

THE PERCEIVED IMPACT OF CPD ON EARLY CAREER SCIENCE TEACHERS

by

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Abstract

According to STEM Learning UK (2018) a skills shortage in STEM (Science, Technology, Engineering and Mathematics) is costing the economy £1.5bn a year, and while the number of students attending secondary schools increases, students opting to take science-based A levels is only showing only a small increase according to Ofqual (2018). It is important that teachers are constantly improving their knowledge and skills to make desirable changes (Roth et al., 2019) to provide good quality education as ultimately, as Hattie (2012) suggests, teachers are best placed to enact changes in students. It is therefore imperative that CPD (Continuing Professional Development) is of good quality and creates an impact on students (Enser and Enser, 2021), otherwise there is “little point” (p. 107).

This small scale (n=15), online survey was completed by science teachers after a CPD session. The data was then analysed using the SPSS 25 package and the Chi square test used to identify statistical analysis. The aim was to identify the impact of CPD on Early Career science Teachers (ECTs) compared to non-ECTs and it was generally found that there was no statistical significance between the two groups, so CPD is having an equal effect on ECTs when compared to non-ECTs. Non-ECTs tend to read around their subject more than ECTs and so this should be encouraged in order to close the gap between the two groups. In addition, ECTs tended to increase their range of activities used to teach science after CPD more than non-ECTs and ECTs had a greater level of perceived need with subject knowledge than non-ECTs, but it was found that both groups attended subject knowledge CPD equally.

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1.0 Introduction

1.1 Personal rationale

As a teacher, I have often sat through CPD (Continuing Professional Development) sessions both in school and externally and at the end made a snap judgement as to whether I thought it was good or not. When I started delivering CPD to Early Career Teachers (ECTs) in STEM (Science, Technology, Engineering and Mathematics), focusing on science, it got me thinking about exactly what teachers leave CPD having perceived to have gained. ECTs are those teachers who are in their first two years of teaching and so have reduced contact time in schools and are offered additional training by a mentor within the school to aide their transition to tacking full responsibility for a class or classes. Many CPD sessions seemed to follow the same pattern: some ice breakers to get people talking; a knowledgeable facilitator talking for a while; the odd activity to be completed in small groups here and there; and some enthusiastic teachers asking numerous questions while everyone else sat quietly. Personally, I particularly enjoy the social aspect of getting out of school and talking to other teachers about their experiences as this was often, for me, the most helpful discussion and CPD. Which led me to this project to understand what impact CPD has on ECTs, initially on whether it builds confidence or competence, but more broadly on what exactly CPD does for new teachers.

Undertaking a research project during the Covid-19 pandemic has been incredibly tough. The initial plan to produce a survey with follow up interviews changed dramatically as schools closed and learning moved online. Schools were not hosting CPD sessions, neither were outside agencies and so it was difficult for anyone to see my survey. Additionally, travelling around to various schools to interview teachers was unwise and forbidden under temporary laws and so the project had to adapt and change. I have learned a lot and hope that this project has already changed the way that I personally deliver CPD: hopefully for the better.

1.2 Academic rationale

To understand the current climate in terms of ECTs, STEM, and CPD, existing literature has been identified to highlight any gaps in the knowledge and set out in Chapter 2.0 'Literature Review'. According to STEM Learning UK (2018) a skills shortage in STEM is costing the economy £1.5bn a year, and while the number of students attending secondary schools increases, students opting to take science-based A levels is only showing a small increase according to Ofqual (2018). STEM education is

important in schools as it gives pupils more than just content-based knowledge: students can be hands on; work collaboratively; and problem solve, all of which is important to industry.

CPD is a process whereby teachers are constantly working to improve their skills over their entire careers, which Jackson (1992, cited in Hargreaves and Fullan, 1993) suggests allows for desirable changes to the teacher and Roth et al. (2019) suggest CPD improves outcomes for students. Schools spend huge sums of money on CPD and so it's important that CPD is worthwhile for all stakeholders otherwise, as Enser and Enser (2021) suggest, there is "little point" (p. 107). What is not clear however, is exactly how this push translates to the needs of ECTs. Often, those teachers with more experience grow cynical about CPD and structural barriers (Hamilton Broad, 2015) prevent meaningful growth. ECTs may not be impeded by these interceptions being new to the profession, but current literature doesn't make this clear.

CPD can be more than sitting in a hall with a knowledgeable speaker leading from the front. McNamara (2019) describes CPD as "learning that is implicit, social and spontaneous" (p. 690) and so, given that ECTs are often younger and have grown up with technology, their access to alternative forms of informal CPD may be greatly different to non-ECTs. Again, there seems to be a gap in the literature highlighting the various types of informal and formal CPD available to teachers and how its utilised.

Finally, Opfer and Pedder (2010) outlined the stakeholders likely impacted by gains made by teachers and Capps, Crawford and Constan (2017), in a review of CPD, demonstrated how teachers were impacted by CPD but there is no real literature analysing specifically how ECTs fit into this frame. ECTs typically have recently come from a university course, and before that have studied a degree, and so are in the mindset of studying, using research and striving to improve.

1.3 Research questions

After identifying gaps in the literature, the overarching aim is to investigate the perceived impact of CPD on Early Career science Teachers. This will be achieved by breaking this aim down into the following research questions:

- Are science Early Career Teachers intrinsically motivated to develop through Continuing Professional Development?
- Does formal and informal professional development jointly contribute to the progression of science Early Career Teachers?
- Does Continuing Professional Development increase the range of activities used to deliver science in Secondary education amongst Early Career Teachers?

- Does Continuing Professional Development develop perceived confidence or perceived competence amongst Early Career Secondary teachers?
- Is the perceived impact of Continuing Professional Development greater for science Early Career Teachers than non-Early career teachers?
- Are the needs of Early Career science Teachers different to their more experienced counterparts?

To gather evidence, a questionnaire was produced using SurveyMonkey, under the criteria mentioned by Ritter and Sue (2007) as online surveys are fairly cheap (Hooley et al., 2012) and large quantities of anonymous data (Park et al., 2019) can be collected. The survey was disseminated at the end of a CPD session: initially this was going to be undertaken by a large CPD provider however due to the Covid-19 pandemic, this changed to a much smaller scale provider. This is outlined in chapter 3.0 'Methodology'.

1.4 Summary of findings

The project was a small-scale, snapshot survey of CPD in Kent and Medway. The amount of data was impacted significantly by the Covid-19 pandemic and the planned post-survey interviews could not take place. After analysing the data using the SPSS 25 package, there was no statistical significance shown between ECTs and non-ECTs, indicating that the impact of CPD is similar for both groups.

A significant finding, however, is that non-ECTs tend to read around their subject in greater proportions to ECTs and so, to narrow the gap between the two groups, ECTs should be encouraged to partake in this activity more and should be built into CPD sessions to create homogeneity. There was also a difference shown in that ECTs increase the range of activities they use to teach science as a result of CPD whereas this is not always the case for non-ECTs. Finally, ECTs perceive a greater level of need in terms of subject knowledge compared to non-ECTs but both groups attend subject knowledge CPD equally.

2.0 Literature Review

This chapter will discuss the wealth of literature that currently exists within the academic sphere. The literature review will explore the literature predominantly in the areas of:

- STEM – Why STEM is important as an industry; skills gained in STEM education; should we embrace STEM?
- What is good teaching? – continuous learning; stakeholders in education; features of teaching
- Continuing professional Development – What is CPD?; who benefits from CPD?; limitations to successful implementation; needs of ECTs; and range of activities

Within this chapter, a number of acronyms will be used. Firstly, the term Science, Technology, Engineering and Mathematics (STEM) is used to encompass the four academic disciplines. In the UK, STEM is used when referring to the curricula within schools, academic disciplines in universities, as well as when referring to career paths. Medical careers, veterinary careers, computer science, statistics, any career rooted in science and technology like materials science and communications, as well as more creative professions such as architecture, computer science and space technologies would all be considered as STEM.

Secondly, Continuing Professional Development (CPD) is used to refer to training or staff development undertaken by teachers and its definition is discussed in more detail within the literature review. In the US this is commonly referred to as professional development.

Finally, the term Newly Qualified Teacher (NQT) is used to refer to teachers that have finished their initial training and are in their first full year of teaching. These teachers require a reduced timetable compared to other teachers for them to continue honing their teaching craft. Recent changes by the Department for Education (2021) have now superseded the term NQT with ECT (Early Career Teacher) which comes into effect from September 2021 and aims to elongate and enhance new teacher's induction to the profession by offering two years of induction, rather than one, and so the phrase ECT will be used throughout.

2.1 STEM

According to STEM Learning Ltd. (2018) the skills shortage in STEM is costing the economic sector £1.5bn a year in “recruitment, temporary staffing, inflated salaries and additional training costs”. This is a staggeringly large amount in terms of costs. Not least, as students in the UK study these subjects

in one form or another throughout the primary and secondary education. In 2018, there were over 1.2 million science GCSE entries (Ofqual, 2018) as well as 715,775 mathematics entries, 117,605 Design & Technology entries and even 4,715 Engineering entries. A-level entries for Biology, Chemistry, Physics and Mathematics all saw small increases in entries from 2017 to 2018 (Ofqual, 2018) although as the numbers of students attending secondary schools increases, this is likely. Students are taking up the opportunities to study STEM subjects but this does not necessarily correlate to large numbers of people entering the job sector. Over the next 10 years, over half of businesses (STEM Learning Ltd., 2018) expect the problem to get worse in terms of employing suitably skilled candidates. Many universities, in order to reduce costs, have reduced the access to practical laboratories and the number of hours spent hands-on during degree courses (Bosworth, Lyonette and Wilson, 2013, p. 14) which has led to a decline in what graduates can offer. This is mirrored by Rayner and Papakonstantinou (2015) in that Universities have a focus on knowledge as opposed to more practical, work-related skills. So, graduates lack interpersonal skills such as planning and organisational skills, understanding ethical conduct and flexibility across the board.

STEM offers students a lot more than just a job: a large range of transferable skills relevant for the 21st Century. Transversal, multidimensional and higher order skills (Ismail, 2018) are developed by those in the STEM sector. Students and those in jobs are required to use computer systems and networks, work with many stakeholders of all educational backgrounds and social classes as well as managing teams, working to time pressures and working within financial constraints. Jobs involve new and changing technologies and require a high level of literacy when writing reports and preparing other documents. These skills are highly valuable and attractive, meaning those with higher education qualifications often transfer into other work sectors when seeking employment (Mellors-Bourne, Connor and Jackson, 2011).

Education in STEM subjects starts in the Early Years Foundation Stage (Department for Education, 2022) of education. The expectations of what children, from the age of as young as 4 years old all the way through to Key Stage 4 (aged 14-16 taking GCSEs) is set out in statutory documents (Department for Education, 2015; Department for Education, 2017). This ensures that pupils are exposed to the scientific method, can think logically, make and design things (even if this is through play) and learn to count: or at least that is the government guidance. The Industrial Strategy paper from BEIS (2017) seems to suggest that the quality of education, and subsequently the quality of teaching, is sub-par and needs significant investment. The document sets out a whole host of big-spending projects aimed at driving up teaching standards. The introduction of a “£42m...Teacher Development Premium” to offer “high-quality professional development for teachers” (p. 11) in areas that have fallen behind is

an example of this. For maths, they will implement an “£8.5m pilot” (p. 105) to increase the number of qualifications taken up and quality of maths teaching. There is little indication as to what exactly this ‘pilot’ is, who it will be rolled out to or how the government knows if the pilot has been a success. These are substantial sums of money that are evidently signposting what the government perceives as a big issue, and one that needs fixing within a narrow time frame. Interestingly, there is little indication as to how the increase in standards will be achieved, what will be an affective measure as to whether these targets have been met and ultimately if these millions of pounds of investment have been well spent. Shortly after the Industrial white paper, the House of Commons Committee of Public accounts (2018) suggest that between the DfE and the BEIS, there is not a clear understanding of what businesses and industry really need and want from their STEM workforce. They go on to express concern that over governmental boards do not have sufficient industry representation, so the vast sums of money being put forward may give very little tangible gains. On the contrary, an article from Peters (2020) quotes a number of government sources as indicating that past government funding has made a marked improvement on STEM skills and employability. Some subjects will see this focus on STEM as an overemphasis. McInerney (2019) wrote that “three types of English A-level have seen their numbers decline by one-fifth over the past three years” and this is directly correlated to the push on students studying STEM subjects. Clearly, there is an identified need to further the education of young people in STEM disciplines through education and improving the quality of teaching; how that improvement is quantified is very difficult to show.

2.2 What is good teaching?

Teachers have a large amount to learn to educate young people. But it is unclear as to what would be considered as ‘good teaching’. Through observations by senior members of staff and by outside inspectors (such as Ofsted), teachers are given an idea of where they fit on a scale. When areas for improvement are identified, teachers frequently fall back on CPD to help bridge these gaps.

Over time, educationalists change what they consider should be seen in a ‘good lesson’. Many researchers have suggested that ideas introduced into teaching have very little evidence to support reforms. For example, many educationalists advocated teaching using learning styles (Mdikiff and Thomasson, 1993) and tests were produced to establish learning styles (for example audio, visual or kinaesthetic) of students. Riener & Willingham (2010) and Golightly (2019) suggests there is no evidence to support that humans learn more when information is presented in a particular style. Yet for many years this idea became a staple of lessons. Additionally, the idea of a three-part lesson was implemented and trainee teachers across the country were (and still are [Riches, 2019]) encouraged to have a starter, main and plenary within each lesson. According to Hibbs (2010, p.26), this is purely

as “teachers believe that a lesson will only be judged to be successful if it has three-parts”. It then poses a dilemma for inexperienced teachers: implement ideas that may not positively add to their lessons or get told they’re doing a bad job. Instead, teachers should be encouraged to be more “adaptable and reflexive” (Riches, 2019) and focus on what works for them and their students (Severs, 2019). For experienced teachers, it can be much easier to reflect on what is a good addition to the lesson, but for ECTs this may be more difficult as they are lacking in confidence.

Defining teaching (and learning) from a constructivist point of view gives a take on the teacher’s role. In a book often referred to on teacher training courses, Capel, Leask and Turner (2004) suggest that “teaching is becoming more of a research- and evidence-based profession” (p. xvi) and that fundamentals such as “respect and a concern for meeting the individual needs of learners”, “the ability to explain difficult concepts” and having “an attitude to learning which means that you are prepared to continue learning” (p. xvi) are important. Liem and McInerney (2008) have a slightly broader take on teaching and learning, advocating for teachers to be “innovative, creative, research-informed and learner-orientated” (p. 4).

In schools across the UK, teachers manage the needs of all stakeholders on a daily basis. The Department for Education (DfE) (2011) produced a document (Teacher’s Standards) that sets out several key characteristics that teachers of all career stages must adhere to. The DfE aimed to ensure that ECTs meet a “minimum level of practice” (p. 3). These standards should ensure consistency across the profession and attempt to level the playing field in terms of the education that pupils receive. These standards support Capel, Leask and Turner’s opinion that teachers should be constantly learning throughout their careers. Research suggests that when it comes to student’s perception of their teachers, there are a number of factors that can create a successful partnership, or not. Students, in general, like to think that teachers have self-confidence and are sure of what they’re teaching (Saini, Sethi and Chauhan, 2019) and that teachers are good at solving student’s problems. They didn’t tend to rate personal factors like gender, physical appearance or age as highly important. This research has limitations in that it looked at Nursing students in India. However, being a primarily taught course that involves learning content, practical activities and scientific principles, it fits nicely into what STEM stands for in the UK. There have been numerous studies that investigate the self-efficacy and enthusiasm of teachers in schools. Burić and Moè (2020) indicate that “teacher self-efficacy is beneficial for both teacher and student outcomes” (p. 2) and that this can be fostered by “ensuring opportunities for success” (p. 7). Providing teachers with various ways to succeed creates motivated and confident teachers, which, if adopted early on in their careers, can help to retain teachers. Other

studies, such as Hand (2014) highlight that teachers come into education with vastly different previous experiences so there is a need to constantly assist teachers in their learning to create confidence. Earlier, in his ground-breaking research “Visible Learning” (Hattie, 2009) and the follow up “Visible learning for teachers” Hattie (2012) suggests that as students are difficult to change and transform, it is educators and teachers who are best placed to create positive change.

Clearly then, teachers need to have a good grasp of their subject to come across as self-confident and sure of themselves. Over many decades, how to teach and what constitutes a ‘good’ lesson have changed. Hattie’s research is hugely useful to schools in that it looked at over 800 research papers on what increases student achievement. It then gives different aspects of education a score to determine how much this factor adds to students’ education.

Most of what goes on in the classroom inevitably increases students’ knowledge and their ability to achieve. Clearly though, some aspects are preferential, and it is then for schools to determine whether the cost to benefit is worthwhile (for example, cutting class sizes to get a small increase in achievement) (Hattie, 2009). Teaching requires teachers to be deliberate with their actions, with the words they use and how they develop learning over time (Hattie, 2012, p. 19) and there is some difference between how successfully each teacher does this. Factors that are influential include student-teacher relationships ($d= 0.72$), passion for teaching and learning ($d= 0.90$) and having a deeper understanding of delivering content ($d= 0.87$) (Hattie, 2012, pp. 108-128). This is supported by Saini, Sethi and Chauhan’s (2019) research whilst also proving that students have a good grasp of what constitutes good teaching: the factors they look for score highly in Hattie’s meta-analysis.

Interestingly, the teacher’s subject knowledge was almost insignificant ($d= 0.09$) (Hattie, 2012, pp.108-128). According to this research, spending large amounts of time improving teachers’ subject knowledge is potentially a fruitless task (in terms of increasing student outcomes). All teachers are expected to have a minimum level of expertise in their respective field, so it is right then to assume that all teachers are somewhat equal in this respect. Experienced teachers have had time to bond with students over a number of years, get a good balance of strict and welcoming traits and have had a number of years developing their knowledge of the curriculum. They are more likely to have a good idea of the types of questions and frequency of occurrence of topics in exams. There is no clear data that says one way or another whether inexperienced teachers negatively affect the outcomes for students (Greaves, Belfield and Allen, 2019) but yet schools often shield ECTs from having “exam groups”, such as year 11 and year 13. Hattie’s research would support these decisions, but this may make an ECT feel less valued.

The UK has aimed at establishing a standard (the teacher's standards) (Department for Education, 2011). These standards are an end, rather than a means. The standards indicate the attributes teachers must have. In addition, the DfE also provides "mandatory guidance" (Department for Education, 2020) for Initial Teacher Training (ITT) courses. Whilst there are some specific criteria that are compulsory, for example obtaining a Disclosure and Barring Service (DBS) check indicating any criminal convictions, most of the guidance uses vague language like "where possible" and "as secure as possible" (Department for Education, 2020). The guidance also includes no specifics on pedagogy to be learned or subject knowledge for specific subjects, instead indicating that courses should be designed to allow trainees to meet the teacher standards. It is easy to argue that the guidance provided by DfE supports the international ideas back in 2000 that there is likely to be very little consistency between the knowledge of teachers. When looking at the website for Canterbury Christ Church University's (CCCU, n.d.) teacher training course for secondary and University of Greenwich's (University of Greenwich, n.d.) science Post Graduate Certificate in Education (PGCE) it is evident that both courses look at pedagogical approaches to teaching, subject knowledge and engage in professional practice: lacking in specifics is something they have in common. Both these lists of content are both vague and importantly, different. In addition, they will alter slightly year on year, meaning teachers who trained in consecutive years will receive a different insight into teaching. To cover all bases, then, new teachers are going to need to plug this perceived lack of knowledge by continuing learning, so CPD is highly valuable for ECTs.

This idea of inconsistency may explain why teacher education has a relatively low score of 0.11 (Hattie, 2012, p.108). Hattie (2012, p.203) suggests that questioning has a score of $d = 0.93$, problem solving is $d = 0.54$ and experimental enquiry has a high score of $d = 1.14$ (all above average scores). All of these scores are an average of all teaching ability so are likely to be lower for an ECT. Often, ECTs shy away from deep questioning as this involves unknowns: pupils can respond with whatever they chose, often putting the teacher in a position where they are unsure with how to proceed. Problem-solving and experimental enquiry often require good behaviour management, which again are often not well-established by ECTs (amongst others). Therefore, encouraging new teachers to perform these potentially useful activities will habitually not happen: they are clearly at a disadvantage.

From the research it appears that defining good teaching is quite difficult. An outcome from this is to suggest that for those less experienced teachers in particular, their professional development should focus attention on highlighting what they do well and how they can build on this.

2.3 Continuing Professional Development (CPD)

Throughout the career of a teaching professional, one is expected to keep on improving. Year after year, teachers engage in a wide range of activities that are designed to increase the quality of the teaching profession and subsequently, outcomes for students (Roth et al., 2019). Schools across the UK allocate part of their, quite limited, yearly expenditure on CPD for staff. As of 2017, schools in the UK spent £235.8 million on CPD (Staufenerg, 2019) equating to approximately £7700 per school (using current estimates [BESA, 2019]). The DfE (2016, p.3) suggests that teaching is “the most important profession for our nation’s future” and that “teachers need considerable knowledge and skill” hence why trainee teachers must go through a rigorous programme of learning, understanding pedagogy and deliberately practising the art of teaching. Secondary teachers are expected to know large amounts of subject content, often jumping between Key Stage 3, 4 and 5 (ages 11 to 18) throughout any given day and expected to deal with the needs of children with a problem home life or with SEN (Special Educational Needs) whilst being able to essentially perform in front of 30+ children or young people.

The planning of CPD by schools and other facilitators should allow teachers to develop, as opposed to just change (Jackson, 1992, p.63 cited in Hargreaves and Fullan, 1993). As teachers progress through their careers some teachers will change because of this passage of time by, for example, gaining subject specific knowledge, gaining knowledge of students, and being better prepared to deal with student behaviour. But the term ‘development’ is usually saved for referencing desirable changes where teachers are better able to plan or evaluate their lessons or how to move lessons from imparting surface to deeper level knowledge (Jackson, 1992, pp. 64-65).

2.3.1 Self

Not all teachers approach CPD with a positive, forward-thinking attitude. In some cases, teachers are over-worked and lacking in time, and don’t always see CPD as a good use of their time (Hamilton Broad, 2015). There is also a notion that, as CPD is compulsory throughout a teachers’ lifetime, CPD is a “process done to teachers” and that all teachers need to be “forced into developing” and that all teachers have “deficits in knowledge and skills” (Clark, 1992 cited in Hargreaves and Fullan, 1993). This may seem as a somewhat negative way of thinking of CPD, and most teachers tend to be active and aware of their strengths and weaknesses: they want to improve to give their students the best education. Some studies even suggest that ECTs intrinsically understand the importance of CPD to improve upon their limited skills (Robinson, 2020). It is important, nevertheless, for education to create an atmosphere conducive to learning for both teachers and students. In a study of Further

Education (FE) educators (Hamilton Broad, 2015), barriers to accessing CPD suggest that over-working of staff has a dramatic effect on the impact CPD can essentially have. Legislation has meant that colleges have had to become more efficient, which inevitably leads to less teachers and teachers doing more work. It is suggested that teachers often work “in isolation” (Hamilton Broad, 2015, p. 19) in these settings which goes against the previous studies mentioned where collaboration is key to effect CPD. It was reported in the literature that teachers overwhelmingly wish to access CPD to improve their knowledge and skills but are often prevented due to structural barriers.

Before the start of the Covid-19 pandemic, Truong and Murray (2019) commented on the increasing interest in online CPD in Vietnam. Facilitators are opting to use online teaching platforms as they tend to be cheaper, flexible and teachers are generally able to access them easily with modern technology. When it comes to motivation, it is believed that when teachers want to improve, they gain more from CPD, as opposed to “top-down” (Truong and Murray, 2019, p.4) determination of what a teacher may be alleged to need. The results of this study showed that there was a mix of teachers wanting to improve and having to improve. Although this study was fairly small (n=19) and this was focused on learning English as a second language rather than increasing subject or pedagogical competency, it highlights the balance between intrinsic motivation and extrinsic, institutional need. Truong and Murray’s research corroborated previous research from Tan, Chang and Teng (2015) in that teachers often faced a dilemma when it came to CPD: put the need of self first or the needs of the teaching organisation first? The study also surmises that what teachers perceive to be the benefits of specific CPD can be down to how each individual interprets benefits given their own “cultural and societal context” (p. 1585) so this can be hard for facilitators to cover all bases for all participants.

CPD “cannot exist in isolation” (Department for Education, 2016, p. 3) but must be part of a teacher’s ongoing want to improve. Schools must create a culture whereby improvement of individuals (teachers and pupils alike) is caused by a carrot rather than a stick: therefore “helping teachers to improve their practice takes thought, planning and effort” (p. 3). Teachers need to be shown that this investment in them is on an individual basis to improve outcomes, as opposed to teachers being another cog in the corporate wheel. As Daniel Ward (2011), president of the National Association of Biology Teachers in the US states: attending CPD can make you a “better biology educator” (p. 376), making no mention of the system or student outcomes. ECTs often experience what is referred to as a “reality shock” (Spencer et al., 2018) as the demands on teachers early on in their careers can be somewhat more substantial than their training years and so getting buy-in from teachers in terms of intrinsic motivation to improve is vital. It is important for CPD providers and facilitators to know what

exactly ECTs get out of CPD to ensure that they achieve the necessary buy in to see these incremental improvements.

2.3.2 Alternative CPD

CPD can be argued to be much more than one off, discrete sessions. Any activity or task that involves teachers to analyse curricula or choose a suitable textbook, for example, could be considered as development (Little, 1993 cited in Desimone, 2009; Guskey, 2009) and McNamara (2019) describes informal CPD as “learning that is implicit, social and spontaneous” (p. 690), whilst being considered a key component of any teachers’ CPD as it allows teachers to self-direct (Richter et al., 2011). If teachers actively engage in online forums or conversations on social media, like Facebook and Twitter, they are reflecting on their practice or some specific aspect of education as well as using subject textbooks to assist them in their planning or background reading. McNamara (2019) suggested several years ago that the use of social media has been steadily increasing for a decade and a half (data available up to 2019) and the recent Covid-19 pandemic has meant that many events have had to transition to almost entirely online (with many staying online into the 2021/22 academic year). Spencer et al. (2017) references a study in Scotland that highlighted some of the key ‘themes’ that less experienced teachers should address. This study sits nicely within this research as, although Scotland has differences in its curricula and qualifications, the outlook and mentality within teaching and CPD is practically the same. It inevitably takes time (Bichler et al., 2021) for CPD suppliers to re-design and adapt to online teaching and learning. In the meantime, it is not unreasonable for teachers to seek solace elsewhere, particularly as teaching was moved to online across schools in both primary and secondary schools across the UK as well as in 194 countries worldwide (Teo, Tan and Chan, 2021). A teacher could read an article about a new discovery in their field or a book about pedagogy: all these activities could be argued to be CPD. This is nicely summarised by Capps, Crawford and Constan (2017) in that CPD extends from teacher training through to retirement and includes any experiences that are both formal and informal training. As a result of this, teachers must surely benefit, and indirectly so must their students. As educators, it is likely that Covid-19 will lead to new norms (Teo, Tan and Chan, 2021) which leads to the questions: does formal and informal professional development jointly contribute to the progression?

2.3.3 Range of activities

Jackson (1992, p.63) suggested that “teachers develop in the process of their careers or how the teaching profession as a whole is developed”. Although the ideas developed are 20 years old, the ideas are relevant today and are similar to what other literature outlines: teachers improve personally to

better their ability to teach students. The significance of this idea (CPD aiming to develop the teaching profession as a whole) is that educationalists may be looking at CPD in a very narrow fashion. This seems to suggest that education should adopt ideas on how to make each generation more efficient at understanding and explaining concepts and that education embraces technological advances en masse. Each generation of students should get 'smarter' as the whole profession gets better. For this to happen, teachers must adopt a broader range of techniques, collectively, and should be more welcome to seeking out evidence to suggest if what they are doing is 'the best' or whether they can improve. Throughout academic literature, there are several techniques that make regular appearances. The use of assessment as a means for improving on teaching and learning is often cited as having a powerful positive impact (Christoforidou and Kyriakides, 2021) even though there are a range of ways in which Assessment for Learning (AfL) can be utilised in practice. Judge (2021) used the Covid-19 crisis to build on AfL in classrooms across Ireland. The research built on Hattie's (2009) belief that feedback to students increases achievement and the Covid-19 pandemic offered an opportunity to utilise technology to vastly improve consistency across Irish schools. Christoforidou and Kyriakides (2021) showed that, like Hattie (2009), there are myriad ways to implement AfL but that there is a positive overall impact on students when using this technique.

2.3.4 Impact

Teachers have a considerable impact on the achievements of students (Rowan and Townend, 2016) and so it is not unreasonable for teachers to want to improve their practice to better their students. Schools usually offer a mix of CPD sessions so fund both internal and external CPD: it's reasonable to assume that school leadership will want to see some benefit. As outlined above, teachers too want to benefit from engaging with a training course. Opfer and Pedder (2010, pp. 413-414) suggest that there are 3 types of impacts of CPD:

- "CPD that leads to change in pupils', teachers' or school practices sees as desirable be either teachers or head teachers is understood as having *direct impacts*
- CPD that enhances a teacher's *status* or career prospects, and even salary, is considered as imparting *indirect benefits to teachers*
- CPD that increases recruitment or retention is considered as imparting *indirect benefits to the school*"

Inevitably, different CPD activities will have different impacts: either by focussing on the different stakeholders (the teacher or the school as per Opfer and Pedder's suggestion) or by the quality of the CPD being delivered. Ultimately, much of the literature strongly suggests that education reform is

ultimately driven by increasing the outcomes for students (Hargreaves and Fullan, 1993; Desimone, 2009; King, 2014; Department for Education, 2016) and this is often set out in any programme aims. Throughout the literature, many studies do not give a clear indication of what impact CPD has on the students, so it is difficult to link back to the DfE's (2016) primary objective of CPD. Opfer and Pedder (2010) admit themselves that there is little to suggest that CPD is actually "closing the gap" in achievement. Why then, do we persevere with teacher CPD? It may be that CPD is having an impact on students, but that previous studies have gone about determining this the wrong way. King (2014) and Spowart et al. (2017) are highly critical in the data collected to assess CPD. They suggest that, often, CPD is followed up by questionnaires that focus primarily on teacher satisfaction that they refer to as "Happy sheets" King (2014) and (Spowart et al., 2017) indicate that CPD impact has focused on the teacher's satisfaction rather than any impact on learning. The questionnaires tend to shift the emphasis on to "housekeeping" and ask teachers whether the event was well planned or ran smoothly, which is likely to be helpful for the provider to know whether they succeeded, but this goes little way to identifying whether teachers or students have gained. While Spowart et al. (2017) criticize these questionnaires, they do suggest that "the breadth and nature of CPD also complicates the analysis" (p. 369) of CPD. This is a key point as all CPD is different: it may be formal or informal. They are right, then, to suggest that although there is a problem, it is not necessarily an easy one to solve.

2.3.5 Confidence or Competence

Desimone (2009) hypothesises that CPD might be about more than just driving forward results for students. It could be argued that, as it is the teachers that are physically being developed, they are gaining specific knowledge and skills whilst also gaining soft skills in their "personal, social, and emotional growth as teachers" (p. 182). This is agreed by the three criteria set out by Opfer and Pedder (2010) in that teachers gaining these soft skills improves personally, whilst benefitting the school too. One interpretation of the gaining of these soft skills is that teachers become happier in their own abilities and therefore have a better ability to educate their students. It is likely that student outcomes are increasing by proxy. In addition, teachers that regularly engage with CPD may be more willing to try these new techniques that they have traditionally shied away from, such as deep questioning or practical learning.

In a small study of teachers from Uganda, Wabule (2016) explains how, often when teachers are offered the chance to communicate with one another, "teachers become more reflective and researchers of their own practice" (p. 151). This is an intriguing point as the vast majority of CPD is likely to be carried out in collaboration with other professionals which is reflected in the vast majority of research. This communication may be a reason why CPD is helpful.

Leaving aside any intended, planned aims from CPD (in whatever form it is presented) it is assumed that teachers can, as a minimum, increase their ability to reflect. This implies that CPD will often have a direct impact and benefit on the teachers themselves. Valdmann, Rannikmae and Holbrook (2016) designed a CPD sessions to specifically help promote teachers' self-efficacy. Whilst this is different to most literature in that they have designed a specific CPD course (whereas others have assessed the outcomes of existing schemes), the paper concludes that the "programme was able to significantly raise teachers' reported self-confidence" (p. 295) whereby "72% [of] teachers found sharing best practice" was extremely helpful in aiding this. It is yet to be seen if this conclusion can be applied to existing or current CPD sessions, but this could identify a constant in terms of benefit. A new approach is therefore needed to bring together the outcomes for teachers that result from CPD that is often aimed at raising the attainment of pupils and determine whether current CPD increases teacher confidence.

Although the number of studies included in the review by Capps, Crawford and Conostas (2017) is a relatively small number at 17 studies, it does show that many CPD programmes don't always improve outcomes for students. Instead, teachers often come away from training sessions with something new to try in the classroom. The reason for this, though, is unclear. The review itself identifies that 15 of the studies "promoted teacher reflection in their [C]PD" (Capps, Crawford and Conostas, 2017, p.302) but there is no data included to suggest what the outcomes of this critique was on reflection. It is not clear if teachers felt they improved or became better teachers as a result. This mirrored earlier work by Nielsen (2015, p.61) whereby teachers were often "positive when others during CPD provide them with good activities to copy". Several questions regarding the teachers' intentions remain to be addressed. Are teachers actually 'copying' the new idea, or does the expert confirm to them that they are right to try this technique or activity that they previously lacked the assurance to implement? Previous literature has indicated that CPD has the ability to increase teacher confidence under certain conditions (Joyce and Showers, 1995; Iredale et al., 2013; Valdmann, Rannikmae and Holbrook, 2016; Makapoulou et al., 2019), but the research to date has tended to focus on teachers who have a considerable level of prior experience in the field. It is unclear as to whether ECTs will make changes to their teaching to reflect what they learn and gain from CPD.

This is also seen at primary level. Varvarigou, Creech and Hallam (2012) state that CPD leaders "offer ideas presented in a generalised mode for all attendees to understand and use despite their level of experience" (p. 149), requiring individual teachers to assess the usefulness of ideas. There is a gap in the literature that fails to identify if teachers are just blindly following authority (as in they consider the educator leading the CPD to be an 'expert') when implementing new ideas. Finally on this point, Jackson (1992, p. 67, cited in Hargreaves and Fullan, 1993) suggests that once teachers "have

mastered the rudimentary pedagogical skills” (for example, classroom management or how to conduct a practical), their future development is more focused on the psychological aspects on teaching; teachers’ self-efficacy; how individual teachers can help to improve education; becoming more reflective in their practice, as opposed to how they may get a fractionally better grade for their students.

2.3.6 Needs of ECTs

It has been reported in literature that there is a lack of equality in the way that teachers access and how much they can ultimately gain from CPD. There are a range of number of years’ experience amongst teachers and UK teachers are younger (average 39 years old) than the Organisation for Economic Cooperation and Development (OECD) average of 44 years old (OECD, 2019). Quite often, more experienced, older teachers grow more cynical about implementing new principals or making changes to their long-established routines (Dilkes, Cunningham and Gray, 2014; Sau-Ching Yim and Moses, 2016; Will, 2019). This cynicism develops often due to teachers not aligning with ideologies of their institution, constant changes, pay, supervision and through interactions with colleagues; this often hinders their ability to take onboard what CPD facilitators are producing, even if the idea is strongly rooted in evidence. On the other hand, trainee teachers and ECTs are more likely to be up to date with current pedagogical paradigms but may have a lack of certainty in rocking the boat. ECTs may also be more likely to accept ideas due to evidence as they are more likely to have been versed in using evidence more recently (for example, during a bachelor’s degree or PGCE). In addition, more experienced teachers are likely to consider themselves highly competent in most, if not all, aspects of teaching. Huberman (1992, pp. 132-136 cited in Hargreaves and Fullan, 1993) surveyed 160 teachers who each had at least 5 years’ experience (40% had more than 20 years’ experience). They asked teachers to decide whether certain “facets” had been mastered or not, in the teachers’ own opinion: most facets received a mastered rate in 65% or more of respondents. The 5 facets that received less than 65% mastered rate still ranked high amongst the teachers. The aforementioned study conclusively indicated that teachers with 5 years or more experience are confident and assured in their knowledge and their ability to teach. There is no direct data for teachers with less than 5 years’ experience, but they are likely to be considerably lower (Jegede, Taplin and Chan, 2000) in areas such as: AfL; classroom management; subject knowledge; use of ICT; SEN; and motivating pupils. The author identifies that the data does indicate how the teachers came to master these facets: whether they progressed quicker because of training or that these facets develop over time. This is unhelpful in the sense that the data cannot be used to inform future CPD, but it does suggest that more experienced teachers have an instinct that they have already mastered many of the principals of teaching.

2.4 Summary

To summarise, this chapter has taken a critical view on the existing literature surrounding STEM and why there is a need for a nationwide focus; What is considered to be good teaching and why it is important for teachers to continually improve; and what counts as CPD and who benefits from the practice. It seems that there is a purposeful need to fund projects aimed at increasing the numbers of students who progress through school, into university and take up a life-long career in a STEM subject. In schools, this can be improved through competent teaching (as viewed by students) and by providing teachers with the best possible chances of succeeding and being the best they can for both them and their students. It has become clear, however, that the beneficiaries from CPD is often unclear and that whilst the aim of CPD is to increase the outcomes for students, it is more likely to have not been measured or that the biggest outcomes can often be for the teachers themselves. Further study is suggested to determine whether ECTs and less experienced teachers gain from current CPD. In addition, to help future CPD sessions be tailored to the needs of new teachers, there is a gap in the research as to how much CPD improves their competence or how much CPD adds to their confidence levels.

As has been identified throughout this chapter, this research will answer the following five research questions:

- Are science Early Career Teachers intrinsically motivated to develop through Continuing Professional Development?
- Does formal and informal professional development jointly contribute to the progression of science Early Career Teachers?
- Does Continuing Professional Development increase the range of activities used to deliver science in Secondary education amongst Early Career Teachers?
- Does Continuing Professional Development develop perceived confidence or perceived competence amongst early-career Secondary teachers?
- Is the perceived impact of Continuing Professional Development greater for science Early Career Teachers than non-Early Career Teachers?
- Are the needs of Early Career science Teachers different to their more experienced counterparts?

3.0 Methodology

When undertaking original research, it is important to acknowledge the world-views of the researcher. Research philosophy outlines a set of beliefs that the author holds that may determine their relationship with the world and therefore how they may go about collating information. In addition, having a full and informed understanding of philosophical principles allows the research to focus the design of their social research (Moon and Blackman, 2017). This chapter will also identify methods in collecting data and producing surveys. In engaging with fellow teachers, it is important that the researcher acknowledges and makes suitable allowances for any position of power. This chapter will also identify any limitations to the data and therefore the implications on any conclusions made.

As a science teacher, it always seems more appropriate to resort to collecting primary data (as per an investigation or experiment) in a quantitative manner (as per the positivist paradigm discussed shortly) but it is not necessarily the most appropriate stance to take to all data collection so the researcher's position, and reasoning must be carefully thought out and expressed throughout.

This chapter will set out how the research questions can be answered, the methods for collating data to answer these questions as well as exploring the theory for how these methods of research came about.

3.1 Research and Methodological Paradigms

Research is often categorised as either qualitative or quantitative and according to Holtz and Odag (2020) "depicted as two incommensurable paradigms" (p.542) with each being underpinned by their corresponding epistemologies and ontologies (Guba and Lincoln, 1994). Bryman (1992) goes on to suggest that, historically quantitative and quantitative data collection styles have become associated with distinct methods of data collection but that "approaches to research can have and do have an independence from their epistemological beginnings" (p. 506). More recently, researchers are becoming more pragmatic and seeing data collection as a way to collate evidence and answering questions without so much emphasis put on the traditional paradigms (Doyle, Brady and Byrne, 2009). Often, paradigms encompass a wide range of ideas meaning that Ryan (2015) says "one can belong to 'several' scientific communities at once" (p. 423) so it may be prudent to accept that one won't always fall into a defined position. Mixed methods research seeks to combine the advantages of both quantitative and qualitative methods of collecting data to better answer research questions (Plano Clark and Ivankova, 2017). Petrovic et al. (2017) suggest that mixed methods research, whilst fairly

new in the explicit use of new terminology, is not new in its application, and that there are examples of research from 1990 employing similar techniques.

To answer the research questions set out in this study, it will be important to collect both qualitative and quantitative data and so employing a mix of techniques would be prudent. Surveys and experiments with closed questions (to collect quantitative data) tend to fit with the positivist methodologies, to understand the 'why' behind teachers' answers will require a more nuanced technique such as an interview (falling into the qualitative approach) (Creswell, 2003 in Petrovic et al. 2017). In this case, and with many other research studies, being able to formulate a suitable conclusion after data collection would be the primary goal, rather than aligning fully with any one particular paradigm. This is explained by Doyle, Brady and Byrne (2009) as the end justifying the means.

To understand the way that human beings perceive aspects of the world, why they hold certain beliefs and how they have come to devise these beliefs, requires researchers to understand epistemological ideas as well ontological concepts. Within these two categories, there are then differing schools of thought as to how we can access and interpret ideas. Researchers will have their own "metatheories" (Sousa, 2010), that is ideas that researchers are likely to hold about knowledge and therefore perpetuate, and "should make metatheoretical commitments unambiguous" throughout their research. Therefore, it will be necessary to comment on the nature of this study. It is also important to acknowledge that this study is primarily studying science teachers. It may therefore be helpful to consider experiences that they have and their familiarities when answering questions and also ways in which they are used to thinking about what they do and don't know. During teacher training it is often beneficial to be reflective in your practice. This is likely to affect the outcomes of studies, in that science teachers may feel just as at ease giving open-ended answers to questions as they are ranking ideas, for example.

Within this study, there are two dominant paradigms where researchers, and subsequently research, fit either into the category of positivism, relying more on quantitative research, or interpretivism, relying on qualitative data (Alharahsheh and Pius, 2020). The process of "understanding a problem" (Kuhn, 2012) requires humans and researchers to know what is reality (ontology), how we know something (epistemology) and how will we go about finding something out (methodology) (Corbetta, 2011). So, to move on with designing an investigative study, these things need careful consideration. To understand the questions being asked in this research, gaining knowledge on the changes to teachers' educational practice will be sought and collected quantitatively. To understand whether the

CPD sessions cause ECTs to gain confidence or competence, for example, will need a little more nuance and require the researcher to have a more “flexible research perspective” (Panhwar et al., 2017, p. 254).

When undertaking research, the practicalities of collecting data are hugely important. However, the way that researchers think about knowledge is arguably more significant. Hitchcock and Hughes (1995 cited in Cohen et al., 2018) suggest that:

“ontological assumptions (assumptions about the nature of reality and the nature of things) give rise to epistemological assumptions (ways of researching and enquiring into the nature of reality and the nature of things”. (p. 3)

This statement indicates that, before researchers can make assumptions into the ways of collecting information, they must first contemplate the way we see knowledge. Cohen et al. (2018) suggest that research methods are more than collecting data, but “how we view our world(s), what we take understanding to be and what we see as the purposes of understanding” suggesting researchers must have a good grasp of social motives before delving into the “technical exercise” (Cohen et al., 2018, p. 3). Potentially, questions could not be simply answered by a teacher without some careful thought, reflection and time to consider the implications of the questions – being a reflective practitioner is something that is considered powerful for teachers throughout their careers (Ghaye, 2011) and researchers, such as Jiang and Zheng (2021) conduct studies to help teachers overcome barriers to reflective practice. So, any research would have to carefully extract the ideas that the teacher may hold.

To fully understand why teachers may hold certain views on education, and in particular views around what they and their profession gain from CPD events, it is important to understand how views and values develop within individuals. Being an ECT may mean that you have preconceived ideas that may alter and develop with experience, you may have developed ideas based on a research-based approach to teacher training or you may have absorbed views from the first school that you have taught at. To draw on this menagerie of experiences will require careful thought in terms of designing a series of questions that adequately cover all bases. In addition, the initial standpoint of both the researcher (in this case a fellow science teacher) and the wider science teaching profession must be considered.

3.1.1 Positivist and Post-positivist Epistemology

According to Walliman (2006), there are two main paradigms surrounding the acquisition of knowledge: empiricism and rationalism. Empiricism is a long-held ideology that physical experiences cause knowledge to be acquired, through inductive reasoning (Walliman, 2006) whereas Rationalism suggests that knowledge is gained through reasoning, “using deductive reasoning”.

There are then two ways that researchers can aim to gather information to answer a question. For positivist researchers, there is a held belief that “the human mind is born blank” (Sousa, 2010, p. 465), that the world and its observable phenomena existed before the human mind. Humans then experience these phenomena and with observation and experimentation, researchers then extract these ideas and that researchers are able to unlock access to the information that an individual has gained, throughout their lives. Importantly, the positivist viewpoint, according to Fleetwood (2001) assumes that phenomena have a route cause in another event, and so through empirical evidence, all knowledge is fundamental, observable and predictable, and therefore separate from any human construct or the mind. This differs from the alternate interpretivist paradigm of experience through social interaction.

The main point is that these phenomena are experienced multiple times and can be generalised from a sample to a population (Sousa, 2010). At the same time, the “investigator is capable of studying a phenomenon without influencing it” (Sale et al., 2002, p.44) as the researcher and researched phenomenon are independent of one another. There is an assumed link between what individuals have gained through their senses, and the perceived tangible evidence that individuals can give to a researcher. Ryan (2015) suggests that “positivism is a culture” (p. 422) and this idea allows us to recognise that people that come from a similar background, have had similar experiences and therefore see the world in a similar way will more than likely have shared beliefs and reproduce these when probed at a later date. Observations and experimentation can provide one with evidence and those researchers will produce studies that they accept as empirical (Sousa, 2010), enabling researchers to deduce knowledge into neat laws, identifying causal links through careful observation (Henn et al., 2009). These ideas, then, seem to fit with the study of quantitative research where Sale et al. (2002) conclude that quantitative research is both reductionist and positivist. This fits with a scientific model way of undertaking research but also with the way that, specifically in this case, science teachers would be able to suitably understand closed-question type surveys and a positivist study, as outlined by Sapsford and Jupp (2006), typically follows a quantitative approach. It is often argued that qualitative data doesn’t always allow for clear conclusions (Sapsford and Jupp, 2006) whilst quantitative data can better control for variables and remove the data from context. Any ECT

in science should hold a science-based degree and therefore a study founded on the scientific model of postulating a hypothesis, collecting primary, quantitative data and coming to a conclusion (the scientific model) is likely to align with the participants' knowledge base and preferred way of working. This idea fits with the idea that "positivist epistemology is one of objectivism" (Scotland, 2012) and so this positivistic paradigm lends itself to some parts of the study; specifically the question of whether teachers come away from CPD sessions with new activities or ideas they may wish to try with their class or classes.

In addition, researchers can ponder and wonder the exact meaning of this paradigm and that theory, but it is generally conceived that "positivists just 'get on with the research'" (Sousa, 2010, p.464) to collect information to further the world of knowledge. This is important when looking at CPD as the rationale for this thesis is to better deliver CPD sessions to ECTs. A pragmatic approach to finding the most efficient way to deliver training to new teachers is beneficial to both the teacher and CPD facilitator.

Researchers of this nature avoid hypothetical discussion and focus attention on the ideas surrounding quality of data collection, where data is considered 'valid' if results "correspond to how things really are out there in the world" (Sale et al., 2002, p. 45). This snapshot data of what is happening in the CPD-sphere right now can give an accurate picture of education as is. This allows any significant findings to be implemented and changes enacted in real time. A longitudinal study, for example, may miss the nuance of what is happening right now and instead provide an average picture.

Research of a positivist nature concentrates on "observation or experimentation" (Sousa, 2010, p.465) whilst being systematic (Cohen et al., 2018) and Scotland outlines that "true-experiments are preferred" (p.10) to gain an insightful understanding into knowledge that can be actively received from the world. Typically, methods included surveys or questionnaires, controlled-variable experiments and random samples (considered a more quantitative approach). On this occasion, a true experiment cannot be achieved but surveys will be issued to collect primary, quantitative data and so aligns with a positivist outlook.

The alternative paradigm within epistemology is interpretivism. This school of thought focuses less on discovering facts, but instead on building up a case study to uncover accounts or beliefs held by individual or groups (Atkins and Wallace, 2015) to understand subjective experiences. This methodological approach assumes that the researcher has some influence over the subjects being investigated and that this relationship can have significant effects on the outcome: in which case, researchers should take careful measures to ensure "credibility" (Kivunja and Kutini, 2017, p. 34).

Whilst this is not always the case, it is significant enough to be considered by those researchers aligning with this approach.

To fully appreciate the outcome of any quantitative data, questions must be included to understand why teacher's may have given the answers they have. For example, if they felt that a CPD session didn't increase their knowledge this could be because they were given knowledge that they felt they already held, the knowledge given wasn't relevant to their context, wasn't delivered to them in an accessible way or many other reasons for the way they may feel, and a more interpretivist view could be helpful here in that each experience may vary individually (Kivunja and Kutini, 2017) as opposed to a universal law. If the researcher wishes to understand the reasons behind such intrinsic attitudes and beliefs, it is likely to be necessary that some part of the study focuses less on facts and more on answering the question 'why'.

Science is ever changing and progressive (White and McBurney, 2013), and therefore so are social sciences, so researchers and research should change too. The idea that all research fits into either of these two objective or subjective, positivist or interpretivist paradigms could be seen to be somewhat archaic. For some, post-positivism is irresponsible and akin to supporting subjective research (Pontaki and Wight, 2000) and that finding a compromise between the two 'sides' combines the worst of both positions whilst Panhwar et al. (2017) suggest post-positivism is a positive, new paradigm, suggesting it can reduce biases found in interpretivism. However, from a different standpoint, it must be true that it also takes the benefits of both extremes. When undertaking this research, it would therefore be wise to consider the reactionary post-positivism paradigm.

It was felt by some researchers that positivism, whilst perfecting the art of giving empirical truths, was not always a suitable position to take (Panhwar et al., 2017), especially for social sciences as the study of human behaviour is often too abstract (Greenfield et al., 2007) and isn't predictable enough to fit the positivist epistemological methods. This new paradigm (post-positivism) brings together aspects of both positivism and interpretivism, to utilise quantitative data and lived experiences whilst accepting that an empirical truth is not always a possibility. Mittwede (2012) explains how, outside of the strictest experimental research, it is unrealistic to believe that assertions on knowledge cannot be made without some caveat that somewhere along the line, any findings are likely to have picked up some inaccuracies and post-positivism takes this into account in its ideals. As this research is not solely experimental, whilst still intending to find a quasi-truth, it is therefore believed that this research most closely aligns with the post-positivism paradigm.

3.1.2 Realist Ontology

Ontological assumptions are those “about the nature of reality and the nature of things” (Cohen et al., 2018) or “what constitutes reality” (Scotland, 2012, p.9). When designing social research, one must focus carefully on the way that humans see the world and what they perceive as to be real.

When it comes to scientific research, most would argue that a hypothesis, based on theory, can be tested and truths found to be real. In terms of ontology, this would fit with the paradigm of ontological realism, as outlined by Denzin and Lincoln (2018). In general, ontological realism suggests that things are real, they can have descriptive features and that we can start to share commonalities between these things (Nola, 1988 in Pernecky, 2016). In addition, Pernecky (2016) suggests ontological claims around non-tangible objects can be made in relation to those objects that are considered real.

According to Moon and Blackman (2014) “realist ontology holds that one single reality exists and can be studied” (p. 1170) which allows researchers to design studies that utilise methods such as questionnaires to collect data to prove or disprove this perceived reality. This is key when trying to understand what teachers specifically gain from CPD events, as with careful questioning, it will be possible to determine whether ECTs have been impacted differently when compared to non-ECTs. In addition, knowing if they have gone away and tried out a new technique is a black and white concept, as is using this data from questionnaires to make comparisons between new teachers and those with years of experience. One must act with caution, however, when using simplistic methods to collect data and show causality. Pernecky (2016) advise that these philosophical standpoints can exist along a spectrum where the exact truth may vary and therefore increase or decreases one’s confidence in making grand claims. It is also possible that as researchers carry out their work over years or decades, they might drift along this spectrum. For example, Hilary Putnam moved from being a strong “scientific realist in his early career” to “embracing internal realism” (Pernecky, 2016, p. 115).

It is worth noting that although realism acts to find absolute truths, Abercrombie, Hill and Turner (2006, p. 320) suggest that “explanation in both natural and social science consists of uncovering the (real) underlying and often unobservable mechanisms that connect phenomena causally, and not merely in showing that phenomena are instances of some observed regularity”. To uncover unobservable phenomena, research design needs to carefully tease out ideas held by individuals, when they may not know themselves on which their position is on certain qualities or ideas.

Alternatively, the position of relativist ontology exists whereby reality is thought to exist within each individual, with each individual creating his or own version of events that is non-contradictory

compared with others (Hugly and Sayward, 1987) suggesting that maybe there is not one single, confirmed 'truth' but instead truth exists within a group with each individual accessing ideas slightly differently. This research will lean more towards the realist position as it is often used to find 'definite truths' that can later be used to make predictions as to how other humans may act or behave given certain situations. This is a plausible stance to take in this research as it is helpful to later on know what teachers gained from CPD, for example.

It is key to distinguish between what is coined Naïve realism and Critical realism, with Naïve realism accepting that experiences are separate from the mind (Dermicioglu, 2016) whereas Critical realism draws on an individual's unique collection of experiences and perceptions (Summers, 2014). If one is completing a purely scientific hypothesis with clearly defined variables and easily managed controls, scientists and researchers can be quite confident in the correlations and causality that is the outcome of a study. This may be suitable for a laboratory study. However, when researching humans as subjects research should err on the side of caution. Naïve realism would happily accept that the research outcomes are pure truths; often with unequivocal, empirical truths (Morgan, 2017) and that the things that one is perceiving is exactly as that thing is in the world. It would be sensible and functional to take a critical stance where it is perceived that truths are 'real' but we can only assume they are real to some degree of probability (Guba and Lincoln, 1994) and therefore this paradigm will be acknowledged for this study.

3.2 Methods

To answer the research questions, there was a need to collect both qualitative and quantitative data from respondents. Primarily, an online survey (Appendix 1) will be shared with respondents containing a majority of closed questions along with some open-ended questions. This would be followed up with a sample of respondents taking part in an interview to delve deeper into the reasons behind beliefs held and why attitudes have formed over time.

It's worth noting at this point that the planned methods and the final methods differed somewhat due to restrictions throughout the Covid-19 pandemic, particularly when it came to face-to-face activities or any research involving teachers as participants.

3.2.1 Use of Online survey

To answer the research questions outlined in this study, primary data is required to understand what ECTs gain from CPD events. There are two types of data that can be collected: quantitative data which

typically results in numbers (Sapsford and Jupp, 2006) and qualitative data that is “largely descriptive in character” (Boulton and Hammersley, 2006, p. 245).

To collect this data, a survey or questionnaire will be needed. There are a number of options available: in-person surveys; mail questionnaires; email questionnaires (various types); and online surveys. Traditionally, the term ‘survey’ and ‘questionnaire’ have been used interchangeably, although a survey more widely is the process of collecting data from a population at a given point in time (Cohen et al., 2018) and a questionnaire is a set of designed questions with the aim of collecting specific information (Davies and Hughes, 2014), and the term ‘survey’ will be used throughout this research as it appears frequently in literature as ‘online survey’. Web, internet or online surveys have become a modern method for data collection as: response times are much quicker as suggested by Fan and Yan (2010) and later by Park et al. (2019); they are much cheaper than alternatives (Lozar Manfreda and Vehovar, 2008; Fan and Yan 2010 and Hooley et al., 2012); large amounts of data can be collected and analysed (Fan and Yan, 2010 and Park et al., 2019); and anonymity is much easier to achieve (Hooley et al., 2012) than alternatives. This is the preferred method in this research as it’s likely these ECTs will have the skills and technology to complete this type of survey (Ritter and Sue, 2007) as they are likely to be younger than their colleagues. The downside of online surveys is that response rates can be somewhat difficult to predict: some researchers suggest online surveys often receive lower response rates (Cohen et al., 2018) and can lead to larger non-response rates as often respondents will be exposed to large numbers of surveys (often spam) and struggle to break through the noise (Bozman and Stem Jr, 2005). Fan and Yan (2010) suggest that this leads online surveys to have lower response rates than in-person surveys or mail surveys, whilst Saleh and Bista (2017) propose that “online surveys yield significantly higher response rates than paper surveys” (p. 64). Factors such as participants interest in the topic can help to increase response rates (Saleh and Bista, 2017) which, if is always the case, will be helpful for this study. To cut through the noise, so to speak, teachers will be exposed to this survey at the end of CPD sessions where they are already in attendance, as opposed to trying to seek at teachers at other, more random times within busy schedules.

This survey will be included at the end of CPD sessions and events undertaken by an organisation running events in Kent and Medway in what Cohen et al. (2018) refer to as Cluster Sampling: due to the large geographical area that schools cover it is impractical to randomly select schools and spend the time travelling between them. This will have ramifications on the validity of results: all data will be collected from one area of the country and not through a sample across the UK and so one should be careful to account for bias. This is due to the difficult nature of working with many organisations

across the UK that all aim to provide CPD to science teachers. It would additionally be difficult to ensure that all areas of the country have a similar accessibility to numbers of CPD events to ensure equal representation. Focusing the survey in Kent and Medway allows for easier data collection by the researcher and the researcher already works alongside this organisation so permission has already been sought prior to commencement of this research. However, this method of data collection may be easier, but limits the researcher's ability to generalise conclusions (Vicsek, 2010) as standardisation may be hard to achieve. For example, CPD may be delivered well in one area of the country so therefore teachers feel it is beneficial: this may not be the case nationwide.

3.2.2 Design of online survey

The survey will be created using a paid for SurveyMonkey account. This online software allows for an unlimited number of questions per survey and 5000 responses per month, as well as a range of data exports and data analysis tools (SurveyMonkey, 2021). The software provides a user-friendly interface that many internet users will be familiar with from a range of other sources, particularly as research suggests (Poynter, 2012) online users typically completed multiple online surveys. The software also provides a predicted success rate (based on length and complexity of questions) in addition to a predicted completion time. The length of time that the survey will take each individual is key to the study: if surveys are too long, respondents tend to give "don't know" answers, shorter responses or leave the survey incomplete (Deutskens et al. 2004 and Revilla and Hohne, 2020) and shorter surveys tend to receive higher response rates (Deutskens et al., 2004). As suggested by Revilla and Hohne (2020), respondents feel that surveys should not take longer than around 20 mins with the optimum time around 10 mins.

The online survey follows the basic structure as set out by Raclaw et al. (2020): Invitation; Introduction; Content modules; and The Closing (an acknowledgement that the survey is completed and a *Thank you*). The initial invitation is a PowerPoint slide outlining the research, with a web link and QR code to allow respondents to access the survey (Appendix 2). The introduction includes stating the purpose of the research, what data is stored and how this will remain confidential and two check boxes for the respondent to confirm that they are consenting to the study and that they have completed at least one CPD event (otherwise their responses cannot contribute to the study). The Content modules are the main body of the online survey, where a series of 26 questions is asked. The Closing is a *Thank you* to the respondent for taking part as well as researcher information so the respondent can contact the researcher should they wish to. The very final part asks respondents to type in their email address

should they wish to contribute further to the study with a follow-up interview, which is an optional extra.

Good quality question design is key to the validity of any research: in that any answers given should correspond with reality (Fink, 2003; Fowler Jr. and Cosenza, 2008). The survey will combine a mixture of open-ended questions and closed questions, of which the latter will comprise of a variety of simple choices, grids and rating-style questions. Having each respondent understand each question in the same way is also key to allow for comparison, so questions will be written so that they don't contain unfamiliar or technical terms, abstract nouns and verbs or lack a time frame (Fowler Jr. and Cosenza, 2008).

To help find any errors or corrections to be made, the survey was tested on two teachers known to the researcher who would not participate in the study. This type of 'pilot study' is considered best practice (Westlund and Stuart, 2017) before delving into any survey, where the purpose was: to ensure questions were interpreted as expected (with some phrases altered to account for this); to ensure all phrases were understood; to ensure the survey functioned on a range of devices; and simply to spot any mistakes made. The survey then went through four iterations of amendments before it went live which offered the researcher opportunity to adjust the methodology (Schachtebeck et al., 2018).

3.2.3 Data collection procedures

The survey was 'live' throughout January to April 2021. The survey was included in CPD sessions run by a science communicator in Kent, during online sessions. Whilst not specifically targeting ECTs at the outset, all teachers are welcome to complete the survey (on an opt-in basis) with the survey not overtly stating that ECTs are the focus of this study. Allowing all teachers to participate will allow data to be collected from all experiences. The CPD events took place during the Covid-19 pandemic.

Some personal information will be collected from participants in order to make comparisons between respondents' demographics. According to the Information Commissioners Office (n.d.) "personal data is information that relates to an identified or identifiable individual" and could be as simple as an "IP address". The study will collect potentially sensitive data, such as gender, type of school taught in and length of time as a teacher (this may allow for individuals to be identified, hence termed sensitive). The SurveyMonkey software has an optional function to not store the IP address of respondents and individuals' names or school names will not be collected. There is an optional question at the end of the online survey, where participants may enter their email address to be contacted about a potential

follow up. It is important to note that this data is not used as part of the study itself, but as an agreement that the individual is happy to participate further. This data will therefore remain anonymous. Finally, the survey will not be offered at any sessions delivered by the researcher in order to keep all identities anonymous.

Sampling allows researchers to study a small section of a population and to extrapolate conclusions across that entire population (Fink, 1995). In this research, an opportunistic sampling (or “convenience sampling” [Cohen et al., 2018, p 218]) method will be used to gain access to science ECTs taking part in CPD events. Whilst this method may be considered as a weak form of sampling (Jupp, 2006), it does offer advantages in that it’s the least demanding sampling technique available to a researcher and does not require access to a large database of information (such as contact details). Every science teacher in Kent can access the CPD offered by the science communicator, so, all teachers have an equal chance to take part in the survey. Participants are then asked to opt-in (in a volunteer sampling fashion) to the research, rather than being ‘selected’ and chased up with reminders as the researcher is conscious that teachers have a high workload (Department for Education, 2019) and are unlikely to appreciate the additional, unwanted burden. Whilst volunteer sampling can also be seen as a less effective sampling technique, it is advantageous insofar as respondents are quasi-consenting just by clicking the link and starting the online survey (Jupp, 2006) but caution should be taken to avoid building in any bias (Cohen et al., 2018) to what is occasionally referred to as cluster sampling. Some caution should be noted when making any grand claims from these methods of sampling: it will be unknown as to why teachers chose either to participate or not.

3.2.4 Ethics

In order to collect data directly from human beings, there are a number of ethical implications that must be considered. The data that will be collected must be sufficient to answer any research questions without being too personal that teachers would not wish to participate. It’s also important that any respondents feel comfortable that any data associated with them is kept confidential and secure and that they can withdraw from this study should they wish. The ethics application relevant to this research is ETH1920-0062, approved by the University Ethics Committee.

This study is required to conform with the General Data Protection Regulation (GDPR) which implements the Data Protection Act (2018) in the UK. The data is almost entirely anonymised. Email addresses collected are not needed for data analysis, and so will be kept in a separate password-protected database (that corresponds with the unique correspondent number) so data can be

removed if requested, but to prevent any breaches in anonymity during data analysis and so that data was treated as sensitively as practicable. Finally, as per BERA (2018) guidelines, no participant was able to participate in the survey without giving explicit consent and having confirmed they had read key information regarding how data was used, stored, and how to withdraw from the study if required.

The first survey question serves the purpose of introducing the purpose of the online survey, how to contact the researcher and acting as a consent form. This is vital to give information to respondents as to what they are answering and what will happen with their data. It also outlines how they can withdraw from the study, and under which time frame this can happen. To take part in the study, a slide was shown at the end of CPD sessions inviting teachers to take part by either scanning a QR code or by manually entering in a web address (Appendix 2). It was important for teachers to 'opt-in' after the CPD, rather than feeling that they had to complete the online survey as part of the CPD session. As previously mentioned, success rates tend to be higher if the individuals have a personal want to complete the survey (Saleh and Bista, 2017) or have a personal interest.

At a number of key points, participants were invited to contact the researcher using a university email address where any concerns or queries could be addressed. It is therefore assumed that any data provided was done so willingly and with the full knowledge of the participant as to exactly what they were agreeing to. Cohen et al. (2018) lay caution that any fewer than 30 individual data sets make generalisability incredibly difficult, particularly when dealing with majority quantitative data. However, due to Covid-19, this could not be avoided.

The researcher provided participants with a university email address to contact to request data, withdrawal (as is the right of any human subject (Schaefer and Wertheimer, 2010) or further information. As per the ethics approval, withdrawal can take place up until the point the thesis is submitted. It is important to note that only three individuals (the researcher and two supervisors) would have access to any data submitted along with the thesis, and that all data is secured on an encrypted cloud-based storage site, which Li et al. (2013) conclude to protect data privacy adequately, and on SurveyMonkey itself (with a two-stage encryption): data will be deleted upon completion of the study. In addition, the use of SurveyMonkey as a survey tool means that any data collected is anonymised, with no personal data linked to results.

3.2.5 Participants

Table 1 shows the number of participants (n=15) and the breakdown, with percentage, of certain categories of defining characteristics. These characteristics allow the researcher to analyse the data against independent variables. (As percentages are rounded, total percentages may not equate to 100%).

| | Number of participants | As a percentage |
|------------------------------------|------------------------|-----------------|
| Gender | | |
| Male | 3 | 20% |
| Female | 12 | 80% |
| | | |
| Length of time as a teacher | | |
| ECT (NQT and 1 year) | 5 | 33% |
| 2 years | 1 | 7% |
| 3 years | 1 | 7% |
| 4 years | 3 | 20% |
| 5 years | 1 | 7% |
| More than 5 years | 4 | 27% |
| | | |
| Type of school taught in | | |
| Grammar | 1 | 7% |
| Comprehensive or High school | 11 | 73% |
| Religious or faith school | 1 | 7% |
| Independent | 2 | 13% |

Table 1 – participants

3.3 Data analysis

Once the data is collected, a database will be created in version 25 of the IBM SPSS statistics software package. This software package allows the data collected to be collated; compared using a range of different testing techniques; produce graphs of variables; and undertake confidence testing. For the

results of this study, the respondents were re-coded into either ECT (NQT or 1 year of experience as per the DfE's new definition) or non-ECT (2 years+). ECT was then given a value of '1' and non-ECT a value of '2' to allow the SPSS software to treat this data as nominal. This process was subsequently repeated for other questions, such as those that asked for level of need (no need, low level, moderate level and high level) as, again, the use of a numeric value allowed the data to be treated as nominal. Additionally, this allowed the MANOVA (Field, 2017) tests to be utilised, whereby one independent variable can be analysed against multiple dependent variables. This then allows a statistical significance (or p value) to be ascertained using the multivariate tests: this indicates whether these results happened purely by chance or not. In this study, a confidence of 95% ($p < 0.05$) that this was not by chance will be accepted as a statistical significance. The Levene test could be used to confirm the significance as we can assume that the population, in this case teachers, has homogeneity of variance (Foster et al., 2021) between variables. However, Field (2017) suggests that for small sample sizes, as in this study, an alternative test is used so the Chi-square test will be used to determine the significance. Finally, SPSS 25 was utilised for the graph plotting ability that runs alongside the statistical significance tests. These graphs form the figures within the results chapter.

As the researcher was unable to carry out the planned interviews, and therefore very little qualitative data was collected (from one question within the questionnaire), the qualitative data was coded for manually. The process to analyse qualitative data required the research to assign responses into categories (Basit, 2010) in what is referred to as coding. The raw data, whilst often interesting, is often too varied to be included in research in its pure form. Instead, responses are categorised based on the context of what they are saying. This process is a prerequisite to data analysis, so once the coding was complete, analysis was carried out in much of the same way as the quantitative data. As there was only a limited amount of qualitative data collected, this was completed manually by the researcher.

4.0 Results

4.1 Introduction

In this chapter, the results from the collected data will be displayed in a visual form as well as analysed with a p-value indicating a statistical significance. To reject the null hypothesis (and therefore accept that there is an association), the resulting p-value should be less than .05 indicating a more than 95% confidence that these results have not happened by chance. Primarily, the analysis has been carried out between ECT and non-ECT, however where necessary, comparisons have been made with regards to gender. When it comes to school type, the majority of respondents came from comprehensive/high schools with other setting types being represented by only one or two teachers, so these results have been treated with caution as the spread of school type does not fit with the national trend of school type.

The Chi-square test (χ^2) is a statistical test to determine whether two categorical variables are independent of each other or are related (Kent State University, 2021). The Chi-square test is conventionally used for sets of data that are moderate or smaller in size, hence the use in this study. Additionally, the Chi-square test is relevant to this study as it allows cross tabulation (putting results into a table where specific options have been chosen due to the categorical nature of data) of the two variables and the two variables can be analysed at the same time. If no association existed between the variables, we would expect a uniform distribution of data (Mindrila and Belantyne, n.d.) and so expected counts are considered. The null hypothesis then would suggest “no association between variables” and the Chi-square test “is a measure of how far the observed counts are from the expected counts” (p. 6). To reject the null hypothesis (and therefore accept that there is an association), the resulting p-value should be less than .05. To accept the Chi-square results, each cell within the cross tabulated table should be more than or equal to 5 but as long as less than 20% of cells do not fall outside of this parameter, assumptions of the test can be thought to be met. This will be outlined in the proceeding results.

Question 3 asked participants to indicate the amount of time that they have been working as a teacher. There is a range of participants from ECT through to teachers who have more than 5 years of experience. To fully utilise the comparisons between ECT and non-ECT teachers, this data was then re-coded into two categories: ECT and non-ECT.

This shows more clearly the proportions of ECT and non-ECT participants. Out of the total number of participants (n=15), one third (5) were ECT's whilst two thirds (10) were non-ECT's.

Of these teachers, all of the ECT's taught science with no other subject in their school, whilst 2 of the non-ECT's had a secondary subject that they taught (Maths and Health & Social care).

The vast majority of participants currently worked in a comprehensive (or high) school (73%), 7% grammar school, 13% independent school teachers and 7% religious school. The data collected on setting type is heavily skewed towards one setting type so makes it extremely difficult to analyse against this variable.

4.2 Type of CPD

There is a wealth of different types of CPD available to teachers and this section aims to understand how frequently teachers access these different types.

Question 8 asked participants about typical CPD activities that are undertaken. The most commonly attended was online courses (14) followed by subject knowledge enhancement (13).

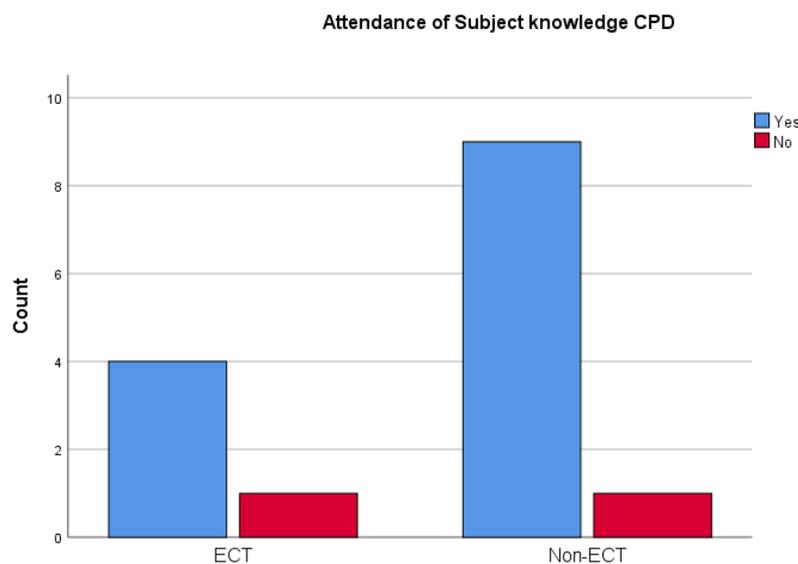


Figure 1 – Attendance of Subject Knowledge CPD

Figure 1 shows the comparison of those who attend subject knowledge enhancement. The data shows that 80% of ECT's attended a subject knowledge course, with the proportion slightly higher at 90% for non-ECT's. The results show that most teachers attend subject knowledge enhancement courses. After applying statistical tests, there was no statistical significance ($\chi^2(1) = .288, p (.591) > .05$).

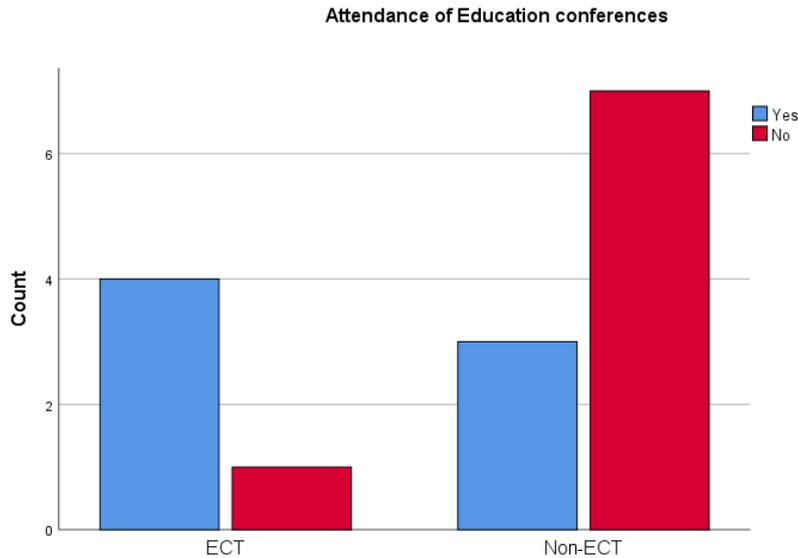


Figure 2 – Attendance of Education conferences

For attended Education conferences, 80% of ECT’s had attended a conference with a much lower value of 30% of for non-ECT’s (Figure 2). There was no statistical significance ($\chi^2(1) = 3.348, p (.067) > .05$).

When it comes to attending online courses, 100% of ECT’s and 90% of non-ECT’s attended this type of CPD. This is inevitable, as all of the participants were recruited from online courses due to the ongoing pandemic. In total, more teachers don’t attend education conferences than do. There was no statistical significance ($\chi^2(1) = .536, p (.464) > .05$).

Attendance of residential courses had a lower uptake than other forms of CPD. Only 1 ECT (20%) had attended a residential course and only 1 non-ECT (10%) had attended a residential course. These are likely to be the most time consuming CPD events as they typically require over-night stays or entire weekends and additionally, this style of CPD has become more common in recent years so older teachers may not have had the opportunity previously. There was no statistical significance ($\chi^2(1) = .288, p (.591) > .05$).

80% of ECTs and 70% of non-ECTs attended CPD aimed at improving pedagogical techniques. From the data, the proportions who attended are very similar between ECTs and non-ECTs. It seems that ECTs and non-ECTs agree that pedagogical CPD is worth attending. There was no statistical significance ($\chi^2(1) = .170, p (.680) > .05$).

When analysis is conducted by gender, attendance to pedagogical CPD was more prevalent in females (83% having attended) compared to males (33% having attended). However, there was no statistical significance ($\chi^2(1) = 3.068, p (.080) > .05$).

4.3 Purpose

As well as having a range of types of CPD to attend, many teachers will have different and specific reasons to attend. The literature review highlights that teachers should be continuously improving, and the section identifies which areas of teaching may be impacted by CPD.

| | TEACHING TECHNIQUE | DEVELOP SKILLS | SUBJECT KNOWLEDGE | TEACHING ONLINE | OTHER PEDAGOGICAL | MOTIVATING PUPILS |
|---------|-----------------------|-------------------|----------------------|--------------------|----------------------|----------------------|
| ECT | 2 | 0 | 2 | 3 | 1 | 0 |
| NON-ECT | 2 | 5 | 1 | 3 | 6 | 0 |

Table 2 - coded results for open ended question why participants attend CPD

Teachers were asked an open-ended question about their last CPD event: “What was your main reason for attending?”. The responses were then manually coded to give the results shown in Table 2.

From the results we can see that for ECTs the main reason noted for attendance was fairly varied with learning to teach online being a key factor, which is likely to be in response to the pandemic situation that teachers find themselves in. This was referenced directly by one of the ECTs. For non-ECTs, developing skills (for example leadership) and other pedagogical factors were most important. Again, it is likely that the nature of the survey dissemination means that the survey was shared at very few CPD events which has likely skewed the results to certain, specific reasons for attending CPD.

The next question asked participants to give a rating of how much help they needed with certain aspects of teaching. For Assessment for Learning, the pattern of need initially looks somewhat different between ECTs and non-ECTs. All ECTs indicated they had some level of need, compared to 80% for non-ECTs. For ECTs, 40% indicated a high level of need with no non-ECTs experiencing the same level of need. Therefore, the level of having some need is similar but the exact level varies slightly. There was no statistical significance ($\chi^2(3) = 5.250, p (.154) > .05$).

There are a few notable points when it comes to the level of need with classroom management. Firstly, no participants from either category indicated they had a high level of need with classroom management. 25% of ECTs indicated they required no help compared to 40% of non-ECTs, both groups had a 50% indication rate for low level of need and secondly, 25% of ECTs indicated a moderate need compared to 10% for non-ECTs. To get a better sense of the overall response we can compare the low or moderate need rates of each group. For ECTs this is 75% and for non-ECT is 60% so the need is slightly higher for ECTs. There was no statistical significance ($\chi^2(2) = .630, p (.730) > .05$).

The next option was subject knowledge. Again, there were no participants who indicated they had a high level of need, which opposes the norm as large numbers of CPD sessions are aimed at gaining subject knowledge. For non-ECTs 80% indicated low level with 20% indicating no need at all. For ECTs, 20% of responses indicate low level and 80% moderate need. There was sufficient evidence to reject the null hypothesis ($\chi^2(2) = 11.000, p (.004) < .05$). However, the assumptions have not been met to accept the Chi-square result.

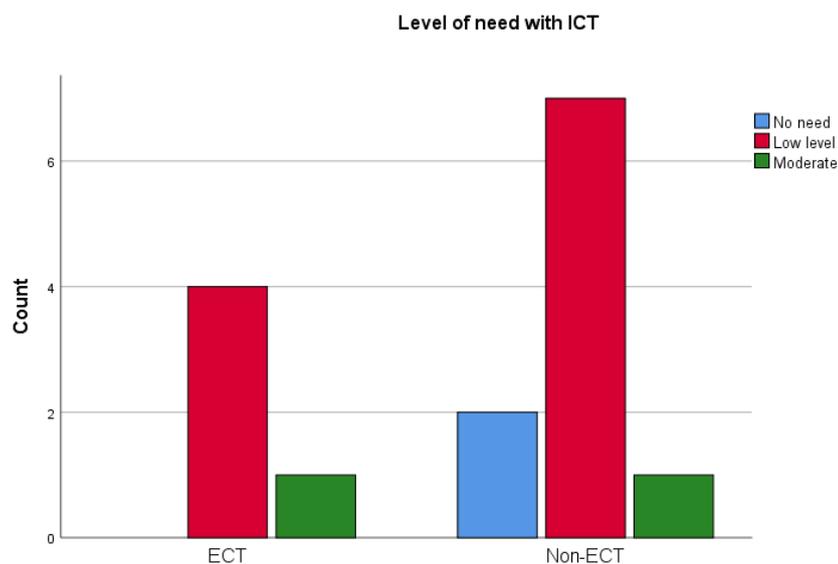


Figure 3 - Level of need with ICT

For need with ICT, Figure 3 shows that no participants had a high level of need. 90% of non-ECT indicated low level or no need compared with 80% for ECTs: this doesn't show a significant difference. For moderate need, ECTs had a slightly higher response of 20% compared to non-ECT of 10%, but again not a great difference. There was no statistical significance ($\chi^2(2) = 1.295, p (.523) > .05$).

When it comes to SEN, it seems that all teachers feel they need some additional help. 100% of respondents indicated they had some need with SEN. For ECTs, 40% responded with moderate need and 60% high level of need. This would suggest then that newer teachers are not yet confident with

the myriad of allowances needed to be made for students with SEN. For non-ECTs, 30% indicated low need, 60% moderate need and 10% high level of need. It would seem, that across the board, this area shows the greatest need for all teachers. There was no statistical significance ($\chi^2(2) = 4.875, p (.087) > .05$).

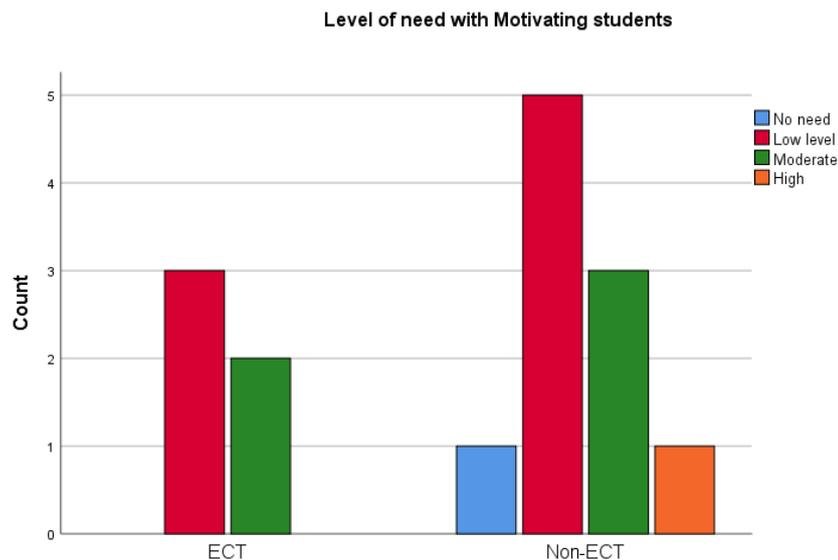


Figure 4 - Level of need with Motivating students

For motivating students (Figure 4), there was an interesting spread and different pattern of responses between ECTs and non-ECTs. All ECTs indicated that they had either low level or moderate level (60% and 40% respectively) of need. For non-ECTs, the spread was much wider with all levels of need selected. 80% of non-ECTs selected low level or moderate level of need. For the more extreme responses, 10% selected no need and 10% high level of need. This question seemed to cause the greatest disparity between both groups, however after applying statistical tests, there was no statistical significance ($\chi^2(3) = 1.163, p (.762) > .05$).

4.4 Self/others

There is often some discrepancy over whether teachers have full autonomy over their CPD needs. Many teachers have the freedom to select CPD whilst others have a schedule of development drawn up for the school year. This section identifies how this fits in with teachers.

Teachers were asked, within the teachers' institutions, who chooses which CPD events to be attended. For ECTs, the results were evenly spread between Me (the individual teacher), line manager

and other. For 'other', it seemed to depend on the course as to whether or not the individual or another member of the school chose the CPD event. For non-ECTs, most respondents (60%) indicated that they chose courses themselves, with 20% being chosen by line manager, 10% a senior leader and 10% other (again suggesting a split between themselves and a senior leader). There was no statistical significance ($\chi^2(3) = .933, p (.817) > .05$).

When compared by gender overall, female teachers are selecting their own CPD (with 64% stating that they choose and 9% chosen by line manager). For males, only 33% of respondents chose their own CPD with 67% being chosen by line managers. However, there was no statistical significance ($\chi^2(3) = 4.843, p (.184) > .05$).

4.4.1 Number of CPD sessions attended

This question asked respondents to approximate how many CPD sessions they attended over the course of a year. 5 or more sessions was the most common response (60% of all respondents across ECT and non-ECT). There seems to be no discernible pattern between ECTs and non-ECTs when it comes to the number of CPD sessions attended, with all teachers attending CPD. This differs from previous research outlined in the Literature Review. There was no statistical significance ($\chi^2(3) = 5.000, p (.172) > .05$).

4.5 Alternatives

As well as attending formal CPD sessions, teachers undertake CPD in a variety of informal ways that improve them as a professional, such as reading books, journals and engaging with social media. The results for these informal or alternative types of CPD are shown in this section.

Respondents were asked to select which less formal CPD activities that they engaged with. Teachers were able to select as many activities that were relevant as they wished. There were six activities to select from. Most teachers had spent time reading educational journals (73% of all respondents). This was slightly higher amongst ECTs (80%) compared to non-ECTs (70%). There was no statistical significance ($\chi^2(1) = .170, p (.680) > .05$). There is an interesting difference between genders: with female teachers on the whole saying yes to reading educational journals but male teachers mostly saying they don't. However, there was no statistical significance ($\chi^2(1) = 3.068, p (.080) > .05$).

When it comes to the number of teachers who read subject specific journals, the proportions were similar for educational journals, with 80% of ECTs and 70% of non-ECTs engaging with these journals. There was no statistical significance ($\chi^2(1) = .170, p (.680) > .05$).

For engaging with discussions online, the proportion of ECTs and non-ECTs was identical at 60%. However, after applying statistical tests the observed and expected values were identical meaning the expected random spread is exactly what was observed ($\chi^2(1) = .000, p (1.000) > .05$).

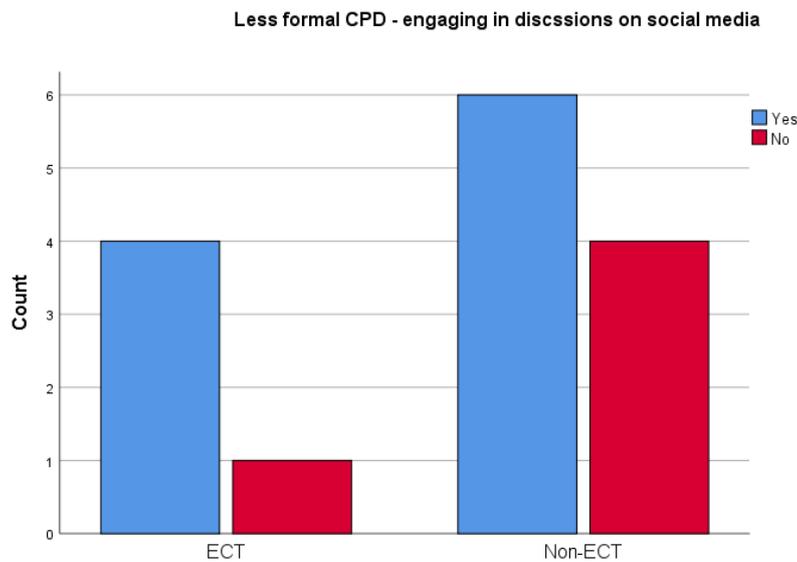


Figure 5 - Less formal CPD - engaging in discussion on social media

The results are slightly different for engaging with discussions on social media (Figure 5). 80% of ECTs had engaged and 60% of non-ECTs had engaged which shows that the same proportion of ECTs are discussing across the internet whereas slightly less non-ECTs are utilising social media. This question didn't ask about specific social media platforms and doesn't give an idea of frequency. This does show that most teachers, both ECTs and non-ECTs, are making use of social media. It is not clear at this juncture whether this is down to any effect due to the Covid-19 pandemic. There was no statistical significance ($\chi^2(1) = .600, p (.439) > .05$).

Using textbooks during lessons at secondary level is often utilised, but the option is available to teachers to use textbooks as a method of CPD. Data shows that 100% of ECTs and 90% of non-ECTs have used textbooks as CPD. It would seem then that there's little difference between teachers and that most see this as a useful activity. There was no statistical significance ($\chi^2(1) = .536, p (.464) > .05$).

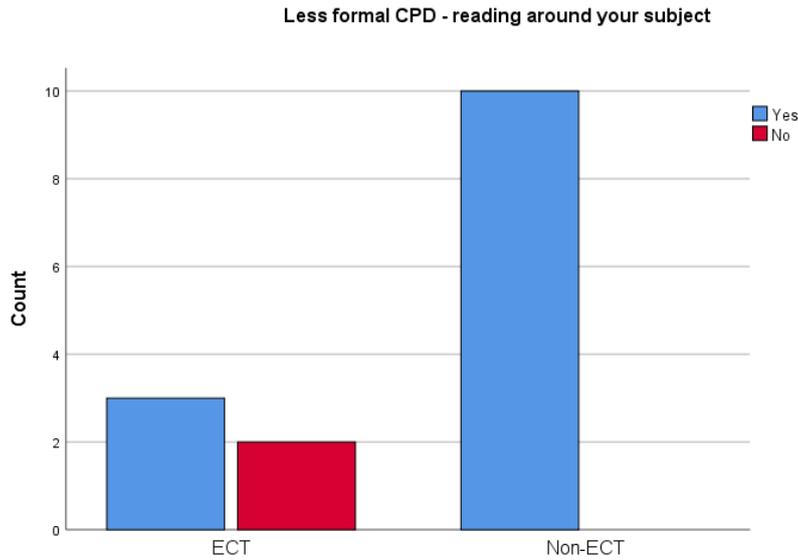


Figure 6 - Less formal CPD - reading around your subject

Finally for this section, respondents were asked if they read around their subject more generally. This wasn't defined exactly by the question or by the respondents, but this will encapsulate any reading about science not from a science-specific textbook. Figure 6 shows that 100% of non-ECTs had carried out this activity and 60% of ECTs had engaged. This seems to show a significant difference between ECTs and non-ECTs and seems that more experienced teachers see this as value., There was sufficient evidence to reject the null hypothesis ($\chi^2(1) = 4.615, p (.032) < .05$). However, as 75% of cells had a count of less than 5, the assumptions have not been met to accept the Chi-square result and therefore there is no statistical significance.

4.6 Impact

In this section, the results highlight the immediate impact that attending CPD has on the individual teachers' skills, as well as on their students, schools, and colleagues.

4.6.1 How does CPD make you feel

The following questions asked respondents to comment on how the most recent CPD they attended made them feel on a range of subjects.

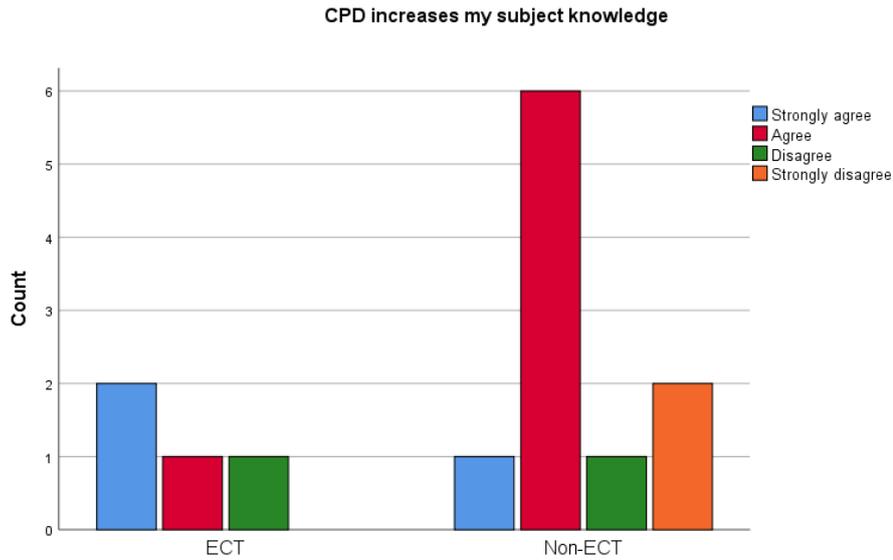


Figure 7 - CPD increases my subject knowledge

The first question asked teachers if the most recent CPD activity increased subject knowledge and is shown in Figure 7. 75% of ECTs agreed (25% agreed and 50% strongly agreed) compared to 70% (60% agree and 10% strongly agree) of non-ECTs. The proportions are broadly the same then. There was no statistical significance ($\chi^2(3) = 4.083, p (.253) > .05$).

The next question asked teachers whether CPD caused them to reconsider teaching as a profession. For ECTs 100% strongly disagreed that the CPD they attended made them reconsider teaching. 60% of non-ECTs strongly disagreed, 30% disagreed and 10% neither agreed nor disagreed. Overall, none of the teachers felt that attending CPD caused them to reconsider teaching. There was no statistical significance ($\chi^2(2) = 2.240, p (.326) > .05$).

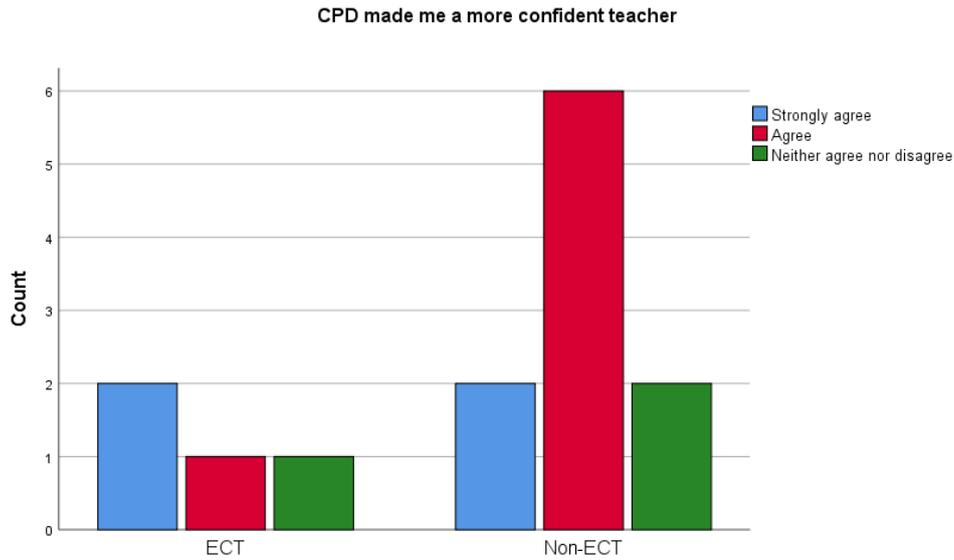


Figure 8 - CPD made me a more confident teacher

The next question asked if CPD made teachers more confident teachers. Figure 9 shows that 75% of ECTs agreed (25% agreed and 50% strongly agreed) that the last CPD made them more confident. For non-ECTs, 80% of teachers agreed (60% agreed and 20% strongly agreed). On the whole, teachers felt more confident as a teacher after attending CPD. There was no statistical significance ($\chi^2(2) = 1.633, p (.422) > .05$). When it comes to gender splits, 67% of males neither agreed nor disagreed with 33% agreeing. For female teachers, 91% agreed or strongly agreed that CPD made them more confident with just 9% neither agreeing nor disagreeing.

The results for CPD causing teachers to make changes to their teaching showed an interesting trend. 100% of ECTs agreed with this statement (50% agreed and 50% strongly agreed) compared to 70% of non-ECTs (50% agreed and 20% strongly agreed). This shows a marked difference between the two groups, as 30% of non-ECTs felt that attending CPD didn't cause a change in teaching. This doesn't highlight any changes to attitude or mindset etc. There was no statistical significance ($\chi^2(3) = 2.100, p (.552) > .05$).

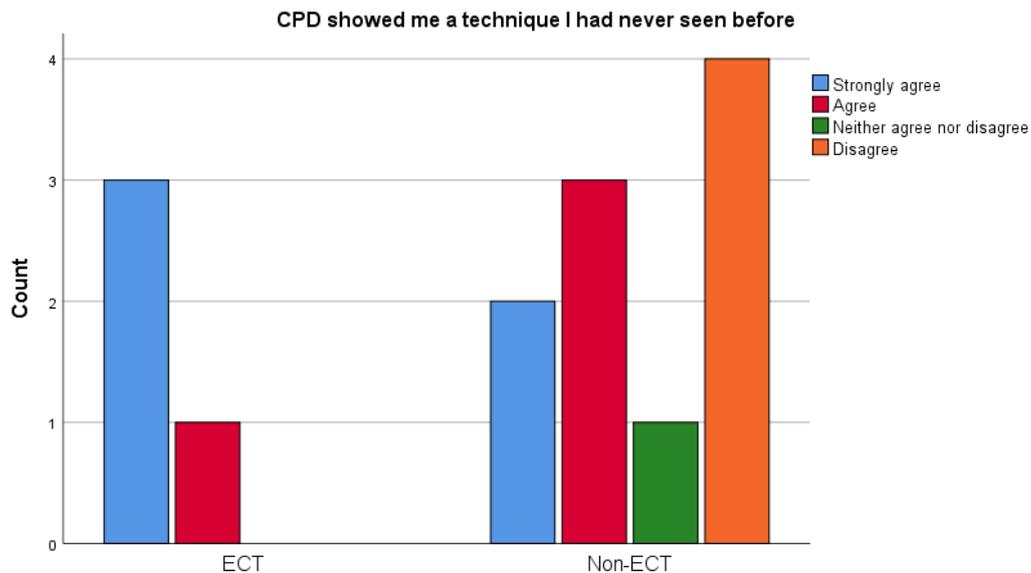


Figure 9 - CPD showed me a technique I had never seen before

The next question in this series asked if CPD showed teachers new techniques. In Figure 10, it is shown that 100% of ECTs felt this to be true (50% agreed and 50% strongly agreed). For non-ECTs, the data was more varied. 50% of non-ECTs agreed (30% agreed and 20% strongly agreed), 10% neither agreed nor disagreed and 40% disagreed with the statement. There seems to be a higher chance of ECTs seeing a new technique, but this is only a 50-50 chance for more experienced teachers. There was no statistical significance ($\chi^2(3) = 4.445, p (.217) > .05$).

The penultimate question in the series asked if CPD caused teachers to doubt their ability. No teachers, either ECT or non-ECT, agreed with this statement. For ECTs 25% disagreed with 75% strongly disagreeing. For non-ECTs, 30% disagree and 70% strongly disagree. It would seem that all teachers agree that CPD generally doesn't make them doubt their ability. There was no statistical significance ($\chi^2(1) = .035, p (.852) > .05$).

Finally, data for the question "CPD increased my love of learning" indicates that 100% of ECTs agreed (50% agreed and 50% strongly agreed) and 80% of non-ECTs agreed (40% agreed and 30% strongly agree), with 20% neither agreeing or disagreeing and 10% disagree. This is a slight difference in the number who agree, with ECTs in agreement compared to non-ECTs. There was no statistical significance ($\chi^2(3) = 1.587, p (.662) > .05$).

4.7 Impact on your school

The next three questions asked respondents to consider what impact the CPD may have had on the respondent's school.

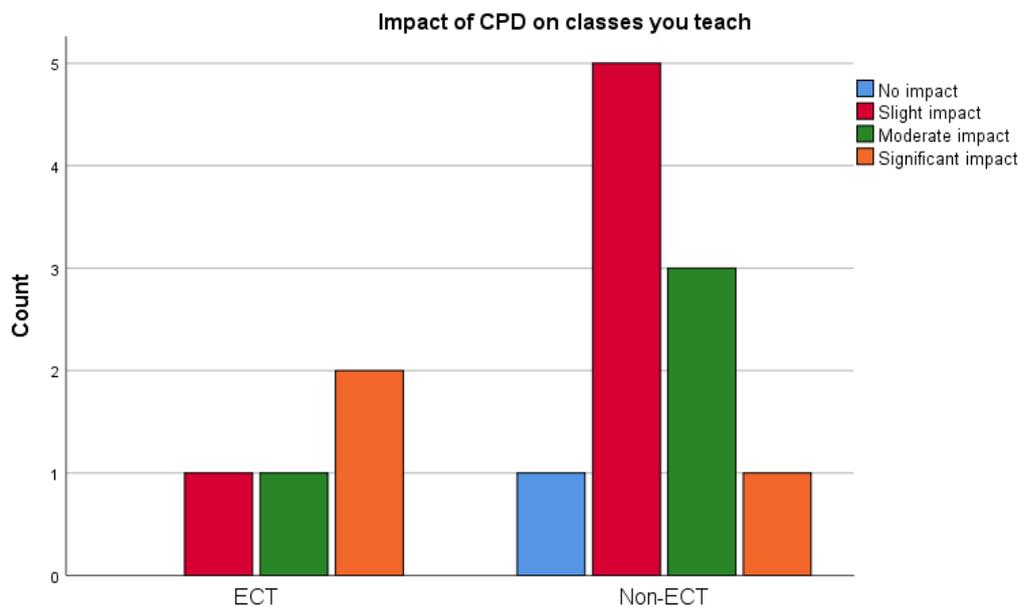


Figure 10 - Impact of CPD on classes you teach

Figure 11 shows the impact on classes taught by the respondent. All of the ECTs felt that there was some impact on their classes with 50% suggesting there was a significant impact. For non-ECTs 10% felt there was no impact and 50% felt there was a slight impact. This is an interesting difference but of course, this is based on the innate feeling of those responding to the survey. After applying statistical tests, there was no statistical significance ($\chi^2(3) = 2.975, p (.395) > .05$).

The next questions evaluated impact on other teachers within your school. All of the ECTs felt there was at least some impact on other teachers (50% slight and 50% moderate impact). For non-ECTs there was slightly less optimism. 20% felt there was no impact on anyone else with the remainder feeling there was at least some impact. There was no statistical significance ($\chi^2(3) = 2.567, p (.463) > .05$).

The final question asked for the impact on the school as a whole. None of the respondents rated the impact higher than moderate. For ECTs, 75% felt there was a slight impact with 25% moderate impact. In contrast, 20% of non-ECTs felt there was no impact with the remainder sighting slight or moderate. It seems some teachers feel that CPD has had little to no impact on the school as a whole, possibly negating the point of attending the CPD.

4.8 Range of teaching techniques

This question asked teachers whether CPD had changed the frequency of certain activities within the teachers' practice. The first question asked how often Direct Instruction (DI) was used because of CPD. In both ECTs and non-ECTs, 50% of teachers said they used Direct Instruction more often. For ECTs, 25% indicated that used DI less often after CPD but no non-ECT reduced the amount. There was no statistical significance ($\chi^2(3) = 3.733, p (.292) > .05$).

The next question asked about the use of group work in lessons. For ECTs, there was either no change (50%) or a decrease in group work (25% less often). For non-ECTs again 50% no change but only 10% less often. Interestingly, 20% of non-ECTs used group work more often after attending CPD. There was no statistical significance ($\chi^2(3) = 1.283, p (.733) > .05$).

During the Covid-19 pandemic, the vast majority of teaching was moved online and so the use of new technology is likely to be prevalent in teachers' minds. 100% of ECTs used technology more often as a result of CPD. For non-ECTs there was some variety with 70% stating more often and 20% no change. There was no statistical significance ($\chi^2(2) = 1.527, p (.466) > .05$).

Next up, teachers were asked about the use of engaging demonstrations or practicals. All teachers who responded, both ECT and non-ECTs, either saw no change in the amount of use or increased the use of demonstrations and practicals. 25% of ECTs responded no change as did 30% of non-ECTs. 75% of ECTs and 60% on non-ECTs responded that they used engaging demonstrations more often as a result of CPD. Data suggests that both groups favoured this teaching technique. There was no statistical significance ($\chi^2(2) = .525, p (.769) > .05$).

The next question asked about the use of SLOP (repetitive practice of questions) worksheets with results showing a fairly similar distribution amongst ECTs and non-ECTs. Neither group responded with less often, nearly all reported no change (25% ECT and 30% non-ECT) or more often (50% ECT and 40% non-ECT). There was no statistical significance ($\chi^2(2) = .117, p (.943) > .05$).

The penultimate question on teaching techniques is the use of lollipop sticks as a method for selecting students to call upon. Again, no respondents reported less often and one ECT and one non-ECT reported N/A. For ECTs, 25% reported no change with 50% reporting more often and for non-ECTs, 60% reported no change and 10% reported more often. Very few teachers are using lollipop sticks more because of CPD but it's not clear to what level they are currently being used in order for teachers to select 'no change'. There was no statistical significance ($\chi^2(2) = 2.858, p (.240) > .05$).

The final question asked about the use of retrieval practice. Again, no respondents reported a decrease in use. More respondents replied N/A than any other question (25% of ECT and 20% of non-ECTs) implying that potentially this technique is not being used by these teachers. All of the ECTs who gave an answer (75%) replied more often and for non-ECTs, 30% replied no change and 50% more often. There was no statistical significance ($\chi^2(2) = 1.546, p (.462) > .05$).

4.9 What happens after CPD?

Teachers were asked to comment on what happened in their teaching since attending CPD sessions. Teachers could respond with strongly agree, agree, neither agree nor disagree, disagree or strongly disagree within a matrix.

The first question in the matrix stated, "I can explain concepts more clearly". For ECTs, 50% neither agree nor disagree and 50% strongly agree. With non-ECTs, 30% neither agree nor disagree, 60% agree and 10% strongly agree. It would seem then most either carried on as normal or have improved their explanations, but skills have not declined. There was no statistical significance ($\chi^2(2) = 4.853, p (.088) > .05$).

The next statement in the matrix says, "my students find my lessons more engaging". This question asked teachers to consider this from their point of view so is more of an instinct rather than collecting data from students. Most teachers agreed, with 75% of ECTs agreeing or strongly agreeing compared with 60% of non-ECTs agreeing. This is a slightly higher value for ECTs but there was no statistical significance ($\chi^2(2) = 2.730, p (.255) > .05$).

The next statement suggests that "I am more determined to improve my teaching skills". 100% of ECTs strongly agreed. For non-ECTs there was more of a spread: 10% neither agreed nor disagreed, 50% agreed and 40% strongly agreed. This is interesting then that 10% of non-ECT had no opinion on whether they wanted to improve their teaching skills or not. However, there was no statistical significance ($\chi^2(2) = 4.200, p (.122) > .05$).

The next statement was "I feel able to try new ideas". Like the last statement, all of the ECTs responded strongly agree with a spread for non-ECTs. For non-ECTs, 10% neither agreed nor disagreed, 40% agreed and 50% strongly agreed. Similarly, most ECTs and non-ECTs agree with this statement. There was no statistical significance ($\chi^2(2) = 3.111, p (.211) > .05$).

The penultimate statement in the matrix states “I have increased my range of teaching skills” which 100% of ECTs agreed with. 20% of non-ECTs neither agreed nor disagreed and 80% agreed (70% agree and 10% strongly agree). There is a strong statistical significance ($\chi^2(2) = 10.080, p (.006) < .05$). Under the assumptions of the chi-square test all cells must contain a count of 5 or more and in this case, 83% of cells do not meet this rule. So, this strong, statistical significance must be treated with some caution.

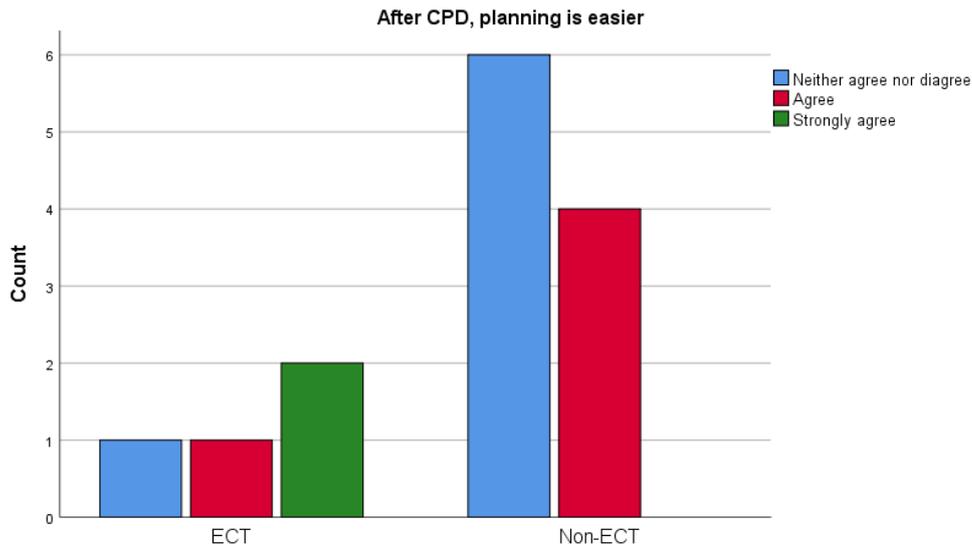


Figure 11 - After CPD, planning is easier

The final statement states “Planning is easier”. For the non-ECTs, 60% neither agreed nor disagreed and 40% agreed with the statement, as seen in Figure 12. For ECTs, 25% neither agreed nor disagreed, 25% agreed and 50% strongly agreed. Therefore, a higher proportion of ECTs felt that CPD made their planning easier but there was no statistical significance ($\chi^2(2) = 5.880, p (.053) > .05$), although this p-value is very close to the 95% certainty value to reject the null hypothesis.

5.0 Discussion

This chapter will focus on bringing together the results of the study with the literature discussed at the start of this thesis to explain and explore the findings. The section will also highlight any limitations of the study, as well as suggesting future research to fill any gaps in the field as identified.

As a reminder, the key research questions outlined at the start of this study are:

- Are science Early Career Teachers intrinsically motivated to develop through Continuing Professional Development?
- Does formal and informal professional development jointly contribute to the progression of science Early Career Teachers?
- Does Continuing Professional Development increase the range of activities used to deliver science in Secondary education amongst Early Career Teachers?
- Does Continuing Professional Development develop perceived confidence or perceived competence amongst early-career Secondary teachers?
- Is the perceived impact of Continuing Professional Development greater for science Early Career Teachers than non-Early Career teachers?
- Are the needs of Early Career science Teachers different to their more experienced counterparts?

5.1 Adjustments made due to Covid-19 pandemic

From March 2020, the global Covid-19 pandemic had significant implications on this research. The working practices of the researcher (their primary job) changed significantly, whilst Canterbury Christ Church University issued guidelines (Appendix 3) preventing researchers from working with teachers to reduce any additional burden being put on these individuals during a tumultuous time. This meant that the nature of data collection inevitably had to change, timelines had to be shifted and the expectation of what data could be collected had to be significantly lowered. The adjustments made are outlined in this section.

Initially, the online survey was to be followed up by a face-to-face interview with a sample of participants. However, due to Covid-19 restrictions no face-to-face interviews were conducted. Subsequently, the only qualitative data collected is in the online survey. This decision was made as it

was incredibly difficult to meet with teachers from multiple different schools and it seemed unwise to travel around a large geographic area when unnecessary travel was not advisable due to government and University guidelines. This means that, other than generating initial questions to cover CPD as a whole, specific interview questions were not generated in order to delve deeper with the specific set of teachers in this study. As per the risk assessment, “burnout” of the researcher could become an issue which also factored into the reasoning for removing interviews from the study as a result of Covid-19. In addition, the data collected shows that few ECTs took part in the study, meaning that any sample size would be too small to conduct separate analysis.

Due to the nature of CPD sessions during Covid-19, the survey was unable to be shared by the intended external organisation: with Covid-19 restrictions in place, they were unable to run many (if at all) in-person sessions. To compensate for this, and to allow any data to be collected, a different, more specialised CPD provider agreed to share the online survey to participants. Whilst this allowed data to be collected, this resulted in a one-shot survey, carried out over a much shorter period, which both Fink (2003) and Sapsford and Jupp (2006) suggest leads to the data not being representative of the norm. As a consequence of this, when the Chi-square test (χ^2) for statistical significance was applied, there were no relationships that were found to be significant (within the bounds of this test) and therefore all data and assumptions, whilst providing overarching ideas, offer a snapshot of what CPD looked like during a global pandemic as opposed to during a ‘normal’ academic year (although CPD may not return to this previous ‘normal’). Analysing this new way of carrying out CPD may be helpful as, if this novel method is here to stay, CPD suppliers and providers will need to take into note of what occurred during the pandemic.

5.2 Are science Early Career Teachers intrinsically motivated to develop through Continuing Professional Development?

Clark (1992 cited in Hargreaves and Fullan, 1993) suggested that CPD was a process done to teachers and all teachers have a deficit in knowledge and skills. Contrary to Clark’s work, data from this study shows that for the majority of the time, individual teachers are making the decisions over their own CPD needs. This is consistent amongst both ECTs and non-ECTs. Whilst it is unknown whether teachers are being instructed to attend CPD sessions on the whole, they are masters of their own destiny, so to speak. There is a more interesting pattern when it comes to a gender split: nearly two-thirds of female teachers chose their own CPD whilst this was closer to one-third for males. Whilst this study had a small sample size, and there is no statistical significance ($p > .05$) it does open up avenues for exploration in future studies. It is unclear why this difference may have emerged, and while any

attempt at explaining the data would be speculation, this may prove interesting if it correlated with a national trend.

Participants were asked about the number of CPD session that they typically attend. The most widely reported answer was 5 or more sessions per year and this was broadly the same amongst ECT and non-ECTs. It has been previously mentioned in the literature review that teachers may have an innate want to improve so this data that many teachers are engaging with multiple CPD sessions across a year validates Hattie's (2012) research on outcomes: teachers are best placed to create desirable changes in their classrooms, with passion for teaching and learning having a clear positive impact on outcomes. It may be that some teachers particularly enjoy attending CPD to further their knowledge or indeed they may see their passion for learning rubbing off on their students. It may not be clear exactly why some teachers may attend a large number of CPD sessions over the course of a year, but it certainly shows enthusiasm. This would support Hattie (2012) and Burić and Moè (2020) in that they both posited that a more enthusiastic, motivated teacher has a net-positive effect on the outcomes of their students. Some teachers thrive when given the opportunity to succeed and take any chance to attend CPD as a chance to succeed (and therefore their school's leadership is fostering a want to improve through CPD as set out by DfE [2016]). Given that ECTs have a lower allocation of contact time, they are not using up this additional time to seek out CPD sessions. That's not to say that they do not use the time for more informal CPD (as discussed in this research). The data is interesting in that there is not a disparity: ECTs do not attend more CPD than non-ECTs even though their need for improvement may be perceived to be greatest and their rates of improvement in most areas of teaching will be greatest early on. This is also significant as the results do not corroborate thinking by Hamilton Broad (2015). The suggestion was that non-ECTs have less available time to undertake activities such as CPD and so one would expect to see a significant reduction in numbers of days attended by non-ECTs compared with ECTs, but this is not the case. This is significant for CPD providers as ECTs may be equally as choosy as their non-ECT colleagues when it comes to time outside of school attending CPD sessions. This may outline some interesting, future study to understand where their rapid rates of learning and growth come from, if it's not from additional CPD sessions.

5.3 Does formal and informal professional development jointly contribute to the progression of science Early Career Teachers?

McNamara (2019) considered anything that is implicitly learning, has a social element and happens spontaneously as CPD for teachers. The data shown in this study suggest that teachers are overwhelmingly taking part in informal CPD. In all areas questioned, more teachers were taking part

in informal or alternative forms of CPD than not, supporting previous research by Richter et al. (2011). These results are likely due to the easily accessible nature of, for example, journals as they can be accessed digitally for a minimal cost when factored alongside membership to a professional organisation. This finding substantiates Capel, Leask and Turner's (2004) view that teaching is increasingly moving towards a research and evidence-based profession, with these journals able to produce this evidence in a timely fashion to teachers. Not only is the use of journals timely, it is constantly evolving and moving forward so teachers do not have to just rely on any research they were exposed to at the start of their career. This particular finding is important in that it highlights that the majority of teachers, regardless of where they are in their career, are making an attempt to improve. The rise of the internet, and in particular social media, has proved invaluable to teachers. 6 in 10 teachers engage in online discussions, with no discernible difference shown in terms of teacher experience and Figure 5 shows that, whilst ECTs are engaging with social media in larger proportions, non-ECTs are following suit and using this tool. Why the individuals do this is at this point unclear, but Teo, Tan and Chan (2021) conducted a study during the Covid-19 pandemic that suggested the move to online teaching will lead to new norms and so this could also be the case for accessing informal CPD. In addition, the use of platforms such as Zoom and Microsoft Teams has meant that teachers from a much wider geographical area can come together to listen to speakers and converse around a myriad of topics both formally and informally to create online networks to support each other. Whilst this may have happened without a global pandemic, it has certainly been greatly sped up due to the nature of being isolated and being forced to teach and work online.

An alternative notion is that the ECT participants used social media as a way of socialising, given socialising was discouraged during Covid-19 or, as previously mentioned, these social and informal CPD activities have been coming up in literature much before the pandemic. This disparity between ECTs and non-ECTs could be down to the "digital native" effect (Wilson et al., 2020, p. 1) in that "generations born after 1980 are fundamentally different from members of previous generations" (p. 1) when it comes to technology. Teachers of a certain generation will have been brought up surrounded by technology, both in school and in the home, and so are more familiar with utilisation and adaptation. This is further emphasised by Crook (2012) with the notion of "Web 2.0" where some generations are not just brought up with technology, but specifically with the internet and connectivity interwoven into general competencies. A recent study by Aguilar et al. (2021) looked at the social media use of teachers before and during the pandemic found a significant shift echoed by ECTs. Aguilar et al. found that, whilst the specific platform used and exact need was highly specific to each teacher, use of social media increased.

Moving away from more modern technology, the use of textbooks as a vehicle for improvements was used by all ECTs and by 90% of non-ECTs. The evidence is clear that teachers value the expert knowledge and descriptions, tasks and activities that have been collated by fellow professionals, especially as content on the internet can often be thwart with errors (Murphy and Murphy, 2021) and lack quality assurance.

The final point on informal CPD is probably the most. All non-ECTs read around their subject, compared with 60% of ECTs (Figure 6). This is a stark difference that may then have implications on ECTs. The first thing to note is that for ECTs to become more aligned with non-ECTs they should mimic more closely how those teachers behave. From the data, we can see that just over half are reading around their subject but that leaves a large gap to other teachers who are not indulging in this activity. As Huberman (1992) suggests, experienced teachers consider themselves to have mastered many of the facets required to be a skilled teacher and so potentially have the time and cognitive load to read up on their subject, looking at ways of introducing stories and history (such as the 'Stories in Physics' published by the Institute of Physics [n.d.]) or better incorporating germane knowledge into lessons. Jegede, Taplin and Chan (2000) hypothesised that teachers with less than 5 years' experience are likely to be lacking in skills in areas such as AfL, use of technology and SEN, it would seem wise then that ECTs are focusing on these key areas early in their careers before moving onto their wider subject. Whilst ECTs and non-ECTs tended to, by majority, utilise all of the alternative, informal types of CPD, reading around your subject is the first time that all non-ECTs were carrying out the same task and so this is significant for ECTs.

5.4 Does Continuing Professional Development increase the range of activities used to deliver science in Secondary education amongst Early Career Teachers?

The next question raised from the literature centres around the increase in activities used by teachers. All of the ECTs asked felt they learned something new by attending CPD. This is to be expected as ECTs are new to the profession so are unlikely to have been exposed to large numbers of ideas or pedagogical techniques. Previous studies described in the literature review highlight that there are still ideas in education that may crop up in teacher training that give teachers the idea that these superseded pedagogies should be utilised. For example, the three-part lesson (Riches, 2019) appears in many university courses; it is only when teachers broaden their horizons and attend CPD sessions that they may experience alternatives. There was a lot more variety, however, within the responses of non-ECTs. Only half of non-ECT participants felt that they learned something new which again is likely to fit with teachers who have been in the profession far longer and therefore are likely to have attended many CPD sessions. It's worth noting here that 40% of non-ECTs in this study actively

disagreed, which may validate research by Will (2019) in that older teachers become more cynical about change and so would need to see or experience something that is fundamentally going to improve outcomes for their students for them to 'change'. It is unclear however whether these non-ECTs are gaining other soft skills that Valdmann, Rannikmae and Holbrook (2016) posit comes out of CPD or whether they were able to share best practice with others: maybe their attendance can inadvertently make the experience better for an ECT. Non-ECTs may be gaining in terms of increasing their pedagogical skills rather than picking up new ideas: in this study 70% of non-ECTs attended pedagogical CPD so give some value to this type of development. This area has not been developed in this study but could perhaps prove to be an exciting avenue to explore in the future.

More often than not, teachers seemed to agree that they used demonstrations or practicals more, as well as using retrieval practice more and technology. Group work seems to stand out from the other responses with many teachers on both ends of the experience spectrum indicating that they now use group work less often, with only 20% on non-ECTs stating they use group work more. Due to a lack of follow up questions it is unclear why teachers are opting to use group work less. This may be down to demands on curriculum time, or it may be directly linked to the group work itself. As noted in the literature review, group work allows some students to 'sit back and relax' (Fung, 2022) and so some teachers may try to prevent this. Additionally, in the study analysed by MacQuarrie (2013) teachers benefitted from taking part in specific training around group work: in particular preparing themselves and their class for the group work. For ECTs, it may be that they do not feel adequately prepared for the openness of a practical lesson or able to adequately support pupils. This is unlikely the case for non-ECTs, but this seems to go against the ideas set out by Fung (2022) in that STEM employers are looking for these additional soft skills, often gained through activities in schools such as group work. This area of the study would need some further research to establish why such a large proportion of teachers are opting to reduce the amount of group work in their lessons after attending CPD.

On techniques as a whole, the results support the study discussed by Nielsen (2015) that teachers appreciate a CPD session that sees them leaving with something new to try and so CPD designers and providers should bare this in mind for the future. However, as there is no set list or criteria of what exactly what should be included in a lesson, it is hard to tell whether teachers are using these techniques because these are in vogue at the time of writing or because they genuinely believe these activities and pedagogical stand points genuinely bring about the best outcomes for their students. Whilst researchers can give an overview of typical pedagogical stand points that are beneficial, for example Husbands and Pearce (2012), it can often be the case that individual schools will be promoting certain techniques and will set certain expectations about the use of such techniques in

lessons: teachers may have mixed feelings about the success or benefit but feel obliged to use ideas due to their school. At this point it is hard to establish exactly the root causes and as Byman et al. (2021) suggests, teachers at any stage of their careers are not a homogenous group so creating a criterion of what should be included in CPD at what point in a teacher's careers becomes almost impossible.

Further on in the section on 'Range of teaching techniques', the questions asked moved away from specific techniques and asked about trying out ideas more widely. All ECTs and 90% of non-ECTs agreed or strongly agreed that they feel able to try out new ideas. It seems to be clear that what is happening in CPD sessions translate to teachers feeling able and willing to move into the classroom and try out some new idea. Whether teachers agree or not with a method is unclear, but they are trying to improve.

From the data, it can be seen that all ECTs felt determined to improve their teaching skills. There is not a clear difference in the number of CPD sessions or activities attended between ECTs and non-ECTs which seems unexpected as often ECTs have additional non-contact lessons on timetables and so have more capacity to attend CPD with minimal impact on classes. This could be explained that the survey was disseminated during the Covid-19 pandemic and so teachers as a whole were lacking in time and capacity and possibly inclination to attend CPD. Alternatively, it may have been the case that all teachers, regardless of experience, were in need of support due to immense changes to their teaching because of the pandemic, but at this point the reasons are unclear. It could also be down to whether or not CPD is "prioritised by school leadership" (DfE, 2016, p.11) as discussed in the literature review. The primary driver for attending CPD is the teacher themselves for both ECTs and non-ECTs so the idea of leadership 'buy-in' may not be the sticking point. There is a clear limitation as these more explanatory ideas may have come about from interviews post-questionnaire but as outlined previously, these interviews were unable to happen due to Covid-19. The data set was small and the number of ECTs taking part of the study even smaller, however the results are very encouraging.

5.5 Does Continuing Professional Development develop perceived confidence or perceived competence amongst early-career Secondary teachers?

To answer this question, the results in the 'Impact' section of the results will be heavily relied upon. The results of the explicit question around teacher confidence are shown in Figure 9. No teachers, ECTs or non-ECTs, felt that CPD reduced their confidence meaning that CPD is either having no impact or a positive impact on teachers, rather than any negative impact. It is worth noting here that these questions all rely on perceived impacts, outcomes and increases in use of techniques and so some

cautioned should be retained when making conclusions. A greater proportion of non-ECTs agreed or strongly agreed that they were more confident because of CPD which is extremely surprising. ECTs are coming away from CPD feeling more confident, but not necessarily feeling more confident when compared to their colleagues. One notion that could explain this is that simply attending CPD session after session simply highlights to newer teachers how much they still have to learn. A programme aimed at retaining ECTs by Ovenden-Hope et al. (2018) found that involving ECTs in curriculum development, use of evidence and building professional relationships increased self-efficacy in the teachers and they were much more likely to stay in the profession, as they felt confident in what they were doing. This notion goes way above and beyond the simplistic attendance of CPD sessions and it would suggest then, that a one off CPD day or activity whilst might improve competence in a specific, subject-domain area, may not build overall confidence.

The data is somewhat different when it comes to doubting ability. No teachers that responded agreed that CPD caused any doubt, so it may not be the case that CPD causes any hints of so-called imposter syndrome in teachers of any level of experience. The results suggest that, again, CPD is mostly a positive involvement for teachers, and this is corroborated with the data from the question asking whether teachers reconsider their profession after CPD. 100% of ECTs strongly disagreed so were clearly happy with their job choice. What is not clear here is whether the teachers who are not opting to attend CPD are happy with their job: it may well be that enthusiastic teachers wishing to improve are seeking out CPD and are therefore completing surveys (or happy sheets as coined by Spowart et al., 2017).

When it comes to competence, half of ECTs felt that the knowledge and ideas they gained from CPD had significant perceived impacts on the classes that they teach (Figure 11), with the other 50% stating slight or moderate impact. For non-ECTs, 10% felt there was no impact at all. ECTs also felt that their CPD also had slight or moderate impacts on other teachers and their schools as a whole. These are significant findings that ECTs perceive themselves to be better at their jobs and more beneficial to their schools and colleagues. 75% of ECTs suggested that students are more engaged after CPD. If Hattie's (2012) study is to be believed, students perceive confidence in the way that teachers teach and so are more likely to respect, listen to and engage with more confident teachers. Although this conclusion does not come directly from questions asked of teachers, it can be concluded using previous peer-reviewed research. Newer teachers all agreed that they increased their range of skills after CPD which leans more towards the idea of increased competence than increased confidence.

Finally, ECTs showed a different pattern of responses when it comes to planning. In Figure 12 we can see that three-quarters of ECTs found planning easier after CPD implying that they are now better at their jobs: they may have more ideas, more ways of explaining concepts or of delivering content as

they are now more competent. The majority of non-ECTs neither agreed nor disagreed which is interesting. Even if CPD offers non-ECTs with new ideas or improved methods of instruction, for example, these may not necessarily make planning easier, so this is not unexpected.

These observations may support the hypothesis that CPD increases both confidence and competence on ECTs.

5.6 Is the perceived impact of Continuing Professional Development greater for science Early Career Teachers than non-Early Career teachers?

The study asked teachers how they perceived CPD impacted upon the classes they teach; other teachers within the school; and on the school more widely. Of the ECT responses, all felt that there was some perceived impact on their classes whilst 10% of non-ECTs felt there was no perceived impact at all on their classes (with the remaining 90% agreeing with the ECTs). As with other responses from ECTs, this was expected as teachers are rapidly improving in the early stages of their careers and any additional, outside help is likely to be just that. For non-ECTs this is an encouraging piece of evidence as the vast majority perceived some impact from CPD: the overarching aim of CPD. For the remaining 10% of non-ECTs that felt there was no impact, it may be that CPD is imposed on them and the theme or area for investigation for the CPD attended may not have been a particular weakness of theirs, but this is hard to tell.

When it came to impact on other teachers the ECTs were not agreeing to the same level, instead feeling only a slight or moderate impact. This is possibly due to ECTs often having to work on their own skills first rather than disseminating new knowledge or pedagogy to others in their department or school: non-ECTs are more likely to take up a coaching or more leadership role and therefore having a more significant impact on colleagues. This is supported in the data. Whilst some non-ECTs felt there was no impact on colleagues, some felt that there was a significant impact. The third point considered the school as a whole. Again, ECTs felt there was some impact but only slight and non-ECTs tended to agree (with one fifth of non-ECTs feeling there was no impact at all). Desimone (2009) suggested that teachers gain non-specific 'soft skills' throughout their development and so teachers may be gaining from CPD but not necessarily perceiving this as tangible new skill or technique that can be passed on, and so this level of response from ECTs is not necessarily a negative. It may be an indicator for CPD facilitators and leaders that ECTs need more guidance in identifying gains from CPD sessions over time. Literature shows that teachers are often failing to reflect and it's only when CPD is specifically designed this way, for example in the case of Valdmann, Rannikmae and Holbrook (2016), that teachers can really understand the value of their experiences.

Some of the remaining data in the 'Impact' section of the results are somewhat surprising. Figure 7 shows a quarter of ECTs disagreed that CPD increased their subject knowledge. This is a highly unexpected result. Although Hattie (2019) suggests that subject knowledge has little impact on student outcomes, it is generally perceived that teachers need to build up their subject knowledge over time to become experts (Taplin and Chan, 2000) in their subject. It is worrying then that some ECTs feel that CPD is failing in this respect. There are a number reasons why teachers may have responded the way they did: the CPD chosen by specific teachers may not have had subject knowledge as a core objective of that CPD session; teachers already have an excellent level of subject knowledge from previous degrees or higher-level training; some teachers are capable at delivering content to students through competent application of pedagogical ideas and so only need a basic understanding of domain-specific knowledge; or it could be that the nature of inconsistencies in teachers' starting points mean some ECTs already have far better than expected subject-specific knowledge.

The final idea analysed in the results is the notion of increasing a love of learning. All ECTs felt that CPD increased their love of learning. Burić and Moè (2020) suggested that self-efficacy and an inner drive within teachers is essential for student outcomes and Hattie (2012) highlighted that students are incredibly difficult to change: it is only through hard work, determination and a love for improving within your subject that teachers can start to make real, tangible gains. This research corroborates those ideas and ECTs seem to be really enjoying making these improvements. The picture is slightly different for non-ECTs, with 20% neither agreeing nor disagreeing and 10% of respondents suggesting that CPD does not increase their love of learning. This is an important difference between ECTs and non-ECTs and CPD providers should therefore aim to keep up this enthusiasm. Whilst teachers who have been in the profession may feel like they have fully honed their skills through practice and have little to gain from CPD, they may end up missing out on some key research or evidence-based ideas that could really benefit them and their students. On the other hand, they may be justified in being more negative if the CPD they have attended is of poor quality (as suggested by Opfer and Pedder [2010] in the Literature Review) as it has been shown by Spowart et al. (2017) and King (2014) to be incredibly difficult to accurately assess the quality of CPD.

For CPD after the event has taken place, there are some intriguing differences between ECTs and non-ECTs. The results from this study show that there was a 50/50 split in ECTs when it comes to explaining concepts more clearly after CPD, whereas 70% of non-ECTs felt better able to explain clearly. This is an interesting finding as Kulgemeyer (2018) suggests that explanations, in many forms, are used extensively in science lessons, so this really should be high up on the agenda for improvements, and

an Australian study by Hendry and Jukic (2014) found that students perceived teacher explanations as the most beneficial to their learning, so improving this skill could be key to outcomes. Whilst Hendry and Jukic's was a small-scale study on university students, the preference towards one teaching style compared to others is relevant. It could be assumed that CPD is either not specifically targeting this potentially key area of science teaching or that ECTs are just not quite gaining enough practice in the area to come away from a CPD session with high confidence yet. Nevertheless, the idea may be key to CPD designer and providers as this could be an area for improvement across science teaching.

5.7 Are the needs of Early Career science Teachers different to their more experienced counterparts?

There is a whole host of CPD available to teachers led by a range of different organisations and people. As mentioned in the literature review, Capel, Leask and Turner (2004) suggest that teachers should continue to learn throughout their careers and as a result of this, teachers will attend a whole host of different types of CPD. Figure 1 shows that both ECTs and non-ECTs are attending subject knowledge CPD so there is clearly a value in knowing the content that is to be taught and seeking to gain a wider understanding of the material. This corroborates prior studies that have noted the importance of subject knowledge in that across the experience spectrum, subject knowledge is high on the agenda. Hand (2014) referenced the need for consistency within the teaching profession and as many teachers will come together from varying backgrounds, subject knowledge will be needed. For ECTs, subject knowledge will provide vitally important as often degree level knowledge is helpful for having a wider understanding of your subject but doesn't necessarily directly correlate to national curricula and exam specifications. With 13 teachers responding 'yes' to attending subject knowledge CPD (the second highest response after online courses (14)) it is clearly high up on the priorities for teachers. The high response for online courses is most likely to be a direct result of the Covid-19 situation with most CPD having moved online for a substantial time. From this research, subject knowledge need does not however seem more prevalent amongst ECTs specifically and there seems to be little research available currently on this across the profession. These findings may be somewhat limited by the small number of responses which have led the data to have no statistical significance and therefore the lack of evidence to reject the null hypothesis, but what data is available shows a similarity between teachers of all experience. What is surprising is that the data collected doesn't favour ECTs attending subject knowledge course more often than non-ECTs as suggested by Hand (2014), where the suggestion was made that there is a need for consistency and that the most likely time for inconsistency is when teachers are entering the profession. They may be teaching out of specialism or

in a subject that is much wider than their degree course may have covered which is likely down to the fact that all teachers value this type of CPD.

The next question provided some results which, initially may have proven unexpected, but due to the nature of the current pandemic, now seem to fit with what may have been expected. The vast majority of teachers who responded to this survey have attended online courses: 100% of ECTs and 90% of non-ECTs. Given that there were no face-to-face sessions during the pandemic this is inevitable. During the design stage of this research (pre-pandemic) the expectation would have been that there would be a higher attendance to face-to-face training than online but clearly that has now been transformed. It is also likely that online courses are here to stay, and so future research might highlight how the nature of CPD has shifted because of the Covid-19 pandemic. Research by Hubner et al. (2021) from the United States strongly suggests that there is benefit to student outcomes from both online and face-to-face CPD (Wang and Wang, 2021) and that there is no statistical significance between them, so choosing CPD based on what is most convenient or what is safer (given a pandemic) doesn't seem to be a key issue. A study during the pandemic (König, Jäger-Biela and Glutsch, 2020) looked at the application of ICT amongst German teachers, but primarily and importantly looking at ECTs. The study suggests that whilst ECTs tended to be younger and so brought up with technology, they were not significantly advantaged when it came to a rapid adoption of online tools and technology for teaching. Many schools adopted packages such as Google Classroom and Microsoft 365 (Lambert and Rennie, 2021), which have been in schools for some time. However, teachers were suddenly asked to set work, assess work, provide feedback and potential deliver live lessons through these packages. It is therefore not unlikely that all teachers, regardless of experience and upbringing, would take some time to adjust to this fundamental change to teaching style. What may have been key to a science teachers' arsenal of teaching methods, like demonstrations and practical work, had to change (Wisanti et al., 2021) with teachers having to decide themselves how best to adapt. Research now from Moore et al. (2020) indicates benefits to different ways of teachers giving students experiences of practicals, but this was not available at the time. The data suggests that both ECTs and non-ECTs benefit from CPD on using technology and so would fit with the German study.

Attendance to education conferences, as seen in Figure 2, showed a significant difference between ECTs and non-ECTs: 80% of ECTs attended conferences compared with 30% for non-ECTs. Conferences often provide a day outside of the school setting where teachers can network and chat to other professionals, whilst listening to speakers talk about prominent educational issues and often take part in workshops. In a Royal Society of Chemistry opinion piece, Turner (2018) suggests that education

conferences are a “powerful addition to any teachers CPD’s portfolio”. She also goes on to suggest networking plays a key role in conferences. Many other industries, especially amongst STEM trades, rely on expos and conferences to allow members and professionals to talk to each other on pertinent issues. It appears from the data that ECTs are more able to partake. This may be due to the fact that these teachers have a lighter timetable to enable them to engage in CPD activities meaning schools are less likely to incur large cover costs for example, when teachers go out to a conference. It may be that schools cannot justify a day out of the school setting for a non-ECT with a fuller timetable however, it is impossible to know from the data available in this research and as previously mentioned ECTs are not attending more CPD sessions in total. Follow up interview questions may have allowed a deeper analysis of this but it’s impossible to know for sure. Additionally, there was no statistical significance ($p > .05$), so it is unwise to make too many bold assertions from this data.

When it came to residential CPD numbers were low for both ECTs and non-ECTs: 20% of ECTs had attended and 10% for non-ECTs. We can see then, proportionally twice as many ECTs attend compared to non-ECTs but the numbers are low and there was a lack of statistical significance ($p > .05$). It is possible that the nature of residential CPD means that teachers have to stay away from home or travel long distances by the very nature of the type of training. Many teachers or people in general would have to be very invested in the CPD to give up a weekend or pay out for extensive travel and accommodation costs, amongst other costs involved. Residential CPD may allow teachers to justify travelling further to access CPD. For example, STEM learning operates out of the National STEM centre at York University so teachers congregate from across the country in a slightly longer, more intensive training week or weekend. This is much more likely if teachers don’t have to travel backwards and forwards. In October 2021, the DfE announced a salary boost to teachers joining subjects such as maths, physics, chemistry and computing (DfE, 2021) as a result of shortages in these areas and so it is inevitable that lots of teachers who have recently entered the profession may lack the knowledge needed. These younger teachers might be more likely to attend residential CPD and this is shown in the data, although the difference is only marginal between ECTs and non-ECTs.

When it comes to partaking in pedagogical CPD, it would seem that all teachers feel that this is important. The results illustrate that 80% of ECTs and 70% of non-ECTs engage with this type of CPD which is a high value. The emphasis on practical work and demonstrating key scientific ideas through the use of physical, real equipment and models is exacerbated in that students at both GCSE and A-level have to be exposed to practical activities. During the Covid-19 pandemic, this was increasingly difficult as teachers were often not teaching in specialist labs and students could not share equipment

(Moore et al., 2020). Research by Moore et al. showed that teacher demonstration was more effective than hands-on practicals, most likely due to the “quality of purposeful teacher-led discussion” (p. 10) which likely comes from teachers with expert knowledge of content and student misconceptions. Changes like this (due to the pandemic) may lead to both ECTs and non-ECTs looking to CPD to help them adapt to changes in the way that best outcomes for students can be achieved: the pandemic may have brought about research that has changed current educational thinking. In addition, for a period, teaching moved online. Schools utilised packages such as Microsoft Office and Google Classroom to provide resources to students, interact with them and generally keep up to date with students remotely. The cognitive load on teachers, both ECT and non-ECT, was huge and so understandably they may have been looking at CPD focussed on teaching techniques more broadly rather than subject or content specific. It is unclear at this point, although the number of respondents attending online CPD would have been surprising had there not been a pandemic, what impact this will have on CPD into the future.

There is very little difference between ECTs and non-ECTs in terms of pedagogical CPD, but a significant number of teachers are engaging with activities that focus around how to impart knowledge to students and how to best teach students. This type of CPD is run often due to the nature of teaching: key skills needed by science teachers are the same for, for example, history teachers. Teachers need to be able to manage behaviour, require students to remember new facts or have the skills to answer exam questions, so this type of CPD is commonplace. It can therefore be assumed that, for this type of CPD, ECTs are no more likely to seek this type of CPD out than their non-ECT peers, but that all teachers require some sort of improvement in this area. Whether this contributes to the confidence or competence of the individual in this case is unclear and there was no statistical significance shown ($p > .05$).

When looking at these results through a difference lens, there was a more significant difference in terms of gender. The gender split is interesting: 83.3% of females had attended pedagogical CPD compared to just 33.3% of males. In this study, there were very few males that participated ($n=3$) but regardless, the results are telling. In a study by El-Emadi, Said and Friesen (2019), differences in the teaching style of male and females was identified. Although this study took part in Qatar where education systems are somewhat different the results were interesting and could provide a window into what is happening. There were clear differences in what techniques either gender was perceived by students to be better at. This finding is consistent with El-Emadi, as well as Said and Friesen (2019) in that female teachers were perceived to be less good at practical activities (in El-Emadi et al.’s study specifically the female teachers opted for videos to demonstrate practical activities rather than

physically carrying them out in front of the class), a key part of curricula in the UK, so may wish to improve in this area.

To establish a difference between CPD attended by ECTs and non-ECTs, future research should focus on understanding the typical CPD an ECT receives over the course of their 2-year framework and appraise this against what the ECT feels they have improved on and where they still need to improve.

The reason and purpose behind attending CPD is often varied but is driven by the government policy delivered by the DfE (2011) as part of its Teacher Standards. Many would argue though, that the reasons are wider and more innate than policy. Teachers need to feel motivated and have a want to improve for their students (Burić and Moè, 2020). For a number of reasons, the open-ended question included in the survey gave skewed results that are difficult to draw conclusions from. Table 2 shows the results. Given the nature of how the survey was disseminated to teachers, the responses to the question were closely linked to the limited CPD that was available rather than representative of CPD as a whole. Many teachers attended online courses based around physics practicals with the other type of CPD on offer was around middle leadership skills: this means the CPD as a whole was not representative of the wealth of CPD types typically available outside of a pandemic. Whilst these results may be skewed, it does highlight that the type of CPD attended may vary by experience and therefore the reasons and purpose for attending may vary. Teachers at the start of their career have different needs to those with more experience (Spencer, 2018) and it's almost impossible to prepare a teacher for every eventuality they may encounter. This is as true for subject specific activities as it is for more generic teaching ideas.

By looking at all six 'level of need' questions a general theme emerges. In all areas, the vast majority of teachers indicated some level of need. These areas were assessment for learning; classroom management; subject knowledge; use of ICT; SEN; and motivating students. There is often very little difference between the responses from ECTs and non-ECTs in this respect: these areas of teaching are pedagogical techniques that may never really be mastered as teaching changes, classes change, and techniques come in and out of fashion. The results seem to contradict suggestions by Huberman (1992, in Hargreaves and Fullan, 1993) that, after 5 years' experience, teachers tend to feel they have mastered most facets of teaching. For assessment for learning, all of the ECTs indicate some level of need, whilst 80% of non-ECTs had some level (only 13% of total responses indicated no need) and for motivating students (as shown in Figure 4), non-ECTs showed a similar pattern to ECTs in having a level of need. What is surprising is that even non-ECTs feel they need to improve in these areas which

supports Hattie's (2012) ideas that teachers are best placed to create change, and where identified they are best placed to enact change in their classrooms: if assessment for learning can increase outcomes for students, teachers must want to improve in this pedagogical area.

The next level of need is classroom management. The results in are slightly different to assessment for learning in that 25% of ECTs felt they had no level of need in this area thus feeling confident in this area of teaching. When looking at the low/moderate need rates we see that ECTs have a marginally higher rate (75%) when compared to non-ECTs (60%). This is likely to be an area within a teacher's repertoire that improves over time with practice, and so ECTs or less experienced teachers are more likely to lack confidence and competence in this area so feel a need to improve (Delamarre et al., 2021). The chi-square statistical test shows that $p < .05$, indicating a statistical significance. However, due to the low count rate brought about by the small sample size, the conditions of the chi-square test were not met. The data in this study is in line with results from Spencer et al. (2018) whereby ECTs are given some training on behaviour management but not enough and results by VanLone, Pansé-Barone and Long (2022) in that ECTs who have not had sufficient time in classrooms tend to score lower on self-efficacy scales for behaviour management. VanLone, Pansé-Barone and Long suggest that the best training has the most amount of classroom time and so teachers during a pandemic are likely to show higher levels of dissatisfaction in their own behaviour management abilities (hence the significant difference between ECTs and non-ECTs here).

Delamarre et al.'s (2021) research is ground-breaking in that it uses virtual reality to allow teachers to practice behaviour management techniques on a virtual class, receive feedback and try again. This tool could prove crucial for ECTs who have had limited classroom time and face-to-face interaction with students during their training year due to the Covid-19 pandemic and could help to align ECTs and non-ECTs by removing the barrier of simply improving over time.

Responses to subject knowledge are stark: there is a clear difference here between ECTs and non-ECTs. This study found that ECTs had either a low or moderate level of need (20% and 80% respectively), whereas non-ECTs had either no need or low level of need (80% and 20% respectively). It is likely that non-ECTs have previously engaged in improvements to their subject knowledge, although this is not explicitly shown in the study and we can see in the section on 'Alternatives' that all teachers report to engage in a variety of other types of CPD, so over the course of their career are likely to have improved on their knowledge as a result.

Research suggests, however, that teachers in the UK engage in subject specific CPD less than other "high performing countries" (Cordingley et al., 2018) and so non-ECTs may not be as far ahead of ECTs as immediately thought even though non-ECTs perceive their need to be low. It's also worth noting

that both ECT's and non-ECTs responded that they equally attended subject knowledge CPD, yet the need is perceived as greater by ECTs. This has a significant impact on CPD as there may be a range of differing levels of experience of teacher in a room: some will feel they really need the training whilst some don't and therefore how the facilitator pitches the session can become increasingly difficult to ensure all teachers involved gain something from the session.

ICT is used throughout education in a variety of ways and this is no exception within classrooms. Figure 3 shows the level of need reported and no respondents indicated a high level of need. All ECTs indicated some level of need whilst 20% of non-ECTs had no level of need. This seems to correspond to recent research, in that the majority of teachers feel that they have sufficient skills needed in their job (Saikkonen and Kaarakainen, 2021) but might struggle move outside of this limited comfort zone. ECTs have slightly more need, but it would seem but many of the admin skills needed, for example, are picked up along the way. It is supposed that as teachers are regularly using technology to some level, having completed a PGCE or similar teacher training it is very unlikely that there first year in a school is the first time they have had to use a computer and so the results fit with what is expected. Additionally, with the Covid-19 situation, most schools moved to online learning and so teachers had to utilise online technology through the use of computers. If they didn't know how to do this, they had to learn quickly.

Clearly teachers are highlighting throughout this study that they have a level of need in a variety of areas within their teaching practice, lacking assurances that they are mastering this skill, and so this is likely to be a key motivator for attending CPD sessions. This notion is consistent with Byman et al. (2021) that even within similar groups of teachers there is little to no homogeneity. The purpose is to improve but for each teacher this area of need may be quite diverse. On the whole, the question of whether the needs of ECTs compare to non-ECTs seems to suggest that there are some general themes that teachers must master throughout their careers but that specifically, areas such as SEN and subject knowledge are more problematic for ECTs whilst, surprisingly, ECTs felt more able to motivate students than their non-ECT colleagues.

5.8 Limitations

There are a number of limitations identified throughout this study. The most significant being the impact of Covid-19 on the data collection and subsequently the volume of available data. The dataset is small and far below what would give any statistical significance when undertaking the Chi-squared analysis. For this reason, any assumptions made in this research should be taken with caution. As has

been discussed, this is most likely due to the ongoing Covid-19 pandemic which has caused education to make significant changes. Whilst this study may not have shown differences between the two groups, the lack of statistical significance is significant in itself.

The secondary effect of the pandemic was that this study was limited to the quantitative questionnaire, without any planned face-to-face interviews to provide some qualitative background to attempt to delve more deeply into some of the questions asked. This has meant that understanding the 'why' behind some of the data has been difficult.

Secondly, as indicated by Hamilton Broad (2015), many teachers buy into the notion that CPD is a waste of their precious time and given the additional burden on teachers currently with the pandemic, it may be that less teachers are attending CPD, or teacher's views may be skewed currently and so the data collected now may be different to if there was no pandemic. This should be considered when making any conclusions. We should also mention that the survey technique relies on those teachers who attend CPD to complete the survey. Therefore, as mentioned in the Methodology chapter, it is impossible to survey all teachers: those that do not attend CPD cannot access the survey.

Finally, a key part of CPD is the continuation of the development. This data does not identify if, for example, teachers continue to use techniques learned in CPD, or if the changes in confidence or competence immediately after CPD sessions changes after days, weeks or decades of teaching practice.

5.9 Future research

As a consequence of this thesis, a number of areas for future research have been identified. The researcher was unable to conduct interviews face-to-face and future research could aim to gain insight as to why teachers answered the way they did in the questionnaire to give an understanding of where these answers came from. This might prove useful for CPD providers and facilitators to start to address any shortcomings identified.

The study was carried out during a pandemic when the nature of CPD drastically changed from the norm. It is unclear if CPD will remain in this state of primarily online or if it will return to mostly in person. For future research, the implications of this should be known. The results of this study may have been different if carried out 12 months earlier or carried out in 12 months' time and so this may help to understand how the CPD landscape might look into the future.

The snapshot questionnaire utilised in this study was disseminated to teachers at the end of a CPD session and so only gains the insight of those teachers who are attending CPD regularly, and specifically, outside of their own institution. Therefore, an unknown proportion of teachers' views are missing from the data. To truly gain a balanced view of CPD, any future research should aim to understand the views of these teachers who do not regularly engage with CPD to potentially make changes to the design stage of CPD to engage them more. The methodology for this study did not suit targeting this audience.

Finally, as previously mentioned, a key part of CPD is that it is continuous. This snapshot data collected was unable to determine if teachers continue to develop over time, or to establish if their perceived need, confidence or competence remains stable or changes. This could be addressed by undertaking a longitudinal study that takes into account a much larger sample of the teaching profession to improve the reliability and scalability of results.

6.0 Conclusion

To conclude, this research has looked at the perceived impact of Continuing Professional Development (CPD) on Early Career Teachers (ECT) by looking at a range of questions to compare science teachers at the beginning of their career to those teachers who have more experience.

This study was severely impacted by the Covid-19 pandemic and so the study had small sample size making any assumptions somewhat tentative as the data showed no statistical significance. However, from the data collected, some conclusions can be made about the similarities between ECTs and non-ECTs. CPD does seem to be impacting on ECTs but this impact may not be significantly different to their non-ECT colleagues. Under each question is a short summary:

Are science Early Career Teachers intrinsically motivated to develop through Continuing Professional Development?

ECTs are making decisions over their own CPD needs and attend similar amounts of CPD sessions when compared with non-ECTs, suggesting that teachers have autonomy and involvement in the process, rather than having the process done to them (Clark, 1992 cited in Hargreaves and Fullan, 1993). This research validates Hattie's (2012) claims that teachers are best placed to enact change in the classroom and teachers are engaging with CPD across a wide range of topics: both subject specific, pedagogical, formally and informally. ECTs however do not seem to be any more motivated than non-ECTs to engage with CPD, which conflicts with research from Hamilton Broad (2015) in that teachers often see CPD as a waste of their time.

Does formal and informal professional development jointly contribute to the progression of science Early Career Teachers?

The data suggests that ECTs overwhelmingly take part in both formal and informal CPD and so conform to McNamara's (2019) definitions of CPD that happens whenever teachers are actively thinking about improving their practice. The results show that non-ECTs read around their subjects more than ECTs and ECTs use social media more which may distinguish the two groups from each other. As ECTs tend to be younger they are considered "digital natives" (Wilson et al., 2020, p. 1) and so would be assumed to utilise resources such as social media. However, proportions of ECTs and non-ECTs using social media for CPD are similar, with no statistical significance, which is surprising. If ECTs want to be more like non-ECTs they need to read around their subject more where time and capacity allows.

Does Continuing Professional Development increase the range of activities used to deliver science in Secondary education amongst Early Career Teachers?

ECTs do increase the range of activities after CPD: all ECTs who took part in the study learned something new from CPD which was a different to non-ECTs. Often, non-ECTs express more cynical views (Will, 2019) and so may be resistant to new ideas. When asked about specific pedagogical tools, ECTs and non-ECTs had similar response rates on using new activities such as Direct Instruction, demonstrations and practicals after CPD and most teachers used group work less often. It is unclear why this is the case, but this may be due to the Covid-19 pandemic, with research, for example from Moore et al. (2020), coming out some time after online learning started, or that teachers try to prevent certain students from sitting back and allowing others to do all the work (Fung, 2022). ECTs are often coming away from CPD with new ideas to try which supports previous research by Nielsen (2015) as teachers try to bring about the best outcomes for their students and the majority of ECTs felt the CPD gave them the tools to actually implement new techniques in the classroom. This result showed a disparity between ECTs and non-ECTs in that ECTs were more likely to experience a new technique from CPD than non-ECTs.

Does Continuing Professional Development develop perceived confidence or perceived competence amongst early-career Secondary teachers?

Attending CPD sessions causes ECTs to have less doubt in their abilities and it seems to leave them feeling more competent. The results show that the majority of ECTs are more confident as a result of CPD sessions, which corroborates Valdmann, Rannikmae and Holbrook's (2016) that teachers feel more confident after CPD. Although this is also the case for non-ECTs it is important for ECTs at the start of their careers. This is further good news for ECTs as Hattie (2012) suggests these gains teachers respect from their students when they have more of an air of authority. In addition, CPD does not cause ECTs to doubt their ability so it would seem that CPD is a mostly positive experience. In terms of competence, ECTs often learn new techniques and are using a wide range of resources to access these and so would seem to be gaining in competence too as ECTs perceived lesson planning as easier as a result of attending CPD. The results would suggest, that ECTs are gaining both competence and confidence from CPD as they improve as teachers.

Is the perceived impact of Continuing Professional Development greater for science Early Career Teachers than non-Early Career teachers?

ECTs overwhelmingly feel that CPD has an impact on them and their classes, whilst the vast majority of non-ECTs held this view. This is an expected result as the overarching aim of CPD is to improve

teachers (Department for Education, 2011) and provide expert teaching to students. In addition, teachers may be gaining more soft skills, as suggested by Desimone (2009) than they realise so this perceived impact may be subdued. Surprisingly, only three quarters of ECTs felt CPD increased subject knowledge, and while it is unclear as to whether subject knowledge is actually key to quality teaching (Hattie, 2019) it is viewed as important for teachers to build up a good grounding of how students understand what we are teaching them (Taplin and Chan, 2000). There are a number of reasons though that may give the perception of no increase in subject knowledge: excellent knowledge from previous training or degree; CPD may not specifically focus on domain-specific knowledge; or teachers may not need the additional subject knowledge as they are proficient in using pedagogical techniques to impart knowledge. Finally, Burić and Moè (2020) suggest that self-efficacy for teachers is essential and this study suggests that ECTs increase their love of learning through CPD. This is important for CPD providers and facilitators as they should be attempting to retain this enthusiasm.

Are the needs of Early Career science Teachers different to their more experienced counterparts?

The data suggests that ECTs have a greater level of need when it comes to subject knowledge, even though both ECTs and non-ECTs attend subject knowledge CPD, conforming with the notion that teachers continue to learn throughout their career (Capel, Leask and Turner, 2004). Pedagogical training is high on the agenda for both ECTs and non-ECTs and there was little difference between the two groups. The Covid-19 pandemic has meant that teachers need to adapt to online learning (Sparks, 2021) and ECTs and non-ECTs had similar responses to attending online CPD and so ECTs and non-ECTs have similar needs.

6.1 Implications on future CPD

CPD does then have a perceived impact on Early Career science Teachers but in very similar ways to other science teachers. CPD is important for all teachers and, particularly during times such as a pandemic when the nature of teaching drastically changes, often changes dramatically and at pace. The use of technology constantly evolves the way that teachers and students can engage with science and STEM and so it is key to build this into CPD sessions. This thesis has discussed the interplay between formal and informal CPD. It takes time to prepare and deliver good-quality CPD sessions and so, as has been highlighted, less formal CPD is often the difference between ECTs and non-ECTs and can be a perfectly good way to bridge the gap between levels of experience in a subject area. It has become clear that the needs of ECTs and non-ECTs are not dissimilar and so CPD must continue to focus on areas that all teachers perceive to be difficult.

ECTs still have a love of learning and so it seems important that CPD can harness that enthusiasm: any formal CPD should continue to enthuse teachers (Education Endowment Foundation, 2021) by building on what they already know and using practical, tangible examples (Sims et al., 2022). CPD should continue to expose teachers to new techniques as this is what ECTs report to gain from CPD but also as this is how teachers can then appraise what works for them and their students to make an impact. If a key difference between ECTs and non-ECTs is whether they read around their subject, then CPD providers should link this into their courses by highlighting the need for this type of activity or by actively asking teachers to read prescribed material prior to or between sessions.

Finally, it may be that in the future science lessons will fundamentally change and CPD will need to change too to correspond with what's going on in the classroom. Wisanti et al. (2021) cite technology as the main stumbling block for online learning and so CPD can plug this gap. But more importantly for STEM, a global pandemic opens the door for 'citizen science' where students can learn science in context (Erduran, 2020) using their lived experiences. In the same way the recent TV show 'Chernobyl' excites students when talking about radioactivity, the Covid-19 pandemic is an opportunity to highlight the importance of vaccination, public information, human behaviour, and understanding how a virus spreads and infects etc. and so CPD should adapt to embrace this change (Matuk et al., 2021) so that ultimately any impact is positive for students.

6.2 Further Research

To continue to make gains and improvements to CPD, this study could be repeated again after the pandemic as the current CPD climate is not representative of the 'norm'. It may be that education adopts this new normal, in which case further study with the previously planned interview questions can start to understand why teachers gave the responses found in this research.

Additionally, a key component of CPD is that it is continuous, so a longitudinal study could establish whether teachers' perceived impact is the same after they have gained more experience or whether their attitudes and beliefs change.

This research was disseminated to teachers who attended a CPD session and so gains the insights of those teachers who regularly attend CPD. There is a proportion of teachers that it fails to target: those who don't attend CPD. Any future research, to gain a balanced view, should aim to incorporate those teachers who do not seek out regular CPD to gain their insight.

6.3 Final comment from the researcher

Although undertaking research on education in a time of huge challenge and change has been tough, this research has been immensely rewarding. As a teacher, the endless changes and the difficulties of the job have been balanced out by the constant of this project. I have found this both interesting personally, but it has also helped me professionally as I now speak confidently about research during meetings and often engage with my more experienced colleagues and can hold my own when it comes to current educational theories and research. During this project my partner and I had a baby and so this has by no means been easy to balance work, life and a research project, but I hope this contribution helps me when I deliver future CPD to ECTs (as I have already made changes to the CPD sessions I have delivered during this project as a direct result of what I have read and researched) and I hope it can be helpful for others to so that those delivering and those attending CPD have the best possible experience.

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8.0 Appendices

Appendix 1 – Questionnaire

*** 1. Please read carefully.**

The following survey is aimed at gathering data that will be used in a thesis for a Masters in Education at Canterbury Christ Church University.

The project will aim to investigate secondary teacher experiences with regards to Continued Professional Development (CPD). This could be any training delivered by your department, by your school or by an outside agency (either within your school or at another location). However, CPD could also include activities that you complete on your own, for example reading textbooks to improve your subject knowledge.

If you choose to give your consent, thank you, and please complete the survey. It contains 26 short answer questions and should only take 5-10 mins to complete. By ticking the box below you give consent for your data to be used within this research.

In addition, there is the option at the end of the questionnaire to also participate in an interview to further discuss CPD. This is optional, and the data collected will also be used in the thesis.

Data will remain confidential, and will be anonymised. The raw data and consent forms will remain safely stored and password protected in line with GDPR regulations. The raw data will only be used for this research project, and will be destroyed after this project has been marked.

Please contact Jamie Pout on jp538@canterbury.ac.uk for any further information or if you have any questions.

If you are happy to participate, please tick the box below

- I have participated in at least 1 CPD activity during my teacher training/teaching career
- I have read the above outlining the nature of the research project and give my consent to participate.

Information about you

2. Do you consider yourself to be

- Male
- Female
- Other
- Prefer not to say

* 3. How long have you been working as a teacher?

- NQT
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- More than 5 years

* 4. What is the primary subject that you teach?

- Science
- Design Technology
- Maths
- English
- Geography
- History
- Art
- Computer Science/Computing
- PE
- Other (please specify)

5. Do you teach a second subject? If so, what subject?

- No
- Yes (please specify)

Professional development

8. Which type of CPD activities have you attended? (tick all that apply)

- Subject knowledge enhancement
- Education conference
- Online course
- Residential CPD
- Pedagogical training (e.g. how to use retrieval practice)
- Other (please specify)

* 9. Thinking about the last CPD session you attended, what was the main purpose for attending the event?

* 10. Approximately, how many CPD sessions/events do you participate in per year? (either within school or outside of your school)

- None 1 2 3 4 5+

11. When choosing a CPD event to attend, who makes the choice?

- Me
- Line manager
- Senior Leader
- Head Teacher
- Other (please specify)

12. Thinking about less formal professional development, have you ever done any of the following:

- Reading educational journals
- Reading subject-specific journals
- Engaging in discussions online
- Engaging in discussions on social media (e.g. Twitter or Facebook)
- Reading textbooks
- Reading around subject content online

13. Thinking of your own professional development, please indicate the extent to which you have such needs in each of the following areas:

| | No need at all | Low level of need | Moderate level of need | High level of need |
|--|-----------------------|-----------------------|------------------------|-----------------------|
| Assessment for learning (AfL) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Classroom management | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Knowledge and understanding of my main subject (subject knowledge) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| ICT skills for teaching | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Teaching students with specific needs (SEN, EAL etc) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Motivating students | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Now think about the last CPD event that you attended

14. The last CPD event I attended **increased my subject knowledge**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

15. The last CPD event I attended **caused me to reconsider being a teacher**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

16. The last CPD event I attended **increased my ability to teach my classes**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

17. The last CPD event I attended **made me a more confident teacher**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

18. The last CPD event I attended **caused me to make changes to my teaching**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

19. The last CPD event I attended **showed me a technique I had never seen before**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

20. The last CPD event I attended **made me doubt my ability**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

21. The last CPD event I attended **increased my love of learning**

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

22. Since attending CPD events, have you changed how often you use the following?

| | Less often | No change | More often | N/A |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| Direct instruction | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Group work | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Using new technology (e.g. visualiser, new app etc) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Engaging demonstrations / practicals | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| SLOP worksheets (e.g. lots of repetitive practice) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Use of lollipop sticks/no hands up questioning | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Retrieval practice (e.g. fact recall on a regular basis) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Impact after attending CPD

23. How much impact have recent CPD sessions had on the following groups?

| | No impact | Slight impact | Moderate impact | Significant impact |
|-----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Classes you teach | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Other teachers in your department | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Your school as a whole | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

24. Since attending CPD sessions, how much do you agree with the following statements:

| | Strongly Disagree | Disagree | Neither agree/Disagree | Agree | Strongly Agree |
|--|-----------------------|-----------------------|------------------------|-----------------------|-----------------------|
| I can explain concepts more clearly | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| My students find my lessons more engaging | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I am more determined to improve my teaching skills | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I feel able to try new ideas | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I have increased my range of teaching skills | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Planning lessons is easier | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

25. Do you have any further comments regarding CPD? (Please comment in box)

Thank you for completing the survey!

26. Thank you for completing the survey. If you would be happy to be contacted to discuss your answers further, within an interview, please include your email address in the box below.

To find out more about this project, please email Jamie Pout at jp538@canterbury.ac.uk to find out more!

Email Address

Research project request



Thank you for participating in the CPD today.

I am currently undertaking a Masters in Education by Research at Canterbury Christ Church University and would be grateful if you could share your experiences of CPD with an online survey.

The survey should take approximately 5-10 minutes and is **completely optional**. Please follow the link or scan the QR code.

bit.ly/3nGT7ZJ

Thank you in advance, Jamie Pout

(For more information please feel free to email me jp538@canterbury.ac.uk)

Appendix 3 – Email from CCCU

Continuity of Research and Research-related Activity

Canterbury Christ Church University <graduateschool@canterbury.ac.uk>

Wed 01/04/2020 14:46

To: Pout, Jamie (j.pout538@canterbury.ac.uk) <j.pout538@canterbury.ac.uk>

This email has been sent to you by the Graduate School at Canterbury Christ Church University. If you have any questions about the content of this email, please contact graduateschool@canterbury.ac.uk.

Hello Jamie,

Many of you will quite understandably be concerned about the impact of COVID-19 on your research and research-related activities, and the impact that this might have on your studies and award. Clearly, the closure of the University's campuses in Canterbury, Medway and Tunbridge Wells, and the need to avoid face-to-face interactions and social gatherings to achieve social distancing outcomes, requires that research and research-related activities are undertaken in different ways, or if this is not possible, suspended.

However, the University is committed to ensuring that you, our postgraduate research and taught students, supported by your supervisors, are able to continue to develop and pursue your studies and your research, and consequently we have agreed a set of guidelines for research continuity to support you in doing so. These guidelines, approved by Academic Board on Monday 30th March, cover both ongoing and future research for the period of the COVID-19 pandemic, and can be found [here](#). As well as generic guidelines for staff research, they include guidelines for:

Postgraduate Research Students, whether you are on any form of Doctorate or on a Masters by Research programme: for you, the same guidance as for staff applies.

Research by Students on Taught Programmes, particularly those of you on taught postgraduate programmes who will be undertaking and completing your major projects or dissertations over the summer,

Supervisors of students on both research and taught programmes.

In addition to the attached guidance, we expect to develop and circulate in the near future further advice as follows:

(1) **Alternative Research Approaches**: Together with colleagues in Research Development, the Graduate College is working with researchers across the faculties to provide advice and ideas for alternative research approaches or projects that can be undertaken within the new guidance. This may be particularly relevant for students on taught programmes completing major projects or dissertations. We will circulate these as soon as they are available. In the interim, you should

discuss how the new guidance might affect your study with your supervisor or programme leader.

(2) Period of Registration: The Graduate College will soon be issuing advice for postgraduate research students and their supervisors relating to the implications of the new guidance for your primary data collection and your period of registration. Until then, you should continue with your studies and work on your thesis, and you should discuss how the new guidance might affect your study with your supervisor. You should continue to utilise Research Space to arrange and record meetings and consultations with your supervisor remotely. You should also use Research Space to prepare your submission for review meetings as scheduled and the review itself will take place remotely.

The Graduate College is working as usual, albeit in remote mode, to support your studies, and we can be contacted by email with any questions you may have (graduatecollege@canterbury.ac.uk). The University also continues to offer a wide range of support remotely, for further details please [click here](#).

Equally, we are happy to receive any comments, questions, queries or feedback on the guidance or on the conduct of your studies and research during the COVID-19 pandemic. We can be contacted on susan.millns@canterbury.ac.uk or mike.weed@canterbury.ac.uk.

Professor Sue Millns
Dean of the Graduate College

Professor Mike Weed
Pro Vice-Chancellor (Research & Enterprise)