broad overview provides guidelines for those wishing to take part in or design CPD, and therefore provides an important contribution to knowledge in this area.

12.3.2 Contribution to Practice

Educational research is "critical enquiry aimed at informing educational judgments and decisions in order to improve educational action" (Bassey, 1999, p. 39), and therefore it is important to indicate any contributions to practice from the research. The Skills for Jobs white paper published in January 2021 (Department for Education, 2021d) has indicated the potential for a renewed focus onto the FE sector, but there is still a sparse amount of research investigating the sector. Some recent studies have investigated areas such as effective teaching practice (Smothers *et al.*, 2021) and employer collaboration within FE (James Relly and Laczik, 2021), but there is a distinct lack of focus on curricula choice, and research explicitly focusing on DS. It is here, where this thesis presents some significant contributions to practice. The Four Pillars model allows colleges to follow a model to ensure they consider a wide range of factors important to curricula decisions, without becoming blinkered by one or two specific aspects they tend to base decisions on. This model, in addition to the general findings on curricula offered in the South West also allows colleges to see what is on offer by competitors, and different ways of doing things. The findings should also prove insightful to those designing or suggesting curricula such as Pearson, ACM, the National Centre for Computing Education (NCCE), and the BCS. In fact, this research specifically contributes to addressing one of the aims of the BCS School Curriculum and Assessment Committee of understanding "what qualifications are offered and taken across the 4 nations" (British Computer Society, 2022, p. 5), but specifically for those qualifications offered by colleges within the South West. Furthermore, it has been identified how each college appears to be very different and are susceptible to a range of contextual factors. Hence, there is not a one-size fits all approach for addressing many of the challenges identified. Therefore, for colleges looking to address their own issues by considering recommendations from elsewhere such as the pedagogical factors identified, great care must be taken to ensure that what is applied is appropriate. Nevertheless, college lecturers should place a greater emphasis on understanding and responding to student needs.

Interestingly, findings indicated the need for more collaborative networks between colleges or opportunities where colleges can get involved in shared communities of practice. While some colleges mentioned organisations such as the BCS or Computing at School (CAS), this was rarely the case, and given the number of organisations that exist with the aim to help improve computing teaching, it is suggested that much like in educational policy, further education appears to be somewhat neglected. However, these same organisations may find the created CPD framework very useful for informing their own teacher training offer. As well as colleges themselves who may find the framework useful in deciding what a 'good' CPD opportunity 'looks like', CPD providers and other organisations interested in this area may include the Education and Training Foundation, the AoC, NCCE, IoC, BCS, or CAS. It is somewhat surprising that none of these organisations came out of the interview themes as a driver for curriculum choice, which could potentially indicate how college links with these organisations is not very strong. Hence, there is perhaps work to be done in this area to understand why, and to build stronger links between both parties.

12.3.3 Dissemination

This research is small-scale, and only considers colleges in the South West of England. However, 'fuzzy' generalisations can be made (Bassey, 1999), where practitioners and policy makers can see how the findings of this research could potentially be applied in other contexts, and prove relevant for improving the teaching of DS. Therefore, it is important to disseminate the findings as widely as possible so policy and practice can be informed at a local, national, and perhaps even international level.

In the first eight months of the thesis (March – October 2019), the author was jointly working on developing the thesis topic in addition to working for the IoC. During this time, a literature search was conducted regarding

DS, colleges, and challenges of teaching the subject, in addition to conducting interviews with employees from six different colleges investigating the challenges of teaching computing in colleges. This led to the researcher conducting a presentation about these findings to other HE institution members of the IoC in October 2019 who were also investigating computing education. Discussion and feedback of this presentation informed future directions for research and led to a report being written for the IoC titled “Digital Skills: College Gap Analysis – Stage 1” which was shared with other members of the IoC (such as other UK universities). While this piece of work was not a pilot study of the primary research, it did consider some similar literature and it would be incorrect to say that this work did not contribute to the future direction of the thesis. For instance, the author recommendations included that senior leadership teams perspectives should be considered, and that future research should consider challenges in greater depth. Between October 2019 and March 2021, the researcher continued to work with the IoC, where they would provide vocal updates in bi-monthly meetings, and the occasional presentation detailing thesis progress on what was considered as “College Gap Analysis – Stage 2”.

Mid-way through the interview process (early November 2020), a researcher in the authors department suggested a conference that would be a good opportunity to publish some of the thesis findings to date. Based on some preliminary findings from interviews, in addition to existing literature, the first iteration of the CPD framework was created. This formed the basis of a research paper and was subsequently published in the 2020 International Conference on Computational Science and Computational Intelligence (CSCI) with the paper titled: “A Framework for Effective Continuing Professional Development: The Case of Computer Science Teachers within Further Education Colleges” (Allison, 2020a). Additionally, at this same conference, some of the findings of the work from “College Gap Analysis – Stage 1” was also later written, presented and published at this same conference, with the paper titled: “The System’s Holding Me Back: Challenges of Teaching Computing in Further Education” (Allison, 2020b). These papers were peer reviewed, with the overall paper acceptance rate for regular papers at the conference being 16% and were published on IEEE Xplore.

Once all interviews were complete, and the coding process of transcripts had begun, a report was written for the IoC to be disseminated with other IoC members, detailing a brief overview of the research and a summary of findings. This report, completed in January 2021, was titled: "Addressing the 'Digital Skills' Gap in College Computing Education", and acknowledged how further research and analysis of interview data was required. This was because at the time of the report deadline, the coding process was not complete (i.e., not all five phases of coding had been undertaken at that point).

In parallel to writing up of the first draft of the thesis (March 2021 – August 2021), three papers were written and submitted to various peer-reviewed computer science education research conferences. At the start of August 2021, the author was notified via an email from Marc Berges and Andreas Mühling (WiPSCE Conference Chairs) how their paper titled "Hopes and Concerns for Digital T-Levels: A Preliminary Study" (Allison, 2021a), which provided an overview of T-Levels and some of the findings from interviewees who offered the T-Level, was accepted for WiPSCE 2021 (Workshop in Primary and Secondary Computing Education). This paper is now published on the ACM Digital Library (Allison, 2021a). T-Levels are largely unknown, and this conference provided a good opportunity to discuss with other researchers what future work could be done in this area. Another paper submitted was regarding curriculum choice, and in hindsight it was hastily written for the ACM SIGCSE sponsored UKICER (UK and Ireland Computing Education Research) conference. While one reviewer accepted the paper, two rejected it, but the reviewer comments were incredibly useful to inform the writing in this area. This paper was therefore rewritten and submitted to the Journal of Further and Higher Education, with the title of 'The who, how and why of choosing post-16 computing curricula: a case study of English further education colleges', and was accepted in June 2022 and is now published by Taylor and Francis (Allison, 2022).

The third paper considers the challenges in teaching computing in relation to institutional context and Biggs 3P Model, while also considering Finland's educational policy in relation to that of the UK. Titled "The Importance of Context: Assessing the Challenges of K-12 Computing Education Through the Lens of Biggs 3P Model" (Allison, 2021b), this paper was submitted to the Koli Calling 21st International Conference on Computing Education Research. This was accepted for publication in September 2021, and is now published on the ACM Digital Library (Allison, 2021b). Furthermore, an article regarding the updated CPD framework titled 'Classifying the Characteristics of Effective Continuing Professional Development (CPD) for Computer Science Teachers in the 16-18 Sector', has been submitted to ACM Transactions on Computing Education. As of June 2022, this received a revise and resubmit notification. Meanwhile, a paper regarding pedagogy, titled 'Enabling Effective Student Learning within Colleges: The Case of Computing' has been submitted for potential publication in IEEE Transactions on Education.

Finally, in November 2021, the researcher presented their findings to colleagues within the computing team at the University of Gloucestershire in one of their regular research seminars, while one interviewee has approached the researcher to give a talk to their college staff about the research findings to help inform their practice.

12.4 Study Limitations

This thesis attempted to increase knowledge concerning digital skills education at level 3 within colleges in the South West of England, which included perceptions regarding curriculum choice, challenges related to college context and how colleges overcome these challenges. Nevertheless, there are several limitations which impinge the findings.

A potential weakness of the data collection approach was that participants were only able to give their perceptions at one point in time, which was during a lockdown period of the COVID-19 pandemic. This was a particularly difficult time for educators and would have likely influenced their views on DS teaching at that time, especially regarding any challenges being faced. Unfortunately, a study to detail how DS teaching changes within colleges over time, or how perceptions would be different after COVID-19 would have required a longitudinal study, and was therefore, beyond the scope of this study. Another limitation was that only three main stakeholder types were considered, and while this allowed for the triangulation of interview data within colleges, it neglects other stakeholder perceptions which may have proved valuable. For instance, employer perspectives of those offering level 3 qualifications with a workplace component such as T-levels or Apprenticeships.

Interviews require careful preparation (Robson and McCartan, 2016), and although great care was taken to ensure that any issues were minimised and that the discussion was as beneficial as possible, a key challenge of using semi-structured interviews was the need to listen carefully to what interviewees were saying and responding appropriately. Occasionally, taken this non-scripted approach led to some issues. For example, during the interview with interviewee 14, at one point, they talked for almost 12 minutes with no interruption as the author found it difficult to manage the enthusiastic nature of the participant. While much of the information provided by the participant was useful, ultimately this unstructured discussion led to an undesirable amount of data that was irrelevant to the research questions. Another example is when interviewee 4 interpreted an interview question differently than what was hoped:

Jordan Allison 8:28: "One of the things you obviously mentioned, talking about the skill set. Yeah, especially for those that have just, just been teaching. Is there any want to upskill within the team?"

Interviewee 8:44: "I mean, that's difficult. You're asking me to put opinions into into other people into this, I'm not comfortable doing that."

This was not the intended response, as the author wanted to simply gain an insight into the participant's perception of their team. Hence, questions could have been worded more appropriately in some cases. Furthermore, there are concerns that the lack of standardisation in semi-structured interviews impacts negatively on a studies reliability (Saunders, Lewis, and Thornhill, 2019). Additionally, interviewees were aware that the researcher may have been talking to other stakeholders in their organisation, and knowing this, participants (particularly lecturers) may have been less willing to disclose certain information due to knowing the researcher may have been talking to their superiors. Hence, there were potential issues of trust between the interviewer and the interviewee.

Another limitation of the research is that this thesis presents the findings of what can be considered a small study whose findings are only relevant to their context (i.e., colleges in the South West). Hence, much like other case study research, this study suffers from the limitation of generalisability (Yin, 2009), and so the findings cannot be applied to the whole population of colleges nationally, or further afield in other countries, or to that of other educational institutions. However, as explained by Cohen, Manion, and Morrison (2018), generalisability is not as important in settings like those presented in this thesis, where instead it is important for the phenomenon in question to be allowed to speak for themselves, and to not be too heavily evaluated or judged. Nevertheless, it is hoped that readers would be able to see how the findings could intuitively be applied to their own experiences or other settings.

Finally, interpretivist and qualitative research is often seen as being subjective or biased (Collis and Hussey, 2014; Saunders, Lewis, and Thornhill, 2019), meaning that multiple researchers can interpret data in different ways. Hence, given that the data collected and analysed in this study was conducted by just one sole researcher, this means that although a rigorous process was employed to reduce any bias, another researcher may have interpreted the data differently. Therefore, it was disclosed to readers where bias may exist or stem from (e.g., through reflexivity).

12.5 Areas for Further Research

The findings of this research present opportunities which future work can build upon. This could be a similar study in another region, or perhaps take into consideration the views of employers that are level 3 work placement providers or students studying such courses. This would allow for a more comprehensive understanding of level 3 DS education in colleges. It would also be useful to conduct research which considers Institutes of Technology, as they are collaborative organisations focusing on STEM subjects (Department for Education, 2021d) and are in their infancy with little research available on their effectiveness. Similarly, this thesis has presented some findings regarding the implementation of digital T-Levels, but future work could build upon this, and explicitly focus on this relatively new and under researched qualification.

As suggested by Greatbatch and Tate (2018), it would be useful to see what teacher CPD has the biggest influence on teaching quality, and this could be used to improve the CPD framework further, whilst also identifying if there is anything missing that should be included, especially as teaching quality is just one aspect of defining effective CPD. Approaches to CPD, in addition to pedagogical approaches are important areas for research (Webb *et al.*, 2017), and so future research could also build upon the pedagogy factors identified through identifying what factors are considered as the most important in relation to others such as through a q-methodology study. This would also allow for the identification of how stakeholders differ in a different way, not by job role, but instead by their beliefs and value propositions. Using this approach would also be interesting to consider with the Four Pillars model of curriculum choice, to see if there are any personas that seem to exist in the perceptions of how curriculum decisions should be made.

Finally, as recommended by the Chowen (2014), it would also be advantageous to consider the perceptions, opportunities, and barriers in the consideration of becoming a lecturer in the FE sector, in addition to focusing on DS. Work needs to be done in this area to help overcome the shortfall of those entering the profession. Future work could also investigate individual DS in colleges in even more depth, perhaps through observations of teaching practice, or through a longitudinal study further investigating the depth of a singular college context.

12.6 Chapter Summary

Throughout this thesis, colleges and the teaching of digital skills have been studied in depth, and this chapter has presented the concluding remarks. The research questions set out at the beginning of the thesis have been evaluated, with the findings being assessed in relation to their contribution to knowledge, contribution to practice and their dissemination. Thereafter, some limitations of the thesis have been presented, before areas for future research outlined.

Although the work does have some limitations, it has produced some profound findings in relation to the teaching of level 3 DS and related qualifications within colleges, an important and timely topic in the context of a sector that has typically been a neglected area of research. However, this work should just be seen as a starting point; technology will continue to evolve, and hence, curricula will need to adapt. Therefore, there will continue to be the need to understand and evaluate new programmes of study, their implementation, and what may be considered as pedagogical best practice.

Part V

Reference List

Reference List

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Part VI

Appendices

Appendix A

Interview Guide

1. Firstly, please can you explain who you are and what is your job role?

   (Probe Questions: What is your job role? How long have you been in this position? How long have you been in the education industry? Have you had any other roles within the college? Why did you apply to work here? Do you have any prior experience with digital skills teaching?)

2. I see that the college offers level 3 digital skills related courses such as (. . . research first and fill in here). Why does the college offer these courses in particular?

   (Probe Questions: Are there any other level 3 digital skills related qualifications that the college offers? How long has the college offered these qualifications? What qualifications did they offer before? What are the specifications of these qualifications? What units of study are offered? Why do you think that the college offers (insert qualification) over (other qualifications?). Why does the college offer (insert unit of study), over (other units of study?). What do you think is the decision-making process behind these choices? Do you think that the college offers the right qualifications and units of study? Why/Why not? Do you think the college should offer other qualifications and units of study? Why/Why not?)

3. How much influence do you have on which qualifications and units of study are taught at the college?

   (Probe Questions: Are you actively involved in the decision-making process? Do you think this is an important part of your job? What management responsibilities do you have? What course responsibilities do you have? Who does have the responsibility for which course and units of study are offered at the college? Has it always been this way? Would you like more/less influence?)

4. From your perspective, what challenges influence the teaching of these qualifications and units of study?

   (Probe Questions: Why are all of the above specific issues for this college? Find out more about college context and how these challenges may have changed over time.)

5. From your perspective, what is the most significant challenge the college is facing that influences the teaching of digital skills?

   (Probe Questions: Why is this the most important? (relate to college context). Which would you address first? Why/Why not? Do you think other members of staff would agree with you? Why/Why not?)

6. What are the colleges needs in order to upskill DS teachers?

   (Probe Questions: Is CPD needed? Do teachers currently take part in CPD? How do you think these needs could be met? How well do you manage to recruit DS teachers with the required skills?)

7. What practices has the college implemented to try and overcome the challenges you have mentioned?

   (Probe Questions: What different methods/practices has the college tried? From your perspective what has worked well? Why? From your perspective what has not worked well? Why? Are there any challenges that have already been overcome? How? Are there challenges that you think could be overcome quickly? How and why? What are the most difficult/least difficult challenges to overcome? Why? External speakers/outreach/service learning etc? Sharing resources? Working with other colleges/departments?)

8. Would you say there are any best practices when it comes to digital skills teaching?

   (Probe Questions: What are these practices? Why are they effective? Could they be adopted in other colleges? Why/Why not?)

9. And finally, do you have any other comments you would like to mention or discuss?

Thank you very much for taking the time to answer these questions regarding yourself and digital skills education within your college. That now concludes the end of the interview.

Appendix B

Email Template

Dear *'Research Participant Name'*,

My name is Jordan Allison and I am a PhD student at the University of Gloucestershire. I am kindly requesting your participation in a doctoral research study that I am conducting titled: "Stakeholder Perceptions Regarding Level 3 'Digital Skills' Teaching: The Case of Colleges in South West England".

The intention is to assess the challenges colleges may face in the teaching of digital skills courses (e.g. Computing, ICT etc), so that it can be better understood what is required to help colleges overcome these challenges.

Being part of *'College Name'*, you are in an ideal position to provide valuable first-hand information from your own perspective. Consequently, I would like to ask whether it would be possible to have between 30-45 minutes of your time for an interview? Your responses to questions would be kept confidential as explained in the attached 'Participant Information Sheet'.

If you are willing to participate please suggest a day and time convenient for you and I'll do my best to be available. If you have any further questions, please do not hesitate to contact me:

- Email address:
- Telephone number:

- LinkedIn:

Thank you for reading this email; your time is very much appreciated.

Kind regards,

Jordan Allison

Appendix C

Participant Information Sheet

Research Project

Stakeholder Perceptions Regarding Level 3 'Digital Skills' Teaching: The Case of Colleges in South West England.

Researcher

Name: Jordan Allison

Email: j

Telephone:

LinkedIn:

Invitation

You have been invited to take part in a research study that is entirely voluntary. This information sheet will explain what the study is about and how we would like you to take part so please read this information carefully. Furthermore, if you have any questions or would like any further information, please do not hesitate to contact the researcher.

What is the purpose of the study?

The purpose of this study is to explore stakeholder perceptions regarding how colleges can overcome the challenges that influence the teaching of ‘digital skills’ to students studying post-16 Level 3 education. In order to do this successfully, this study aims to gain an understanding of the different digital skills qualifications taught within colleges, and why. Furthermore, to understand the challenges faced that influence the teaching of these qualifications (and why), and the methods that are used, or have been used to overcome them (and why). Multiple stakeholders’ opinions will be considered, as this should provide a more comprehensive view of what can be done to help improve digital skills teaching within colleges at level 3.

Why have I been chosen?

You have been chosen as you are an important stakeholder within a college with valuable perspective’s on factors that may influence the digital skills teaching delivered at your college. Your involvement could be as a teacher, technician, head of department, part of the senior leadership team or as part of the governing body.

Do I have to take part?

Participation is entirely voluntary. If you do decide to take part, you will be given a copy of this information sheet to keep. Additionally, you will be asked to sign a consent form, to show that you agree to take part in the study. If you do decide to take part, you can still withdraw up until the point of when data analysis begins.

If I take part, what will I be asked?

Your involvement will consist of being interviewed by the researcher, where you will be asked about your role and your involvement regarding level 3 digital skills qualifications taught at the college where you work, and why these qualifications are the ones being delivered. You will also be asked about your perceptions on how the college overcomes the challenges that influence the teaching of digital skills and what those challenges may be.

How long will the interview last?

The interview will last approximately 30-45 minutes.

Will I be recorded?

You will be asked whether you agree for the interview to be audio-recorded. You do not have to agree with this, and if you do not agree, the researcher will take written notes during the course of the interview. If you do agree to be audio-recorded, you can still ask for it to be turned off at any point during the interview.

How are audio recordings stored?

Audio recordings will automatically be uploaded to Microsoft Stream once a recording has finished via Microsoft Teams. These recordings will be kept private and are only available through entering the researcher's credentials. With your permission, audio recordings may be transcribed using the transcription application Otter.ai (see here for their privacy policy: https://otter.ai/privacy). In this case, the audio recording will be uploaded to Otter.ai on the researchers account for the transcription to take place and subsequently deleted once the transcription text has been created.

Will my taking part in this study be kept confidential?

Yes. Information provided in the interview will be used for research purposes only and will not be used in a manner that would allow for identification of your individual responses. As such, your identity will not be revealed to anyone outside of the research study.

What will happen with the results of the research study?

The research will be written up as a thesis as part of the requirement for the award of PhD in the faculty of Business and Technology at the University of Gloucestershire. Research data may also be used and presented in research papers, conferences and other literature.

Thank you for taking the time to read this information sheet and I hope that you agree to take part in this research study.

Appendix D

Consent Form

Research Project

Stakeholder Perceptions Regarding Level 3 'Digital Skills' Teaching: The Case of Colleges in South West England.

Researcher

Name: Jordan Allison

Email:

Telephone:

LinkedIn: h

Please read the below information carefully as by signing this form you are agreeing to the following

- I confirm that I have read and understood the participant information sheet that was provided to me, and have been given the opportunity to ask any questions about the study.
- I understand that my participation is voluntary and that I have the right to withdraw up until the point of when data analysis begins.
- I understand that taking part in this research study involves being interviewed.

- I agree to the interview being audio recorded.
- I agree to audio recordings being transcribed using Otter.ai (see: https://otter.ai/privacy).
- I have been given enough time to consider my decision, and I agree to take part in the research study.
- I understand that any personal details such as my name will not be disclosed to individuals outside of the research study.
- I understand that my words may be quoted in publications, reports and any other materials, but my name will not be used.

Participant:	Researcher:
Date:	Date:
Signature:	Signature:

Appendix E

Sample Interview Transcript

Interview Number: 1

Interviewer: Jordan Allison

Interviewee: (Name - Omitted for confidentiality) – Head of Digital and Professional Development (part of SLT)

Organisation: (Name - Omitted for confidentiality)

Date and Time of Interview: Friday 18th September 2020 at 11:45am

Format: Online via Microsoft Teams

Recording software: Microsoft Teams recording functionality

Jordan Allison 0:02 Okay, so thank you for taking the time to speak with me. So I see that you're the head of digital and professional development. And firstly, can you just give me a bit of context of what that actual job role entails for you. If that's alright.

Interviewee 0:19 Yeah, yeah, it's quite a broad one. I sit on their senior leadership team. And so I'm one of the senior managers. I, I have a curriculum background so I you know, I was a teacher, I was a teacher, teacher of business studies and IT. Before, before taking on this role, obviously, you know, there was various progressions throughout the, throughout, throughout my career. I've been at the college for thirteen years. And, and my role now essentially isn't so I look after all the professional development for the entire college, so all the campuses and across both curriculum and corporate. So I manage the budget, organize, you know, the direction of travel, strategy. And, and the digital stuff is kind of, it started, I started out as head of digital learning. Prior to that I was head of teaching and learning, so very much a curriculum focus. But then I shifted into this head of digital learning probably about three years ago. And that was because, you know, the college needed a change in direction, you know, as you said, yourself, you've seen, you've seen that, you know, there's some challenges. And so I was given the job of kind of pulling together a digital strategy for the curriculum in the first instance. But then there was some restructure in the MIS department, and then it seemed they wanted me to take over the all of the reporting services so. So now I really do have a broad spectrum. So if you imagine I've got three elements really to my three teams that I manage, I've got the professional development team. I've got the digital learning team, the Virtual Learning team, which is a team in itself. And then I've also got the digital services team, which is kind of all the database analysts, the, the information analysts, and the software support. So that is a really positive thing, because I have control really have, you know, I manage all the people that look after Microsoft Office 365. Certainly on the user side and the data side, obviously, we have to work closely with what's called the, the IT infrastructure team who look after the back end stuff. But yeah, so it gives me a very, it's great because I've got a nice overview of, you know, all areas and so it's very easy for me to kind of coordinate the things that I do. And obviously, a big part of digital transformation is, is training. You know, it's a key element of it. So that is good because I'm, I'm essentially the lead training in the college so that helps.

Jordan Allison 3:06 That's great. And so my, my focus what I'm looking at, especially focuses on, should we say what we can call as those digital skills courses?

Interviewee 3:18 Yeah, I saw that, yeah, yeah.

Jordan Allison 3:19 So, such as you know, computing, IT. However each college or each course wants to call it. So I see for yourself just having a quick look on the website at level three specifically, you've got the BTEC IT in computing and also you got a diploma, in say Creative Computing Games Design. Do you have any input in terms of the courses that are delivered or who is responsible for choosing the courses and the specific units of study within those?

Interviewee 3:52 Well that is definitely aligned with the curriculum, not me. I used to teach on the level three computing diploma the Pearson diploma but I don't any more. But certainly the curriculum team decide, and they obviously, try very hard to, to remain in line with, you know, the requirements of industry and obviously, sometimes not easy, but it is, you know I think that's a key component of any learning program is that you try to keep it current and make sure that the skills you're given the students are the ones that they're going to need when they leave the college. But yeah, it's not my, it's not my, that is not my job. That is definitely curriculum.

Jordan Allison 4:35 That's fair enough, so from your perspective, in your, in your role in terms of that team, as we say, because with IT specifically adapted to the needs as it's constantly evolving and changing and trying to keep up to pace with employers, what are the challenges faced of those teachers in that department or from yourself working with that department, in terms of teaching?

Interviewee 5:03 Well certainly keeping there, it's not, it's not easy is it because a lot, a lot of the teachers will come from industry, some straight out of university. But then it's also difficult to make sure that they keep their skills up to date. Especially if you're working full time as a teacher, it's not easy to go back into, you know, that they get, they do get six days a year, which is called subject updating, but it's only six days a year. But normally, that's quite, you know, six days, it's a lot, it's paid, in addition to the holidays, and that they're supposed to go out into industry and update their, their subject knowledge. Whether that happens or not, is another matter altogether, but that they do have these six days to do that. But that's not easy to find places for them to go and subject update and to keep current. So I'd say time constraints are quite a big thing. You know, being a teacher is not an easy job, and it's busy. So, finding time is not it's not easy to keep, to keep up to date, but you know, there's different ways that they can do it, obviously.

Jordan Allison 6:17 Obviously, time is a major constraint. What about in terms of funding? So there's six days, but is there anything that is internally?

Interviewee 6:28 Yeah, we have an internal development budget and if they, they can apply for funding to go on training courses, and often they do. We send staff on training courses quite, quite a lot. We don't normally, you know, it's, it's unusual for us to turn down staff requests for, for development. I mean, it does happen but often it's not. It's not turned down. We support, we support quite a lot. We have some specifically IT, IT level three teachers who are actually doing PhDs currently or a masters alongside their, alongside the course of study. So that's an obviously a very good way for them to keep up to date. And so, yes, but six subject updating days, professional development programmes so they can come to us and tell us what they think they need. You know, when it's subject specialist, it's definitely them leading and us supporting, not us, you know, we would lead the college in kind of cross college themes not in subject specific professional development.

Jordan Allison 6:41 Obviously, the case in across college, obviously with the. Again, I saw, what was it, you became a Microsoft showcase college.

Interviewee 7:46 Yeah, yeah.

Jordan Allison 7:46 A year ago. And so obviously, I assume that is part, part of your role in terms of getting the whole college say up to speed with the transition to working more digitally anyway. And it's especially obviously now due to COVID.

Interviewee 8:01 Well, yeah, so we were, I mean, we were the first college in the country to adopt teams as our virtual learning environment. So, you know, most colleges, as you're probably aware, I think the University of Gloucestershire have Moodle. So we've moved all together, because we didn't think it was current and up to date, it didn't really serve our purposes. So we've shifted all our digital environment, our learning digital learning environment into, into Microsoft Teams, and we were the first, first country, first college in the country to do that. And so we obviously work quite closely with Microsoft. You know, we, we support, we support them on lots of things as well, like we give them because obviously, we're on the ground doing it.

We are experimenting their users as sounding boards quite a lot. And we give, we give presentations on behalf of Microsoft. And so yeah, so We are very, we are very heavily involved in terms of developing the college and that and that is my focus. Yes.

Jordan Allison 9:08 What would you say has been maybe some of the challenges you faced in getting the College up skilled digitally? If there were any,

Interviewee 9:19 Well there's always challenges aren't there Jordan, there's always challenges. It's just how you overcome them. And I think it was a well, a well thought out. So as I said, I started looking at this when I got that job as head of digital learning. So I started investigating what was the best way forward, you know, back in November 2017. So it was a long process, two year process to decide what direction to take, a lot of work on my part, a lot of research. But in terms of the college, you know, you have to, in terms of any kind of big shift, that you know, you change management, your change management, is very important. It's about how you do you prepare staff for this change. And, and there's lots of ways you can go about that, lots of different things that you can do. So, you know, certainly my, my, my main objective was to make it like a ground up change and not a top down change. So I didn't want it to be something that the senior leadership team said, this is what we're going to do. I wanted it to be something that the curriculum staff and the people working on the ground said, this is a great thing for us to do. And that way that makes, that makes your job of implementation much easier. So there's a whole lot of change management before we, before we decided to shift in terms of like, getting, getting people, if you will, we created, we created ambassadors who would kind of not and these, these weren't, like your typical like. I think people like to call them champions. But they were essentially just people who would go out and have conversations, people who we would upskill a bit more, but not people who we expect to go deliver training or anything, just people. The whole remit was really let go out there into the curriculum, into the workforce, and have positive conversations with people and talk to people about teams, if you want show them tidbits here and there, but generally just it's about you having positive conversations. So that was really good.

Jordan Allison 11:28 So, so it just seems a lot of it was trying to just embed that culture, that cultural change, making it seem quite organic through these conversations.

Interviewee 11:39 Yes. And then obviously, listening to you know, explaining to, listening to their worries because obviously, you know, if you say to somebody we're going to, we're going to take Moodle away. Some people are using it quite well. Some people are doing a good job with it, you know, it's serving a purpose and they don't, they don't see, the, they don't see the reason for change. 'Why do I need to do that, I'm doing a great job with Moodle? I, you know, I use it really well, my students engage with it'. But it was about longevity really more than anything. So it was about convincing those people that actually the shift will be better for you, and it will be better for your students. And it's asking lots of questions, lots of kind of, you know, lots of kinds of like, okay, so if you didn't have Moodle, and you had to use teams, what, tell me what you think you wouldn't have, and then it was just about bouncing ideas back and forth and showing them how actually it will be better, not worse. And so yeah, lots and lots of training. We put together, when we did, when we did make the decision. I mean, we put together a training package, six hours training, basic training for all staff. And that was split into kind of eight sessions, eight forty-five minute sessions that we delivered to all staff. And so that, was that was another big project. Obviously, that's not easy to deliver. And that was face to face training that wasn't online. So that was obviously pre, pre COVID. And, but that was a big positive. So yes, the challenges are probably the same of any kind of big change and that is getting people to support you, and then engage with the things that you want to do. Now, that's not always easy, but we did a pretty good job.

Jordan Allison 13:37 By the sounds of it, obviously, being a member of SLT yourself, you can always kind of be the figurehead for you know, help, help driving this. What would you say would need, be needed? If it was a, let's say was just in this kind of training anyway, another college that is actually those member of staff who are teaching and they want to improve on this change, but there isn't someone like yourself that is SLT?

Interviewee 14:12 I'd say that they need to restructure and need to put somebody at SLT that has got that responsibility.

Jordan Allison 14:18 Clearly very important one, well it is a very important role. Well, especially, especially now.

Interviewee 14:23 Yeah. Yeah. We hired, you know, I had a, you know, the Virtual Learning team, we had, we increased when you're, when COVID came, we had, you know, our workload increased significantly. And we, you know, we invested some, in some more human resource there as well. So, not massive, not massive amounts, but enough to kind of promote somebody to take more responsibility and that as well. So, you know, I'm head of digital, but I've also got a head of virtual learning, and she has a small team, and she now leads does most of the kind of operational stuff In terms of like, they're all, all the kind of like teams meetings. And you know, there's so much, there's so much work to be done there. So

Jordan Allison 15:08 If we can just bring this back slightly to the focus on the computing department and their, their kind of courses.

Interviewee 15:16 Yeah.

Jordan Allison 15:16 And with that, with that team specifically, are there or are there or were there any specific challenges due to the nature of the content that they teach, for instance? And what I mean by that is, I know for some examples, there's a lot of, if you're teaching programming, for example, there's quite often a lot of over the shoulder debugging and things like that.

Interviewee 15:47 That's probably a difficult one for me to answer because I'm not in the classroom. And so yeah, I don't know if I could give you a clear answer to that question. And my, my immediate response would be that this this kind of shifting into a blended approach. I mean, the term blended learning has been bounced around for probably 15 years now. But actually, has anybody really done it, well, I don't really think they have, you know, I don't think you know, I think, I think you've always had some online learning some asynchronous online learning, and then you've had the classroom stuff, and never, never to never the two have met properly. But now, that's impossible. You know, you have to have this kind of, you know, now that there's this big shift into synchronous learning, not just asynchronous that,

that things have to change. And that synchronous learning has to, has to kind of really kind of, I think the challenges for most colleges is that synergy between the synchronous and the classroom experience and possibly even the asynchronous that you put into the into the mix as well. But the, but in terms of the difficulties an IT teacher might face, but probably not too dissimilar to the problems that all teachers would probably face. And that's about finding a method to deliver the content in a synchronous way online that kind of covers off some of those bases really. And it's about picking out bits and pieces of your, of your, of your program and making sure that you identify the bits that can be delivered synchronously in a, in a, in a, you know, proper manner. And identifying the bits that you need to be in the classroom for and that really is, is the challenge for all teachers, not just IT teachers, it's looking at your whole curriculum and deciding which bits, of which bits of the program can be delivered synchronously, which bits need can be delivered asynchronously which bits need to be in the classroom, and then how do you pull it all together? So that's really where the challenges are. And obviously, I don't think many teachers are ofay, or certainly at a high level in terms of that synchronous delivery, because this is still very new for people trying to deliver a training session, to deliver a classroom, you know, a learning, a learning experience in teams. And the technology is, you know, still coming on thick and fast enough. In teams, they're just about to release, you know, breakout rooms and, and things like that. So there's lots of technology that is necessary, that's actually not even there yet. So, you know, to create that rich, positive, synchronous learning experience, you know, it's still, I think we're still quite aways from it, although some teachers are doing fabulous work. So

Jordan Allison 18:54 Has there been any, obviously if you're transitioning the whole college moving away from say, maybe Moodle and doing everything on teams. Has it, has it been, okay, the whole, the whole shift in terms of the sense of suddenly everyone especially, say, say now I assume, everyone using teams?

Interviewee 19:14 Oh it's been fantastic. I mean, it's been a breath of fresh air. I mean, you know, teams is very much about communication, collaboration, that's what it's about, and that's what the, you know, that's the that's, that's the, that's the world of the 2020s. You know, that's not a, you know, Moodle was very much about asynchronous learning you do some you know, you go and access a PowerPoint or something and, you know, you read it or whatnot. There was very little collaboration in Moodle you know, that did have some tools for it, but they were not very nice tools. And, and you know, the big difference between Moodle and teams, by the way, is the, is the mobile is, it, you the ability to access it on your mobile, so. You know, there is a mobile app for teams, I think but it's crap. And students didn't, didn't use it. So, you know, we went from, we went, if you imagine, and this is probably one of the biggest kind of impacts really, so in 2018-2019, you had Moodle, that was your virtual learning environment. So we had zero, you know, literally zero learners accessing any kind of learning through their mobile devices. And then you go to 2019-2020 when we're in teams. And you've got three and a half thousand learners accessing teams and the learning and the communication and collaboration through their mobile devices. Three and a half thousand of them. I mean, that's virtually you know, nearly all of them. That was, you know, we've got about four thousand full time learners. So that was virtually all of them. You know, if you looked at the numbers accessing it through either iOS or Android. You know, we get report, we could report on the operating system that accesses the system, that accesses it. So I think it was about over two thousand iOS devices, a thousand Android devices, over a thousand Android devices, then you'll hear about you dropped off to about eight hundred, Windows devices, and three hundred Macs, so it was, yeah.

Jordan Allison 21:32 Students have taken very well to it then?

Interviewee 21:34 Oh, yeah. Oh, my God. I mean, it's been amazing. It's been, you know, and if you get student engagement, you get staff engagement, don't you. I don't know, which comes first, but, you know, maybe they're pulling each other along, depending on who it is.

Jordan Allison 21:51 So a slightly different kind of question, but is, what is the relationships say between, SLT and actual departments in terms of working together in, you know, all this?

Interviewee 22:09 Well I mean I think in our organization, we have a fairly healthy relationship. I mean, most of the senior management team are close to the, to the line reports, I think, I'm certainly I am. I mean, people, you know, people probably too much contact me directly, you know, there's always, you know, but they're comfortable contacting me because I have a relationship with them. So I often, you know, I have to bat it off to the service desk all the time, but, but yeah, you know, it's, I think it's, I think it's a very healthy relationship in that regard.

Jordan Allison 22:54 I don't know. If this, is this, this would be related to yourself. Again in regards to a computing department in terms of their specific systems or, you know, software they need, I know in, from when I've been to quite a few colleges in the past and like, when I was an outreach officer, there's been a lot of say kit or software they've not been able to access to teach the course suitably, they're locked out. So obviously it needs to be raised a lot, a lot higher up. Is, is that the situation for yourself or the department for computing, say, quite, allowed to do what they want in terms of getting the resources they need.

Interviewee 23:50 No. I've never heard of the IT team, the computing department having any restrictions in terms of them being able to access software. I mean, it would normally, the license, you know, the license, that the purchasing of licenses lies. That's the responsibility of the IT director. But I would normally hear about it or, you know, it wouldn't pass me by. But I certainly haven't heard of any issues with that. In terms of certainly the computing department anyway. I mean, there's been some issues around games design, I think, you know, because the software is very expensive, but, but not computing. But again, that's not a 100

Jordan Allison 24:52 So starting to sum up, so just generally for specific relation to say your college context. What do you say is the main challenge that you would say faces? Again, I know it's not necessarily your role in teaching, but for those teaching of those digital skills courses, what would you say? Is that main challenge for them? Yeah, if you had to just pick that one?

Interviewee 25:21 Are we talking about the computing team or the college?

Jordan Allison 25:26 Well, actually, if the answer is different, I'd say can I have an answer for both if that's alright, see how it compares.

Interviewee 25:34 I would say, Well, obviously the computing team have a much higher start, you know, the base knowledge is much higher. So the challenges, you know, the challenges with them is less than with challenges across the college. You know, that's like the differentiation across the colleges, you know, is challenging but I think, I think COVID has actually helped us, you know, if you look at COVID is in terms of being able to deliver training now so, right, so now I can deliver or you can use live events or teams meeting to deliver training to you know, if it's a team meeting, I can deliver training to you know, thirty people, they can be wherever they want, can't they. So actually, I'm, I've got, I couldn't be more impactful online than I can be, you know, and know the face to face that you're trying to get people into a bloody classroom that's got twenty PCs in it, and then try to deliver a session and then making sure that they all show up, has always been a challenge for professional development. But now, we've set a team's meeting or a live event, and people can access it wherever they are. So we're actually in a much stronger position in terms getting training to staff, we can do it easier now. And so we create, you know, we've created a, you know, we've got an infrastructure now in terms of like, between SharePoint and teams, we've got a cross college team that's got all the staff in it. And we can, we can communicate with them through that, when we can run, we run training sessions in that team. And we get really, really good take up. Much better take up than we've had, you know, often in face to face sessions. And also, you can record the session. So that's a, that's a really positive thing as well. So people can go back and, you know, watch it on catch up. So, you know, whereas if you deliver a training session in the classroom it's gone. That's it. So, you know, that the, we've got a lot more scope for training now than we've ever had before. Certainly for training, teaching digital skills. So the digital skills training is going really well because we've got good teachers in place like my team is doing a fabulous job with, we've got a great relationship with Microsoft, they support us. And so we can produce really, really, really powerful and strong learning material that we deliver through teams, to upskill our staff on how to use all the various digital skills they need to do the job, including the computing team. So no, things, COVID has made our jobs in some respects much easier. Although we've had more, we've had more of it to do, but it's definitely getting training to staff now is an easier proposition. Although you're we're still grappling with the, with the issue of hardware. That's it, that's an issue but, you know, that takes time to make sure that everyone's got the right kit, and we're still fighting that problem. But.

Jordan Allison 28:56 Is that hardware issue? A funding issue or is it just figuring out what people need?

Interviewee 29:04 Yea I think a funding issue. And then a logistical issue yeah. Yeah, it's both and then a training issue. I mean, we, you know, we try to, you know, we you can't, you can't click your fingers and then all of a sudden everybody's got a Microsoft Surface, you know, it doesn't let them work like that. So it's about finding, you know, we've got a thousand staff nearly so it's about finding some balance, and slowly but surely, you know, we've got a three year plan now, to pretty much make all staff mobile workers, so including teachers, so that will be you know, it's a three year plan but hopefully, you know, the, we are seeing the death of the PC. Yeah.

Jordan Allison 29:51 Okay, so I'll say in my final question similar to the one before the kind of main challenge, if you had, one recommendation to make to a college of how they could improve. And just generally in terms of teaching of digital skills, or the upskilling of their staff. What would your recommendation be?

Interviewee 30:20 I don't think you can, I mean, you can't really answer that in one suggestion, can you because you can't. And there are so many things that, you know, you can't just say that's the most important thing because that alone wouldn't, wouldn't work. But you know, a, yet somebody at a senior level, who has a good strategy to drive it forward is probably your first base, making sure that he's got the, or she's got the, the, you know, the support of the principle. That's probably, without that you probably don't go anywhere. Do you? So.

Jordan Allison 31:02 No you need that SLT support one way or another.

Interviewee 31:07 Yeah.

Jordan Allison 31:09 Okay, but that is, what I'll just do there is, I've got no further questions. So I'm just going to end the recording. Unless you have any final comments?

Interviewee 31:20 No, no, it's fine. I need a drink of water.

Appendix F

Codes by Job Type

Nodes	Number of Coding References			Number of Cases Coded		
	SLT (n=8)	HOD (n=10)	Lecturer (n=14)	SLT (n=8)	HOD (n=10)	Lecturer (n=14)
Overarching Theme: A Whole New World						
Theme: Evolution of Technology	10	5	7	6	4	5
Curriculum Lag	10	8	18	6	6	8
Outdated Practices	0	0	0	0	0	0
Need new resources	4	2	2	3	2	2
Upskilling required	12	8	12	5	6	6
Theme: Post-Pandemic Life	0	1	1	0	1	1
Accelarated Online Capabilities	5	5	4	4	5	3
Benefits of teaching online	1	3	1	1	3	1
Early Adopter Benefits	5	3	1	3	2	1
Change in Teaching Practices	0	0	0	0	0	0
Can't use in class resources	1	3	3	1	3	3
Changes to timetabling and delivery method	6	3	1	4	2	1
Increased workload	2	2	2	2	2	2
Less work experience opportunties	0	3	6	0	3	4
Requirement to social distance	1	4	3	1	3	3
Understanding virtual teaching tools	5	0	2	3	0	2
Identifying best practice	6	7	6	4	4	3
Theme: T-Levels - The Future of Technical Education	0	0	0	0	0	0
T-Level Benefits	0	0	0	0	0	0
Adding value to employers	5	0	0	2	0	0
Creating employable students	3	4	0	3	4	0
Mix of work placement and taught content	2	1	1	2	1	1
Up-to-date specification	1	2	2	1	2	1
T-Level Champions	4	1	0	2	1	0
T-Level Concerns	0	0	0	0	0	0
Appropriateness of assessment & curriculum	1	3	7	1	3	2
Availability of work placements	6	8	5	3	6	3
General negativity	2	2	0	1	2	0
High resource requirement	0	2	2	0	1	1
Lack of support	0	0	1	0	0	1
Needs time to become established	2	2	1	1	2	1
Seen it all before	2	1	0	1	1	0
Staff skillset and knowledge	0	2	1	0	2	1
T-Levels to replace vocational	1	2	0	1	1	0
Too cutting edge	0	2	1	0	1	1
Transport links	1	1	0	1	1	0
T-Level Government Support	5	6	3	2	3	2
Overarching Theme: Choice of Curriculum						
Theme: Curriculum Control	11	7	28	7	6	12
Theme: Industry Relevance	18	9	9	7	7	6
Theme: Perception of BTECs	0	0	0	0	0	0
Good content	1	6	4	1	3	3
Lower level academically	0	1	6	0	1	2
Out-of-Date Specification	2	3	10	2	3	6
Poor value of the qualification	4	9	6	2	6	4
Problems of Assessment	0	5	9	0	3	5
Problems of Exam Board	1	0	8	1	0	5

	Number of Coding References			Number of Cases Coded		
Nodes	**SLT (n=8)**	**HOD (n=10)**	**Lecturer (n=14)**	**SLT (n=8)**	**HOD (n=10)**	**Lecturer (n=14)**
Overarching Theme: Critical Success Factors						
Theme: Collaborative Digital Culture	25	9	1	7	5	1
Theme: Having the Right Staff	0	0	0	0	0	0
Knowledgeable Staff	1	10	10	1	4	8
Passion for Teaching and Tech	6	15	14	4	3	8
Theme: Pedagogy (Approaches to teaching)	0	0	0	0	0	0
Challenge current practice	8	7	1	4	4	1
Develop student soft skills	9	9	3	4	4	3
Other Teaching tips	2	4	20	2	3	8
Put Emphasis on Students	0	5	12	0	3	6
Tools and Resources	0	0	0	0	0	0
Use freely available online software and resources	1	8	11	1	5	6
Using Microsoft Teams	2	8	2	2	4	2
Theme: Professional Development	0	0	0	0	0	0
Aspiration for higher qualifications	1	1	3	1	1	3
CPD - Difficult to guage effectiveness	4	0	0	4	0	0
CPD Content	0	0	0	0	0	0
General Pedagogy CPD	8	3	6	4	2	4
Subject-Specific CPD	0	3	3	0	2	2
CPD Structure	0	0	0	0	0	0
Cross Curricular CPD	4	0	3	1	0	3
Formal training courses	1	2	3	1	1	2
Industry Experience & Employer Connections	10	7	2	5	4	1
Networks (collaboration and sharing)	4	6	11	3	4	5
Observe lessons	0	2	1	0	2	1
Online Resources and Applications	2	6	12	1	5	7
CPD Teacher Engagement	0	0	0	0	0	0
Awards & Accreditations	1	3	0	1	3	0
Current Experience	1	0	1	1	0	1
Personal Interest	5	7	3	3	4	3
Reflect on current practice	1	2	3	1	2	2
Requirements to Learn (CPD Adoption)	0	0	0	0	0	0
Awareness of opportunities	2	2	3	2	2	2
Culture of Development	5	1	0	3	1	0
Funding for CPD	4	4	2	3	3	2
Leadership Support	15	5	2	6	4	1
Time is required for CPD	4	4	10	3	3	4
Theme: Working Together	0	0	0	0	0	0
College & Industry	0	0	0	0	0	0
External Speakers	2	6	4	2	4	3
Improve Curriculum Design (and staff expertise)	13	6	6	5	4	3
Work Experience for students	8	4	1	3	4	1
Placements must add value to employer	5	1	0	3	1	0
Work Experience Teams (benefical)	2	4	1	2	3	1
SLT & Computing Departments	6	6	7	4	3	3
Staff & Students	0	0	0	0	0	0
Dont assume student knowledge	2	2	0	2	2	0
Dont be a teacher	0	8	3	0	5	2
Honesty and Transparency	0	7	5	0	4	3
Need to understand indiviudal student needs	2	7	11	2	4	6
Work in partnership with students	5	1	3	4	1	2

	Number of Coding References			Number of Cases Coded		
Nodes	**SLT (n=8)**	**HOD (n=10)**	**Lecturer (n=14)**	**SLT (n=8)**	**HOD (n=10)**	**Lecturer (n=14)**
Overarching Theme: Environmental Strain						
Theme: Competing Workplace Demands	0	0	0	0	0	0
Broad Curriculum Offer & less GLH	1	1	19	1	1	8
Building employer relationships	2	4	6	2	3	2
Developing new resources	0	1	5	0	1	3
General reference to lack of time	3	4	13	3	4	10
Keeping skills up to date	0	4	6	0	3	6
Management responsibilities	1	2	3	1	2	2
Paperwork	1	3	12	1	3	6
Pastoral Care	0	6	2	0	3	2
Planning and Marking	0	2	9	0	2	6
Results driven	0	0	6	0	0	3
Teaching	2	6	4	2	5	4
Theme: The Bare Necessities	0	0	0	0	0	0
Conflicts with IT Teams and Policies	1	6	18	1	5	6
Funding required for high quality resources	9	8	14	5	5	7
Specialist facilities required	0	4	11	0	3	7
General comments that resources are needed	1	4	9	1	3	5
Limited teaching materials	0	0	10	0	0	4
Inadequate college network (inc PCs)	1	11	14	1	6	7
We could have better resources	0	3	8	0	3	5
Theme: The Kids Aren't Alright	0	0	0	0	0	0
Student Background	0	0	0	0	0	0
Educational background	4	11	20	2	6	7
Student Tech at home (Disadvantaged)	4	9	7	2	3	5
Student Motivation	0	4	19	0	3	8
Life Pressures	0	2	9	0	2	4
Students have to be there	0	0	5	0	0	3
Overarching Theme: It's a Hard-Knock Life						
Theme: Difficulty of Work-Life Balance	0	4	12	0	3	6
Theme: Mental Wellbeing	2	7	10	2	5	6
Overarching Theme: Tales as Old as Time						
Theme: Lack of Experienced Staff	3	13	23	3	7	8
Earn More in Industry	4	2	3	3	2	2
Theme: Please Sir, I Want Some More (Money)	6	7	9	4	4	5
Theme: We Don't Need no (Secondary) Education	1	9	10	1	5	5
Total	**357**	**458**	**652**	**8**	**10**	**14**