THE UNIVERSITY OF WINCHESTER

Exploring the self-efficacy of preservice teachers: Qualitative analysis of their experiences within the context of primary science

Liz Burgin

ORCID 0000-0001-5939-2537

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Abstract

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The primary aim of this research was to explore how self-efficacy could be operationalised as a useable construct to support preservice teachers, as they develop their knowledge, skills and beliefs about ways in which children learn and engage with science. Additionally this study sought to explore how research into self-efficacy, largely underpinned by quantitative approaches, could be further enriched through qualitative approaches. This study was undertaken at a time when the status of primary science as a core component of the primary curriculum in the UK, was diminishing. Consequently this has led to reduced opportunities for preservice teachers to observe or participate in primary science teaching experiences, affecting the development of self-efficacy beliefs for becoming effective teachers of science. Whilst self-efficacy beliefs are generally discussed in terms of future events they can also be thought of retrospectively to explore how such beliefs are influenced by past experiences. In this research eleven preservice primary teachers who had completed, or were in the process of completing initial teacher training, participated in semi-structured interviews to reflect on their experiences of primary science teaching. Data analysis was guided by thematic analysis to operationalise self-efficacy through participants' responses, making use of an inductive approach and aligning this with themes from literature to include a deductive element. In this way indicators of self-efficacy were identified which included making use of support, resilience and motivation. A further aspect of this research was to explore the factors that may contribute to the development of self-efficacy beliefs. Data analysis was then influenced by conceptual models, including Bandura's work from 1997, illustrating the triadic reciprocal causation (TRC) model, and additional models such as that of Gist and Mitchell from 1992. As a result this research provides insights into the potential for enhancing the usability of self-efficacy research for teachers, through the development and suggested application of new analytical tools including the TRC Integrated Cyclical Model.

Key Words: Self-efficacy, Primary Science, Preservice Teachers, Qualitative Approach, Analytical Framework

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Glossary of Acronyms

AF(TRC)-Analytical framework influenced by the TRC model

CAQDAS-Computer assisted qualitative data analysis

ITT – Initial Teacher Training

KS1 – Key Stage 1

KS2 – Key Stage 2

NQT – Newly Qualified Teacher

PGCE- Post Graduate Certificate of Education ITT course

QTS- Qualifed Teacher Status

RAND corporation is a research and development group that contributes to improving policy and decision making, founded in after the second world war and based in USA

SCT-Social Cognitive Theory

TA – Teaching Assistant

TRC-Triadic Reciprocal Causation model

CHAPTER 1 - Introduction

1.1 Rationale

Effective teachers are expected to have good pedagogical skills as well as subject knowledge and subject pedagogy (Muijs and Reynolds, 2002; Zwozdiak-Myers, 2012; Dunne and Peacock, 2015). Additionally Gibbs (2002) argues that effective teachers need to be willing to use innovative teaching approaches and be resilient enough to cope with potential failure. These are all characteristics that enable teachers to cope with the unexpected situations that they often have to deal with. These are also characteristics that preservice teachers will need to develop if they are to become effective primary science teachers (Gibbs, 2002). Therefore, it would be beneficial for preservice teachers (trainee teachers) to have opportunities to observe effective teaching of primary science, and opportunities to practise teaching science, whilst on assessed placements undertaken during their ITT (Initial Teacher Training) courses.

In my role as a teacher-educator preservice teachers, anecdotally, have indicated mixed experiences on assessed placements regarding primary science. For some preservice teachers this has included a lack of opportunity for mastery experiences involving teaching a science lesson or a series of science lessons (Tschannen-Moran and Hoy, 2005). For others this has resulted in a lack of opportunity for vicarious opportunities from which to observe more experienced teachers, for example, in the use of a range of teaching strategies to support and engage children in learning science. Conversely, preservice teachers such as science specialists can be placed in a position of too much responsibility and asked to teach all the science lessons despite having little personal experience.

Therefore, as a teacher-educator, I was interested in both the practicalities of supporting preservice teachers to teach primary science, as well as interested in how the beliefs and experiences of preservice teachers impacted on their decisions and approaches for teaching primary science. This drew me to the construct of self-efficacy as influenced by the work of Bandura (1977; 1997) and its associations with resilience, the motivation to do things, and the motivation to maintain the effort required to successfully complete activities that are not always familiar (Bandura, 1977). Teachers draw on their self-efficacy beliefs to evaluate their capability for carrying out teaching and whether the teaching approaches they use will be successful in supporting children's learning (Mansfield and Woods-McConney, 2012).

1.2 Theoretical Background

Self-efficacy developed out of the social learning theory of Bandura (1977), later the social cognitive theory of Bandura (1986), in which people learn and evaluate behaviours through observation of others and use these evaluations to determine their own behavioural choices. Self-efficacy is about self-beliefs and judgments about one's own capacity to do something in a specific context (Bandura, 1977) and it has an

impact on the choices and behaviours that follow. A high self-efficacy leads to proactive teachers willing to take risks with new ideas and learn from their mistakes, whereas a low self-efficacy leads to worksheet approaches, avoidance of perceived risky approaches for teaching and letting others take on the mantel wherever possible (Mullholland and Wallace, 2001; Chichekian and Shore, 2016). The implication is that preservice teachers need to develop high self-efficacy so that they feel confident enough to tackle a curriculum area that they have not had so much active teaching experience in.

Much research in self-efficacy relies on quantitative approaches (Palmer, 2006). The outcome of such approaches often focusses on developing suitable measuring tools for self-efficacy (Enochs and Riggs, 1990) or identifying correlational links between self-efficacy and particular attributes such as resilience (Sagone and Caroli, 2013). It does not, however, provide as many insights into the sources which contribute to self-efficacy, or insights into how someone develops their self-efficacy to teach a subject area they may have had little experience of. Research in this area lacks qualitative approaches which might provide richer detail into these areas (Wheatley, 2005). Some mixed method approaches have addressed this issue through using quantitative measurements to assess self-efficacy and then added to these self-assessments, through interviews and observations allowing for comparisons between quantitative and qualitative approaches (Klassen and Durksen, 2014). My focus for this research was to continue to contribute towards qualitative approaches, to explore how preservice teachers' experiences could be used to recognise self-efficacy from interview responses, and to explore how specific experiences could be unpicked to show how these experiences have developed self-efficacy.

1.3 Research Aims

Influenced by the context and research background qualitative approaches were used to explore self-efficacy beliefs and to seek ways to make self-efficacy a more useable construct for professional development. To this end this thesis aims to:

- **Research Aim 1**

  To explore the operationalization of self-efficacy within primary preservice teachers' reflections on their experiences of science teaching through a thematic analysis approach.
- **Research Aim 2**

  To adapt Bandura's Triadic Reciprocal Causation model to explore the factors that contribute to the development of preservice primary teachers' self-efficacy.
- **Research Aim 3**

  To explore the application of using a qualitative research approach to inform understanding of the nature (operationalisation) of self-efficacy and the development of self-efficacy through contributing factors.

1.4 Context

The study sample was made up of eleven participants, all of whom volunteered to take part in this research. Within the context of this thesis, the participants were all preservice teachers attending ITT university-based courses in primary education at one institution. The participants had completed, or were in the process of completing, their final, or only year, of their ITT courses. Three of the participants, had completed their courses in primary education and had obtained teaching posts. Of these three, one had completed a four year ITT undergraduate course, one had completed a three year ITT undergraduate course, and one had completed a PGCE course. A second group consisted of three PGCE participants who had yet to do their first assessed teaching placements. A third group consisted of four undergraduates in their final year of a three year course, who had all chosen science as their specialism. A final group consisted of one undergraduate, in the final year of a three year course, who had chosen art as her specialist subject. Further details of the participants can be found in section 3.7 and Figure 3.4, of chapter three.

At the time of this study, preservice teachers were expected to have a minimum of 120 days in school in order to be recommended for Qualified Teacher Status (QTS). The majority of the school-based days fall within assessed placements where preservice teachers spend several weeks in school working with teacher tutors (mentors) linked with a specific age group or class. Preservice teachers are likely to go on two or more assessed placements dependent on the requirements of their courses, and complete the remaining days through self-directed time. It is expected that preservice teachers will have developed many skills and attributes by the time they have completed their courses so that they are ready to take on the challenges of their first teaching job (DfE, 2012). Primary schools and their teachers are expected to cover a range of subject areas including the core subjects of English, mathematics and science (DfE, 2012). Thus, it might be expected that preservice teachers would have had the opportunity to have had some experiences of teaching science at some point on their courses. While this is very likely for English and mathematics, some preservice teachers may have had very limited or even no experience of teaching science, or even observing science being taught (Wellcome, 2017). To some extent their ITT courses will have covered aspects required to teach science in the National Curriculum (DfE, 2013) such as the use of constructivist approaches when working scientifically (Dunne and Peacock, 2015). Preservice teachers, however need to move from theoretical understanding of learning theories to applying them in the classroom to evaluate and explore the strengths and limitations that arise when working with children in real classroom contexts. Therefore, preservice teachers must, to some extent rely on their own self-beliefs, that even if they have not had much experience of teaching or observing primary science they will be able to teach science as required on taking up their first post. This is where self-efficacy plays its part.

1.5 Outline and Organisation of thesis

This thesis is set out through eight chapters. Chapter one introduces the rationale and research aims. Chapter two provides a summary review of the literature of self-efficacy. I also provide some contextual

background for primary science. Chapter three provides a rationale for the methodology as well as a summary of the ethical considerations undertaken. I also include detail about methods used in data collection and acknowledge my positionality within the research. Chapter four provides detail of the thematic analysis process. Chapter five provides details of the development of analytical tools to illustrate ways to operationalise self-efficacy through indicators developed from the thematic analysis. Chapter six provides details of the development of the analytical tool influenced by the Triadic Reciprocal Causation (TRC) model, developed by Bandura (1997), and its application for identifying factors which may contribute towards self-efficacy. Chapter seven details how the analytical tools can be adapted for different audiences to explore the application of using a qualitative research approach to make the construct of self-efficacy more useable for teacher practitioners. Chapter eight brings the research to a summary conclusion, identifying key findings and limitations of the research.

CHAPTER 2 - Review of the Literature

2.1 Introduction

In this literature review I have chosen to begin with some contextual background to approaches used for teaching and learning primary science, before providing a detailed discussion of self-efficacy as outlined by Bandura's work (1977; 1997). The intention is to provide: a brief historical discussion positioning Bandura's work with other contemporary theories of learning, in particular Rotter's work on Locus of Control (1966); an outline of the key features of self-efficacy and overview of self-efficacy research that has developed from Bandura's work; issues that impact on the complexity of self-efficacy and its links with education through teacher efficacy; progression of self-efficacy research to qualitative approaches; and models, agency and alternative approaches to understanding self-efficacy. In this way, I hope to set the scene for the following chapters which explore ways to make self-efficacy a more useable construct for practitioners such as preservice teachers.

Bandura defines self-efficacy as 'beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments' (1997:3), a definition which underpins this thesis. Much of the literature I have read refers to this definition, although over time this definition has evolved and will be reviewed within this chapter.

2.2 Primary Science

Constructivism is a term used both for learning theory and for methodological decisions which impact on research approaches (Savin-Baden and Howell Major, 2012; Pritchard, 2018). In the methodology chapter, I refer to the constructivist paradigm (Schwandt, 1998 and Lincoln *et al.*, 2018) because it underpins my approach to research in this thesis. In this section I focus on providing a brief outline of the constructivist approach to teaching and learning in primary science (Dunne and Peacock, 2015; Harlen and Qualter, 2018), and how the degree of self-efficacy will determine the extent to which preservice teachers are likely to use constructivist approaches in their own teaching (Hohenstein and Manning, 2010).

Perceived self-efficacy beliefs when applied to teaching, influence: the decisions that teachers will make about their approaches to teaching, reflecting their perceived capabilities; their degree of motivation to support their choices of teaching methods, and their judgement of how effectively they will be able to apply their teaching methods to support children's learning (Bandura, 1997; Bleicher, 2006; Blonder *et al.,* 2014). Furthermore Bandura (1997) argues that self-efficacy is contextual and, therefore, any research into self-efficacy needs to acknowledge the context in which it is being done since self-efficacy can vary from one situation to another. The context is of relevance to teachers in the primary sector because they are expected

to teach a range of subjects for which they have different strengths and backgrounds (Cantrell *et al.,* 2003). For instance, primary teachers may have higher self-efficacy for some subjects, but lower self-efficacy beliefs for other subjects (Cantrell *et al.,* 2003). Bleicher (2006) argues that low self-efficacy beliefs limit the choices that are made by preservice teachers, which impacts on the children's experiences of science. Additionally Norris *et al.,* (2018) agree that preservice teachers' effectiveness for teaching primary science decreases in line with lower self-efficacy. Therefore, it is important to identify and have greater awareness for what influences preservice teachers' self-efficacy beliefs and what experiences may contribute towards changes in self-efficacy beliefs (Kazempour and Sadler, 2015).

Science has been a core component of the National Curriculum since the first science guidance appeared in 1989 (DES, 1989), incorporating subject knowledge and practical work, components which continue to this day (Ofsted, 2021). Over the last thirty years the terminology used to describe practical activities in primary science has changed moving from 'Scientific Investigation' (DES, 1991:14), to 'Working Scientifically' (DfE, 2013:14) to broaden understanding of the range of approaches that can be used in practical work (Harlen and Qualter, 2018). No matter the title, however, the purpose of practical work is to support children in understanding their world through the 'nature, processes and methods of science' (DfE, 2013:3) and to motivate and engage children through active inquiry (Millar, 2010; Harlen and Qualter, 2018). Research has shown that there have been concerns raised about the learning effectiveness associated with practical activities, which might be fun and engaging, but may not lead to effective learning in science (Millar, 2010; Dunne and Maklad, 2015). Therefore, not only do teachers need to be secure in their subject knowledge in science but they also need to develop pedagogical content knowledge (PCK) to inform how to support children's learning in science (Shulman, 1986; Dunne and Maklad, 2015; Harlen and Qualter, 2018). The concept of PCK is attributed to Lee Shulman who identified it as one of the contributing knowledge bases of effective teachers (Shulman, 1986). PCK includes teachers' understanding and use of learning theories working in conjunction with teachers' knowledge of a range of age-appropriate teaching approaches which can be used to support the learning and teaching of science (Shulman, 1986; Howard, 2018). In primary science this supports teachers in developing a deeper understanding of their own science subject knowledge, to be able to choose the most effective ways to probe, challenge and progress children's ideas about science through 'analogies, illustrations, examples, explanations, and demonstrations' (Schulman, 1986:9), appropriate to the age and level of understanding that children have (Harlen and Qualter, 2018; Howard, 2018). Furthermore teachers have the flexibility to utilise a range of creative contexts such as role play, modelling abstract ideas, or presenting science through problem solving, which can be used in addition to the range of working scientifically approaches listed in the National Curriculum (DfE, 2013; Harlen and Qualter, 2018). Preservice teachers' perceptions of their own science subject knowledge as well as their perception of their own ability to make effective use of PCK to support learning in science, will contribute towards their self-efficacy beliefs for teaching science and will influence the choices they make to engage and motivate children in developing 'a body of key foundational knowledge and concepts' (DfE, 2013:3).

Thus, preservice teachers with higher levels of self-efficacy can support the teaching of science subject knowledge with a range of first-hand activities adapted for age and context, to support and scaffold children's understanding of scientific concepts. Conversely preservice teachers with lower self-efficacy beliefs for teaching science may limit their teaching approaches to ones that they are most familiar with, which, as indicated previously, can also limit the experiences that are available within lessons and subsequently negatively impact on the attitude and motivation that primary aged children develop towards science (Bleicher, 2006).

Subject knowledge, pedagogical approaches such as making use of constructivist approaches for working scientifically with children, and managing the expectations of assessment and accountability present primary teachers of science with many challenges, given that the majority are not science specialists and have priorities that often lie with the other core subjects (Millar, 2010, Avrraamidou, 2014; Ofsted, 2021). Additionally in some cases preservice teachers on primary ITT courses may not have studied science beyond their secondary GCSE courses (Wellcome, 2017) and may judge effective science teaching through their own secondary school experiences (Skamp and Mueller, 2001). Therefore, the way in which preservice teachers approach working scientifically is initially underpinned by their own beliefs and experiences of learning science, not all of which may have led to enthusing their views of science (Appleton and Kindt, 2002; Dunne and Maklad, 2015). Children reflect the interest and enthusiasm of their teachers (Ofsted, 2021) and teachers with low self-efficacy beliefs may demotivate children at an informative point in their science learning (Dunne and Peacock, 2015). It would be expected, however, that through the course content of their ITT course providers, that preservice teachers would be open to developing their beliefs about learning and teaching in order to build up a repertoire of approaches to support children with primary science (Dillon and Manning, 2010:16). Active teaching involvement with science, and observation of more experienced practitioners should provide opportunities for preservice teachers to observe, practise and evaluate their own capability to teach primary science effectively (Dunne and Maklad, 2015), and in the process develop their self-efficacy beliefs (Bandura, 1997). In this research, I am seeking ways to support the understanding and influences that affect and alter self-efficacy beliefs, towards teaching primary science successfully to children.

2.3 Approaches to Learning and Teaching Primary Science

In this section, I provide a brief outline of primary science as described in the National Curriculum (DfE, 2013) followed with a discussion of some learning theories, such as behaviourism (Howard, 2018) and constructivist approaches (Dillon and Manning, 2010) which influence teachers in their choice of classroom practice.

The National Curriculum in primary science (DfE, 2013) lays out the subject knowledge that primary-aged children are required to learn within the context of a 'working scientifically' approach underpinned by science inquiry skills and processes. The primary curriculum is divided into key stage one for children in years

one and two, lower key stage two for children in years three and four, and upper key stage two for children in years five and six. Throughout the curriculum children's learning in science is progressed through content drawn from 'biology, chemistry and physics' (DfE, 2013:3) in order to build up their 'knowledge and conceptual understanding' (DfE, 2013:3) of science. As children move through the key stages of the primary curriculum they are expected to make accurate use of scientific and technical vocabulary, and develop more sophisticated approaches to working scientifically, including being able to apply mathematical skills, where appropriate, to support the analysis and presentation of their scientific investigations (DfE, 2013). In this way children are introduced to the nature of science, and the different approaches which scientists use to understand and explain the many diverse aspects of the world that children are often excited and curious about (Harlen and Qualter, 2018). The primary curriculum includes a range of potential approaches for working scientifically through science inquiries that include: 'observing over time; pattern seeking; identifying, classifying and grouping; comparative and fair testing (controlled investigations); and researching using secondary sources' (DfE, 2013:4). The curriculum allows for flexibility and encourages teachers to use a range of contexts and approaches to teaching science in order to 'maximise their pupils' engagement with and motivation to study science' (DfE, 2013:3). Furthermore, the curriculum highlights some of the issues that teachers need to address such as dealing with children's misconceptions about science. In implementing the National Curriculum for science (DfE, 2013) teachers will draw on their self-efficacy beliefs for science, taking into account the topics they are required to teach, the age of the children involved, as well as the time, the resources, and teaching spaces that are available in their schools. Teachers who are not secure with their subject knowledge or their PCK for teaching science, however, may find it challenging to address misconceptions, and to make effective use of the range of working scientifically approaches that underpin the National Curriculum for science. At the time of this study preservice teachers were experiencing limited opportunities to observe or practise teaching primary science (Wellcome, 2017) and therefore I would argue that with little experience to draw on there is an issue of low self-efficacy with regard to the teaching science.

As has been indicated effective teachers need good subject-matter knowledge and pedagogical-content knowledge (Shulman, 1986; Yilmaz, 2011). Furthermore Yilmaz (2011) and Bailey (2018) argue that effective teachers also need a sound theoretical understanding of learning theories in order to develop a range of strategies to support the effective teaching of primary science with different age groups, and in different school contexts.

The way in which learning is perceived distinguishes each of the learning theories from each other (Yilmaz, 2011). Behaviourism, which gained favour early on in the twentieth century, is characterised by teacher-led didactic teaching with successful learning rewarded with good marks and grades, determined by others such as the teacher or external examiners (Taylor and Hamdy, 2013; Howard, 2018). Learners absorb information provided by teachers who act as trainers (Hohenstein and Manning, 2010). Teachers engage learners through selecting and transmitting information using approaches which can involve skills practice, rote

learning, completing worksheets for praise and marks, in order to achieve specific outcomes and goals (Howard, 2018). Taylor and Hamdy (2013) identify criticisms of this transmissive approach since it implies that learning is a passive exercise directed and guided by the teacher. For pragmatic reasons teachers will often deliver science facts through didactic approaches, however such approaches can be complicated by the fact that children come with strongly held alternative ideas about science, often referred to as misconceptions (Harlen and Qualter, 2018). If children are to learn science accurately these misconceptions need to be made explicit and challenged, so that teachers can support children in the process of developing accurate scientific knowledge (DfE, 2013; Howard, 2018). Such criticisms led to alternative constructivist approaches to learning which involved the active role of the learner in their own learning (Howard, 2018).

By the mid twentieth century cognitivist theorists such as Piaget (1896-1980), explored and developed newer approaches towards learning theory (Yilmaz, 2011). Seminal work such as Piaget's empirical studies into staged development influenced by age (Aubrey and Riley, 2019) confirmed that learners do indeed bring their own ideas to the learning process and it is through active participation and restructuring of these ideas that learning takes place through an individual approach (Harlen and Qualter, 2018). Successful learning is recognised by the progress that individuals make in their own understanding. Socio-cultural constructivists, such as Vygotsky (1896-1934), acknowledged that learning takes place through social interaction and talk (Harlen and Qualter, 2018). Vygotsky is also attributed with the concept of the 'Zone of Proximal Development' (Hohenstein and Manning, 2010:74) which marks the difference between what can be achieved individually, with what can be achieved with the help of someone more experienced. Bandura's (1986) work on learning behaviours resonates with constructivist views in that people are active engagers in their own choices for behaviour and that these choices are mediated through their self-efficay beliefs, the environment and interaction with others (Ponton and Carr, 2012; Bailey, 2018).

Several assumptions underpin constructivist approaches to teaching which impact on the roles of both teachers and children (Howard, 2018). Such assumptions include that children are: active learners who come with their own ideas and questions (Adams, 2006). Through inquiry approaches incorporated in working scientifically, children should be able to challenge their ideas and understanding. Constructivist learning is also socially integrated and supported by feedback from others such as other children in the classroom as well as involving interactive discussion with teachers (Hohenstein and Manning, 2010). Therefore, in the constructivist primary science classroom learners are no longer individual absorbers of information, but actively involved in working in groups to develop their understanding through practical investigations instigated by their own ideas (Dunne and Peacock, 2015). Teachers become facilitators of learning by scaffolding and mediating children's experiences of science in order to help children re-construct their ideas to be more closely linked with accepted scientific understanding (Dunne and Maklad, 2015; Howard, 2018).

Nevertheless there is always a concern for teachers that as primary-aged children are still in the process of developing their skills in working scientifically (DfE, 2013), children-led investigations may reinforce

misconceptions rather than lead children towards developing correct scientific knowledge (Hohenstein and Manning, 2010; Dunne and Peacock, 2015). This may be further contributed to because many primary teachers' have limited PCK in science. This tension between ensuring that children learn the correct science subject knowledge, yet at the same time creating opportunities for first-hand experiences to enable children to 'answer their own questions' (DfE, 2013:3) is problematic for teachers (Scott *et al.,* 2006). In classroom practice effective teachers of science select and integrate aspects of learning theories that best support ways to build up children's factual knowledge of science, and develop their understanding further through a range of science inquiries (Scott *et al.,* 2006). The extent to which preservice teachers are open to integrating alternative approaches to learning science, some of which they may be less familiar or experienced with, reflects their self-efficacy beliefs and their chosen teaching approaches in science (Bandura, 1997).

Biesta (2016:1) argues 'that education always involves a risk' because it is about inspiring learning in students through acknowledging their active participation in the processes, rather than simply filling them with accepted facts. Working scientifically involves that risk since it requires time, resources, subject knowledge and vocabulary, understanding of safety with young children, and pedagogical skills such as the use of questioning and discussion to enable children to explore and challenge their own ideas (Harlen and Qualter, 2018). Additionally there is no guarantee that working scientifically will result in successful outcomes, but it does give children the opportunity to test out their ideas in a systematic way and engage in the processes of science in order to re-evaluate their understanding of scientific ideas (Dunne and Maklad, 2015). Working scientifically is also seen as having a positive impact on children's enjoyment of science (Dunne and Makland, 2015). Approaches to working scientifically inquiry can encompass a range of choices such as: observation, classification, and 'comparative and fair testing' (DfE, 2013:14). In the classroom, teachers are expected to elicit children's ideas and work with children to address misconceptions that might impact on their understanding of science. These misconceptions often occur as a result of a mismatch between scientific understanding and everyday usage of common experiences (Hohenstein and Manning, 2010). For instance in science humans are part of the animal kingdom, but children find this difficult to understand initially until they begin to grasp the ideas behind scientific classification (Loxley *et al.,* 2014). Therefore, working from, and developing investigations through children's ideas can be daunting for preservice teachers because it relies on having good subject knowledge, good generic and subject-specific pedagogy, and the ability to cope with the unexpected (Yilmaz, 2011), the lack of which contribute to the belief that science is hard to teach (Peacock and Dunne, 2015). Preservice teachers require opportunities to explore ways in which to use working scientifically approaches effectively to support children's understanding and engagement with science (Dunne and Makland, 2015). Unfortunately preservice teachers are not always given the opportunities to take theoretical ideas and fully engage with them in practical teaching situations (Wellcome, 2017), which in turn impacts on their self-efficacy for teaching science (Blonder *et al.,* 2014).

In November, 2017 the Wellcome Trust issued a report 'to better understand initial teacher training for primary science' (Wellcome, 2017:3). The participants included responses from both a range of different

providers as well as contributions from 'recently trained teachers' (Wellcome, 2017:3). Wellcome stated that 'ITT providers should ensure that every trainee teaches primary science while on placement and observes excellent science teaching' (2017:3). Practical teaching and observation of teaching, which Bandura (1977 and 1997) refers to as Mastery and Vicarious experiences respectively, form part of the four main influences on self-efficacy beliefs. Additional experiences which influence self-efficacy beliefs include verbal persuasion used to encourage preservice teachers' beliefs in their capabilities, and emotional responses which contribute towards how preservice teachers perceive their experiences (Bleicher, 2006; Velthuis *et al.,* 2014). Therefore, more practical teaching experiences for teaching primary science, and more opportunities to observe good practice in primary science are likely to positively contribute towards developing preservice teachers' self-efficacy for teaching primary science (Velthuis *et al.,* 2014). The Wellcome report, however, highlighted that 'science has low priority in schools' (Wellcome, 2017:3) and that some 'ITT providers reported difficulties in ensuring that trainees taught science on placement in schools' (Wellcome, 2017:3). Furthermore the report stated that 'A third of teachers had not had the opportunity to observe science teaching while on school placement something they felt would have been beneficial' (Wellcome, 2017:18). Therefore, preservice teachers are potentially missing out on valuable experiences that would contribute towards developing their self-efficacy for teaching primary science. Research carried out by Blackmore *et al.,* (2018) on preservice teachers' experiences of teaching primary science concluded that 'the very limited opportunites to observe and teach science during their training negatively influenced their overall development' (Abstract: 529).

Fundamentally preservice teachers need opportunities to learn from others teaching science as well as opportunities to develop their own understanding of what it means to work scientifically with children. In the next section, I focus particularly on vicarious experiences, what they are and the ways in which they can affect the self-efficacy of preservice teachers. Mastery experiences are dealt with in section 2.5.1.

2.4 Vicarious Experience

Vicarious experiences result from preservice teachers observing others teach science and learning from this. Others can include a range of people such as teacher-mentors, lecturers and peers. In this section, I explore how Bandura (1997) discussed how observations can impact on the observer and influence the choices they make.

One aspect of vicarious experience is to compare oneself with others (Bandura, 1997). Preservice teachers have a number of different models which they may refer to since they have experienced being taught science, through primary and secondary education as well as in their degree courses. They have also been involved in pre-course experiences where they have observed teachers in the classroom and may also have been able to observe teachers whilst completing school placements and self-directed placements. Bandura (1997) argues that 'modelling serves as another effective tool for promoting a sense of personal efficacy' (Bandura, 1997:86) and that it is easier to make judgements about personal efficacy for teaching in

comparison to their experiences of being taught and observing others teach. Bandura (1997) argues that if the comparison models are considered above the level of the participants, that their efficacy is lowered, but should the participant consider that they could do as well, or outperform the comparison model that their efficacy will be increased. Importantly Bandura (1997:87) argues that 'Self-efficacy appraisal will vary substantially depending upon the talents of those chosen for social comparison (Bandura& Jourden, 1992: Wood, 1989)' (Bandura, 1997:87).

Bandura (1997:87) outlines the processes which govern the impact of modelling:

1. Social comparison: Observing others perform successfully who are 'similar to oneself' (p.87) will raise efficacy beliefs if the observers can visualise themselves doing something 'comparable' (p.87).
2. 'Observing others perceived to be similarly competent' (p.87) but who fail despite a lot of effort lowers self-efficacy. Importantly, 'the greater the assumed similarity, the more persuasive are the models' successes and failures' (Bandura, 1997:87).
3. If the model behaves very differently from the observer then the observer is much less likely to be impacted by the model.
4. 'Self-modelling' (p.87): In this process the participants observe their own successes achieved in safe and scaffolded environments which impact on their personal self-efficacy beliefs.

Bandura (1997:87) lists several reasons why vicarious experiences can be so useful which I have adapted for preservice teachers in the context of primary science for this thesis:

1. Preservice teachers may not have had experiences of teaching themselves and so drawing on previous models of teaching primary science may be very useful.
2. As preservice teachers develop their experiences in a variety of schools, being able to draw on a range of modelled coping strategies may help to increase their self-efficacy in dealing with new situations as they arise in each new setting, new age groups, and new groups of teachers to work with.
3. When things go wrong whilst preservice teachers are teaching, preservice teachers may draw on modelled strategies to address the issues that arise rather than their own experiences.
4. A cycle of failure can be set up. Preservice teachers may excuse their failure at delivering a lesson, because they have seen others fail so comparative modelling may not help to increase self-efficacy if the model is seen to fail. The preservice teacher may then continue to use the experience to confirm that they can't do whatever it is that they are being asked to do and so a cycle of failure, weak attempts to try again only to fail again, contribute to low self-efficacy. However if the model presents ways in which to address the failure and the preservice teacher takes that on board this can lead to increased self-efficacy and be shown through being able to cope with failure and keep on going and working through the difficulty.

5. Preservice teachers will seek models to which they aspire. Bandura (citing Bandura, 1986) argues that the models should be competent, be able to share their way of thinking, and enable observers to identify and learn the skills they need to manage effectively (Bandura, 1987). Bandura argues that this is because 'Aspirational modelling guides and motivates self-development' (Bandura, 1997:88).

Vicarious experiences such as modelling, contribute towards self-efficacy beliefs which Bandura described as 'peoples' beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives' (Bandura, 1994:2). In the absence of actual teaching experiences preservice teachers would benefit from the opportunity to observe others teaching science so they can judge their own capacity for teaching similar topics and age groups in primary schools (Tschannen-Moran and Woolfolk Hoy, 2005). This is discussed further in the next section. As has been argued opportunities to learn from more experienced teachers seem to be much reduced according to the Wellcome Survey (2019) and evidenced in research such as that of Mullholland and Wallace (2001).

2.5 What is Self-Efficacy?

Self-efficacy is one of five components of Bandura's Social Cognitive Theory (SCT), along with modelling, outcome expectancies, goal setting and self-regulation (Bandura, 1986). These five components contribute towards understanding what affects people's chosen behaviour in a range of environments and social situations (Costlow and Bornstein, 2018). An underlying assumption of SCT is that peoples' behaviour is influenced by observation of others through modelling (Schunk *et al.,* 2014). The consequences of such observations impact on peoples' cognitive processes by acting on their 'thoughts, goals, beliefs and values' (Schunk *et al.,* 2014:141). Hence as a result of 'observational learning' (Schunk, 2012:106) people make decisions about the extent to which they are motivated to adapt others' behaviours when faced with comparable situations in which they wish to succeed (Costlow and Bornstein, 2018). For instance preservice teachers may attempt to imitate models of successful teaching that they have already experienced, because these experiences are familiar to them and provide a framework from which to base their own teaching approaches (Costlow and Bornstein, 2018; Schunk *et al.,* 2014). Preservice teachers' outcome expectancies represent the responses that they would expect to achieve from carrying out their chosen teaching approaches (Costlow and Bornstein, 2018), and these too may be influenced by personal experiences of how teaching is done by more experienced practitioners (Korthagen, 2010; Schunk *et al.,* 2014). Outcome expectancies can also be influenced by other factors imposed by government policies such as the National Curriculum (DfE, 2013), or self-assessment monitoring processes such as the Teachers' Standards (DfE, 2012) requirement to achieve QTS, which provide goals and targets for preservice teachers to work towards. Bolton (2010) argues that in order to address the requirements for achieving QTS that preservice teachers want clearly defined steps and methods which can be used for teaching approaches and outcome expectancies, however, in the dynamic situation of the classroom things are not so certain and straightforward (Bolton, 2010). Therefore, preservice teachers need to actively analyse their observational and personal experiences of primary science, and use the outcome from the analysis to re-evaluate and

adjust their approaches to teaching in future situations (Bolton, 2010). This is believed to be done through the self-regulatory component of SCT (Costlow and Bornstein, 2018). Self-efficacy can be increased or decreased dependent on how people view the success of their experiences to date (Bandura, 1977). Additionally SCT links cognitive processes such as self-efficacy beliefs with environmental determinants, and behaviour dynamically in a triadic, bi-directional reciprocity, which if used in conjunction with reflective and reflexive approaches, influence how people view their capability to act in a given way (Schunk, 2012; Zwozdiak-Myers, 2012; Beauchamp *et al.,* 2019). Bandura (1989) argues that SCT links behaviour and agency and which will be addressed in 2.6.13, with discussion about the Triadic Reciprocal Causation Model in section 2.6.12.

Teachers' self-efficacy judgments and perceptions of their capability are influenced by past experiences which can be explored through the processes of reflection and reflexivity (Bandura, 1997; Zwozdiak-Myers, 2012). Reflection and reflexivity involve 'active, persistent and careful' analysis of beliefs such as self-efficacy (Dewey (1933) cited in Stingu, 2012:617) and form part of self-regulatory approaches which support professional development (Bandura, 1994; Pajares, 1997; Schunk *et al.,* 2014). Self-regulatory processes for preservice teachers requires them to scrutinise their teaching practices, evaluate and analyse the extent to which these practices were successful, and then re-evaluate how they might adjust their teaching approaches for professional development (Bandura, 1997; Beauchamp *et al.,* 2019). According to Bolton, reflection and reflexivity are 'states of mind' (2010:9) used to recall, evaluate and analyse experiences, in order to critically question and develop professional practice through an active and open-minded approach (Bolton, 2010). Furthermore, Bolton (2010) argues that for professional reflection to bring about insightful understanding, it should be purposeful, should acknowledge the professional environment in which it occurs, and should incorporate an analysis of experiences from different perspectives.

Deep reflection is closely linked to reflexivity (Savin-Baden and Howell-Major, 2012) which occurs when people become aware that instead of being imitators or passive recipients of previously accepted ways of behaving, that they are active agents in their own behaviour. This may be very different to preservice teachers' perceptions of becoming a teacher, and therefore, may be challenging to do as they move from trainee to becoming agentic for their own teaching decisions (Bandura, 1986; Atkinson and Claxton, 2001). I would argue that it is not dissimilar to a moment of cognitive conflict (Adey and Shayer, 1993), a moment of questioning accepted norms, a transition point that may lead to a change in behaviour and development in the context of learning to teach and at the same time contribute to building self-efficacy (Savin-Baden and Howell-Major, 2012; Bandura, 1977). Atkinson and Claxton (2001) argue, however, that asking preservice teachers to be reflective can be unsatisfactory since it may simply result in a self-indulgent recounting of events rather than a self-critical introspection leading to reflexivity (Bolton, 2010; Savin-Baden and Howell-Major, 2012). Therefore, if preservice teachers are to benefit from self-regulatory processes they need to be guided into the use of reflection and reflexivity in order to critically challenge their views and assumptions, including their self-efficacy beliefs (Bandura, 1986; Atkinson and Claxton, 2001; Bolton, 2010). In further

professional discussions with more experienced teachers or mentors, reflexive preservice teachers would be expected to begin to understand how their self-efficacy beliefs contribute to their own role or agency for developing their professional practice (Bandura, 1997; Bolton, 2010; Zwozdiak-Myers, 2012).

Teaching is a diverse, demanding and 'constantly evolving' process (Atkinson and Claxton, 2001:4), involving interactions between many participants such as children, their parents, and educators. External groups who are part of the wider political landscape that impacts on schools, consider self-efficacy to be a relevant construct for teachers, because of its association with effective teaching approaches and its contribution to their welfare (Zwozdiak-Myers, 2012; Ofsted, 2019). For instance, in their discussion on research in to staff well-being Ofsted (2019) draw on research by Skaalvik and Skaalvik (2007) as well as Klassen and Chiu (2011) to argue that low self-efficacy is linked to stress. Zee and Koomen (2016) argue that stress impacts on teachers' perception of autonomy and agency over their work and work-life balance, and ultimately contributes to teachers leaving the profession. Thus, the causes of low self-efficacy amongst teachers need to be addressed in relation to teacher well-being and teacher retention (Ofsted, 2019). Additionally, Bandura (1994) argues that teachers with high self-efficacy are more likely to motivate their students and enhance the students' learning outcomes than those teachers with lower self-efficacy. Therefore, finding out what influences self-efficacy and using this to further the development of self-efficacy in teachers is a key aspect of this thesis. Based on their research with 292 preservice primary teachers Velthuis *et al.,* (2014) found that self-efficacy is most open to development early on in training courses and thus reinforces the value of this thesis in exploring how preservice teachers draw on their self-efficacy to teach primary science.

Pajares (1997 [online]) contends that Bandura's 'seminal publication of "Self-efficacy: Toward a Unifying Theory of Behavioral change" introduced the construct of self-efficacy for the first time (Bandura, 1977). In this work, Bandura defines self-efficacy as 'the conviction that one can successfully execute the behaviour required to produce the outcomes' (1977:193) [of that behaviour], which indicates clearly that success is an important criteria in determining whether people believe they can do something (Schunk *et al.,* 2014). Conversely, this seems to suggest that a lack of conviction in being able to bring about successful execution, results in giving up or not attempting the activity in the first place (Bandura, 1994). This definition seems quite narrow and focussed and may have been influenced by some of Bandura's (1977) early research work. Bandura (1977) was interested in the relationship between peoples' self-efficacy beliefs and behaviour, and how this could help people to overcome phobias such as snake phobias. Bandura placed participants into the following three groups: participants who were actively involved in handling snakes; participants who watched others handling snakes; and participants who were part of a control group and had no treatment at all. He found that the group who most actively engaged with the snakes, which he referred to as mastery experiences, showed greater changes in self-efficacy and behaviour. It was through this type of research that Bandura (1977) wanted to demonstrate that self-efficacy could be influenced by specific types of experiences. He was able to show that successful experiences resulted in increased self-efficacy whilst

repeated failures lowered self-efficacy, thus making predictive links between self-efficacy and behaviour (Bandura, 1977).

Later Bandura (1986) broadened the definition of self-efficacy into 'People's judgements of their capabilities to organize and execute courses of action required to attain designated types of performance' (Bandura, 1986:391), removing the need for these courses of action to have to be successful as this was seen as too simplistic an approach to explaining what self-efficacy was. By this time, much research work had been done into self-efficacy in a variety of areas and this definition reflects a more generalised summary which can be used in many contexts, one of which is education (Bandura, 1994). The second definition highlights how complex and multi-layered self-efficacy is. The complexity of self-efficacy can be seen through the use of the term 'judgement' in the definition. Judgement is defined as 'the ability to form valuable opinions and make good decisions' (Cambridge Dictionary, [online]), however it does not clarify whether these judgements are made intuitively and based on hunches or feelings, or whether these judgements are more objectively generated and based on analytical use of specific information (Atkinson and Claxton, 2001). It may be that the judgements that Bandura (2001) is referring to, can be found somewhere on a continuum between intuitive and analytic judgements or perhaps these judgements of capability involve a mixture of both as illustrated here.

Atkinson and Claxton (2001:5) argue that teaching is underpinned by three main thinking processes which are intuitive, analytical and reflective thinking. Intuitive thinking processes are 'a holistic way of knowing' (p.5), not consciously analysed, but which enable people to make quick decisions about how to respond to a particular situation whether the experience is new to them or not (Atkinson and Claxton, 2001). Early on in their training preservice teachers are likely to draw on these intuitive judgements about their capability when they are asked to deliver science lessons through a constructivist approach (Scott *et al.,* 1987 and Harlen and Qualter, 2018), simply because they often have very little personal experience of having been taught in this way (Osbourne and Dillon, 2010). In the context of the classroom preservice teachers will have to make quick decisions and adaptations in response to the differing needs of children learning science, and thus may have to rely on their intuition, their unconscious insights into the world of teaching, in order to manage the complexities of the classroom (Atkinson and Claxton, 2001; Traianou, 2007; Serret and Earle, 2018). Following these teaching experiences preservice teachers are in a more informed position to analyse the elements of their lesson in more detail, and as indicated earlier, through reflective and self-regulatory processes, important contributors to self-efficacy, bring about changes in their approach to teaching science in future lessons (Bandura, 1997; Zwozdiak-Myers, 2012; Turford and Turner, 2018). The types of judgments made about capability will involve both intuitive and analytical processes since these judgments are influenced by the types of experiences that preservice teachers draw on to judge their self-efficacy for teaching science through constructivist approaches (Atkinson and Claxton, 2001; Wheatley, 2005). In simpler terms, people develop their self-efficacy beliefs through absorbing and analysing a range of information about themselves and the environment in which these experiences take place, in order to determine what

they perceive they are capable of doing (Tschannen-Moran and Hoy, 2005). Thus in the context of preservice teachers who are novices in the processes of effective teaching and learning, self-efficacy beliefs can contribute towards the decisions they make about their choice of classroom practice (Mansfield and Woods-McConney, 2012). In addition to the impact of self-efficacy on behaviour choices, Bandura (1997) claimed that self-efficacy beliefs can also influence resilience and perseverance in different situations, qualities that preservice teachers will need to draw on when their classroom practice is not as successful as they had intended it to be (Bobek, 2002; Gibbs, 2002). It is not just about feeling confident, a term often synonymously associated with self-efficacy (Aalderen and Smeets, 2011; Chichekian and Shore, 2016), but a more multi-layered construct (Bandura, 1986) in which people draw on the experiences and memories that have led them to believe they have the necessary attributes to perform in a particular way (Schunk *et al.,* 2014). Thus self-efficacy is both about the task and context (Bandura, 2001), and Therefore, an influential factor in enabling people to 'develop a sense of agency' over their behavioural choices (Schunk and Usher, 2012:26).

Schunk *et al.,* (2014) propose that Bandura's work on self-efficacy can be seen to be influenced by the earlier work of Rotter. Rotter (1954) developed a Social Learning Theory in which he sought to explain that the way people behaved was not only influenced by how others had been seen to behave in similar situations, but the behaviour was also moderated by how much value was placed on how others might perceive the behaviour (Rotter, 1954). Rotter (1954:105) acknowledged that these experiences, and the context in which they happened, was important and contributed to the key variables that influence why people choose to behave in particular ways, which he referred to as: 'behavior potential, expectancy and reinforcement value.' Schunk *et al.,* (2014) describe behaviour potential as the likelihood that people will respond in a particular way in given circumstances. For example, a recognisable situation for preservice teachers is that they will develop their understanding and practice of teaching through placement opportunities with partnership schools and more experienced teachers (DfE, 2019).

The type of placement opportunities that preservice teachers experience include: learning from observing teachers teach, learning from being observed teaching, and responding to feedback and advice from teacher-tutors in order to provide evidence to demonstrate the standards for QTS (Zwozdiak- Myers, 2012; DfE, 2019; DfE, 2020). Thus the behaviour potential of preservice teachers in terms of teaching is influenced and mediated by the environment they are in and the people and activities that have most impact on the professional decisions made about them, which might include elements such as lesson observations by more experienced teachers. According to Rotter (1954:105), the decision to choose to behave in a certain way, is also affected by peoples' beliefs, or 'expectancy' that the behaviour will lead to anticipated outcomes.

Preservice teachers are aware that lesson observations, made largely by class teachers who they work closely with, will lead towards the final grading, or outcome, that the preservice teachers receive for that placement. The inherent value that is placed on such outcomes, the 'reinforcement value' (Rotter,

1954:105*)*, will influence the choice of behaviour. If preservice teachers are aiming to pass their placement they are likely to choose whatever approach is most likely to support this outcome. Therefore, behaviour choices within a given context, are determined by personal judgments based on expected rewards which must have some type of benefit for the people making the judgments (Rotter, 1954; Schunk *et al.,* 2014).

Glackin (2016), in her study about the exploration of secondary science teachers' beliefs and their practice, argues that the relationship between beliefs and practice is complex. For example, some teachers claim that they use one type of strategy perhaps influenced by a constructivist approach, but in practice are using a different strategy more linked in reality to a behaviourist approach and 'transmission-based' teaching (Adams, 2006:245). In order to suggest an explanation for this Glackin (2016) develops her argument by identifying that science teachers have multiple beliefs such as: beliefs about science itself, beliefs about the purpose of science education, beliefs about how children learn, and beliefs about management priorities; and that there is a need to explore the interaction between these multiple beliefs in order to understand the pedagogical decisions that teachers make when it comes to practice. Glackin refers to 'belief connectivity' (Glackin, 2016:412) drawing on work done by Rokeach (1968, cited in Glackin, 2016), a term used to summarise that the more connected teachers are to their beliefs the more they are likely to be influenced by them when it comes to making pedagogical choices. Strongly held core beliefs are beliefs that have built up over time and may reflect preservice teachers' own response to past experiences and beliefs about science teaching. Core beliefs have a greater influence on pedagogical decisions than peripheral beliefs which are newer less informed beliefs (Glackin, 2016). Thus if preservice teachers' core beliefs are more strongly connected to constructivist learning theories they are more likely to adapt these approaches in their classroom practice, however if these form part of their peripheral beliefs then they are less likely to use these approaches in the classroom particularly if their classroom teachers are not supportive about making these choices (Glackin, 2016). What preservice teachers believe clearly impacts on pedagogical choices and whether they choose safer options supported by their core beliefs, or choose riskier options which are yet to become part of their core beliefs, is reflected through self-efficacy beliefs (Bandura, 1997).

Bandura developed this understanding of behaviour further because he wanted to explain why people might, and do, opt for riskier choices instead of choosing safer alternatives, which they know they can succeed at, or are more likely to be approved by others who are more familiar with these choices (Bandura, 1977; Schunk *et al.,* 2014). As indicated preservice teachers, for instance, may choose to opt to follow their teacher-tutors' approach to teaching, or they may choose to use teaching strategies that they have little or no practical experience of doing themselves, such as using inquiry based approaches to teaching science (Harlen and Qualter, 2018). What they choose will be influenced by what is most important to them (Schunk *et al.,* 2014). To account for this broader understanding of behaviour, Bandura added the construct of self-efficacy to Rotter's (1954) ideas and exchanged expectancy values to efficacy expectations linked to three dimensions which he referred to as: 'magnitude, generality and strength' (Bandura, 1977:194). Magnitude refers to the level of difficulty of the potential activity for instance whether it is considered to be a simple, moderate or

highly demanding activity. Generality refers to the idea that some efficacy expectations are task specific but others can be applied across many situations. Strength refers to whether an individual has a weak or strong belief in their own abilities (Bandura, 1977). The differing impact of each of these dimensions of self-efficacy will affect the choices made. Thus preservice teachers may tackle inquiry based approaches to teaching science, which may be perceived as difficult (Harlen and Qualter, 2018), if they have a strong belief or confidence in their own ability, and are happy to revert to generic teaching strategies to support them with any issues that arise in the process. Bandura (1977) argued that efficacy expectations, that the predicted behaviour will lead to anticipated outcomes (Schunk *et al.,* 2014), will impact on the motivation to perform a task or activity, and therefore, motivation and self-efficacy are closely linked (Schunk *et al.,* 2014). People with a strong sense of self-efficacy are more likely to want to do something and to be greater risk takers, than those with a lower level of self-efficacy who, if given a choice, will use avoidance strategies, give up if things get difficult, or use known 'safe' procedures in a given situation (Bandura, 1977, 1982).

Bandura also considered what influences might affect the development of self-efficacy and specified particular experiences that had most impact (Bandura, 1977). These influences include: 'hands-on' experience known as enactive mastery; vicarious experiences drawn from observing others do similar activities and modelling approaches to the activities; persuasive experiences in which others use persuasive language to encourage self-belief; and physiological experiences which take account of emotive responses to the experiences (Pajares, 1997). Self-efficacy can then be developed through reflection and self-assessment about the relative impact of these past experiences, which will in turn determine future behaviour (Tschannen-Moran and Woolfolk Hoy, 2005). This process, known as self- regulation, is an important aspect of professional development because it demonstrates an awareness that enables learners, such as preservice teachers, to shape and direct their experiences in order to develop their approaches to teaching (Ritchie, 2014). In summary self-efficacy is a complex construct which Schunk *et al.,* (2014:167) state is 'dynamic, fluctuating and changeable' adding further complexity to this multi-layered construct.

Thus the construct of self-efficacy and self-regulation through reflective practice (Zwozdiak-Myers, 2012), were added to Rotter's (1954) ideas and eventually developed into Bandura's Social Cognitive Theory (Bandura, 1986).

2.5.1 Mastery Experiences

As already indicated according to Bandura (1977) there are four types of experiences, which influence the development of self-efficacy with varying levels of input. These four types of experiences are:

1. mastery or enactive mastery experiences,
2. vicarious experiences,
3. persuasive experiences,
4. affective and physiological experiences.

Bandura (1977) argues that performance accomplishments form one of the four factors that influence self-efficacy. Performance accomplishments, which Bandura (1997) later refers to as enactive mastery experiences, are the most influential sources of high self-efficacy since they provide evidence about personal capability (Bandura, 1977). Conversely Palmer (2006) and Bjerke and Solomon (2020) argue that there is a lack of corroborating evidence for this claim.

Enactive mastery experiences provide the participants with knowledge about what was entailed in carrying out activities and how well they achieved this through their actions (Tschannen-Moran *et al.,* 1998).The information taken away from the experiences will be influenced by what is remembered, how this impacted on affective responses and whether goals were achieved. According to Tschannen-Moran *et al.* (1998), (drawing on Bandura, 1986 and 1997) these experiences have most impact if they are perceived to be successful, are difficult to achieve, have been achieved independently of help and are achieved early in the learning process.

For preservice teachers these experiences may occur within course workshops where they might be asked to teach other students some aspect of science, or through classroom teaching whilst on self-directed or assessed placements in schools (DfE, 2021). These experiences are seen as ways of providing safe opportunities for preservice teachers, to try out developing ideas about teaching and learning but within a supportive environment (Korthagen, 2010). Successful experiences can contribute towards 'higher levels of personal accomplishment' (Zee and Koomen, 2016:1007), and therefore, are likely to strengthen preservice teachers' self-efficacy beliefs for future similar teaching scenarios. Conversely if it is unsuccessful self-efficacy may be weakened, the impact of which may cause preservice teachers to resort to defensive tactics such as avoidance of risk taking or showing a lack of perseverance to overcome issues rather than developing strategies to overcome the problems that are preventing them from achieving their teaching goals (Korthagen, 2010; Bandura, 1977; Chichekian and Shore, 2016). However self-efficacy is a more complex construct than this and Bandura (1997) notes, that those who already have a firm sense of self-efficacy, are in fact able to adapt and learn from occasional unsuccessful experiences.

In the context of ITT courses preservice teachers may have the opportunity to teach whenever they are in an educational setting either on self-directed placements or on assessed placements. Science, however, is not always on the timetable when participants attend the schools, and therefore, it is possible that they could go through their ITT courses and not teach a science lesson, or a series of science lessons. Being given the opportunity to teach science enables the preservice teachers to experience and assess the process of planning and carrying out a science lesson aimed at a particular age group. It also gives them the opportunity to assess the impact of their teaching on the progression of children's learning in science. Much of the ITT input from their courses focusses on using the constructivist approach to teaching science and developing science inquiries from children's ideas (Scott *et al.,* 1987; Adams, 2006; Howard, 2018). Whilst this approach has been very much a part of the vision of how primary science should be taught since the inception of the

National Curriculum, many of the participants have had little experience of this approach and may feel at a disadvantage when coming to teach primary science to children (Osbourne and Dillon, 2010). Therefore, preservice teachers are likely to draw on their past experiences of science to inform their present beliefs about teaching primary science (Tschannen-Moran and Hoy, 2007).

Bandura (1997) argues that mastery experiences may impact on self-efficacy but only when analysed and moderated through cognitive processes and reflection, since each experience is influenced by a range of factors such as personal, social and environmental issues unique to each individual. Mastery experiences no matter how small (Bandura, 1997), are more likely to improve self-efficacy judgements if preservice teachers feel that what has been achieved in the classroom is because they have been actively involved in creating a situation which they can learn from, rather than passively enacting already determined classroom plans. Bandura (1997) argues that performance alone does not explain changes in self-efficacy since there are many factors to consider above and beyond the actual classroom delivery. He lists 'preconceptions of their capabilities, the perceived difficulty of the tasks, the amount of effort they expend, the amount of external aid they receive, the circumstances under which they perform, the temporal pattern of successes and failures, and the way these experiences are cognitively organised and reconstructed in memory' (Bandura, 1996:81). Additionally Bjerke and Solomon (2020) identified that perceptions of mastery experiences were enhanced when linked with other sources of efficacy such as verbal persuasion. Understanding to what extent these factors impact on preservice teachers' mastery experiences will provide a better understanding of how mastery experiences affect self-efficacy judgements (Gist and Mitchell, 1992). Self-efficacy indicators are provided in Figure 2.1 drawing on theoretical summaries linked with high and low self-efficacy.

Author	High self-efficacy	Low self-efficacy
Bandura, 2006	Strategic thinker, optimistic, opt for challenges, committed to achieve goals, puts in the required effort to achieve goals, perseverant and resilient, challenges seen as obstacles to be overcome, stress – excitement, likely to succeed	Erratic thinker, pessimistic, opt out of things considered to be too challenging, less effort put into achieving goals, less perseverant or resilient, tendency to blame failures on personal weaknesses, challenges create stress and anxiety, may opt out rather than fail.
Glackin and Hohenstein, 2018	Good science subject knowledge, open-ended questions used, willingness to try new ideas and new pedagogical approaches, enthusiastic, focus on children's ideas and their learning,	Weak science subject knowledge, more use of closed questioning, avoidance of working with children's ideas, avoidance of new ideas and unfamiliar pedagogical approaches, lacking motivation to sort out problems for themselves, focus on doing it right rather than on working with children's ideas, sees others as more knowledgeable than they are.
Klassen and Durksen 2014	Positive rapport with children resulting in a willingness to go with children's ideas for inquiry, feeling autonomous when planning, feeling prepared and organised, recognising influential strategies, perseverant and resilient, seeking help as support, coping with stress, awareness of limitations but looking to challenge these and learn from experiences	Rapport with children more to do with control- so avoidance of challenges such as developing children's enquiries from their idea, using other's plans without adaptation for own approaches when planning, lack of preparedness and organisation, not seeking to adapt strategies even if what they are doing does not work, avoids difficulties if they arise, seeking help but seeing this as some sort of weakness, avoiding situations that may cause stress, awareness of limitations but using these to avoid challenges
Brigido *et al.,* 2013	Positive beliefs leading to a feeling of competency for teaching and supporting science learning, optimism,	Negative feelings about science, tendency to use transmissive approaches more, insecure about science teaching,

Figure 2.1: Summary showing some examples of theoretical indicators linked to high/low self-efficacy

2.5.2 Relevance of resilience to self-efficacy

Indicators associated with self-efficacy such as resilience (Bandura, 1977; 1997) or motivation (Schunk and Usher, 2012) can also be complex constructs in themselves. Whilst it is not possible to address each of these, I have included this section to provide some theoretical background illustrating the relevance of resilience to self-efficacy, and how resilience might be operationalised through interview responses. Figure 2.2 illustrates how resilience is described an operationalised through theory.

Rotter (1990) cited in Gu and Day (1007:1311) along with Bandura (1989) argue that self-efficacy is an important predictor of resilience with high self-efficacy being directly linked to high resilience. Stajovik defines resilience as 'the capability of individuals to cope successfully in the face of change, adversity and risk' (Stajovik, 2006:1211). Gu and Day (2007) argue that effective teachers need resilience to cope with the complexities of teaching and to be able to manage a range of professional responsibilities such as behaviour management or assessment procedures, some of which they may be familiar with but some of which may be new or unfamiliar to them. Teachers use their self-efficacy beliefs to influence their resilience to deal with problems as they arise (Gibson and Dembo, 1984), as well as to determine what activities the children will do including how much effort and time the teachers will put into the processes required for planning and organising such activities. Bandura (1997) argues that 'People take action when they hold efficacy beliefs and outcome expectancies that make the effort worthwhile' (Bandura, 1997 [online]), and therefore, the more resilient they are the more likely they are to deal with challenging situations. The lower the self-efficacy the more likely that the teachers put less effort in, are more likely to work towards mediocre outcomes and in some circumstances may avoid placing themselves in challenging situations because they have a low resiliency and a low capacity to see these situations as learning opportunities (Bandura, 1989; Glackin and Hohenstein, 2018). The experiences that are gained from learning to cope and deal with the unexpected provide personal resources which teachers can draw on in future classroom practices (Bobek, 2002; DiMenichi and Richmond, 2015) which Hills argues is about evolving not bouncing back (2016). However, too much resilience may lead to teachers overestimating their capabilities and attributing failures to others, such as the ability of the children or not having the correct resources, rather than reflecting on how their own choices led to these failures (Chamorro-Premuzic and Lusk, 2017).

Bobek (2002:203) argues that teachers must be lifelong learners, willing to venture into areas that may challenge their current views of themselves and their practices' which will contribute to developing their resilience. In order to do this teachers may demonstrate some or all of these indicators of resilience such as: perseverance and persistence and commitment to resolve the issue, a reflective ability to evaluate and analyse the situation, a willingness to adapt, a willingness to ask for help, an ability to problem solve, an ability to deal with the situation with a sense of humour, an optimistic outlook, a sense of autonomy and/or autonomy demonstrated through utilising their ideas to deal with the situation, and a sense of accomplishment when this has been done (Walsh *et al.,* 2020; Bobek, 2002; Williams, 2014 and Polk, 1997 cited in Van Breda, 2001). Arnup and Bowles (2016) indicate that a supportive environment helps increase resilience so that teachers can make better use of their own resources and that of the school environment to cope and deal with challenging or threatening circumstances.

Indicators associated with high self-efficacy	Theoretical descriptions of resilience	Operationalisation of a high level of resiliency
Resilience incorporating perseverance	'A teacher's resilience is enhanced when he is capable of assessing adverse situations, recognizing options for coping, and arriving at appropriate resolutions.' (Bobek 2002:202) 'The promotion of teacher resiliency can enhance teaching effectiveness, heighten career satisfaction, and better prepare teachers to adjust to education's everchanging conditions.' (Bobek, 2002:204)	**Bobek List (2002):** Creates purposeful work relationships Shows a sense of competence and skills Shows a sense of personal ownership Shows a sense of accomplishment Shares a sense of humor Accomplishes successes that are recognised personally and benefits further if these are also recognised by others
	'If people experience only easy successes, they come to expect quick results and their sense of efficacy is easily undermined by failure. Some setbacks and difficulties in human pursuits serve a useful purpose in teaching that success usually requires sustained effort. After people become convinced they have what it takes to succeed, they persevere in the face of adversity and quickly rebound from setbacks. By sticking it out through tough times, they emerge from adversity with a stronger sense of efficacy.'(Bandura, 1989:1179)	**Bandura (1994):** Is optimistic Is persistent and committed to change Learns from the experience Set themselves challenging goals Innovative

Figure 2.2: Summary of the indicator resilience and how it might be operationalized

2.6 Issues with defining self-efficacy, teacher efficacy and measuring it

Bandura defines self-efficacy as 'beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments' (1997:3). Glackin and Hohenstein (2019) consider teacher efficacy to be a sub-category of self-efficacy whilst Hawkman *et al.* (2018:2) describe it as an 'extension of self-efficacy'. This thesis focuses on self-efficacy within the context of teaching primary science as it is about what beliefs preservice teachers hold about their capabilities to teach at this point and not focused on the impact they have on student outcomes. This section highlights issues with defining self-efficacy, a brief history behind teacher efficacy research outlining some of the complexities which have evolved dependent on the theoretical framework used to define it.

2.6.1 Bandura's evolving definitions of self-efficacy

Bandura Dates 1977-2006	Efficacy Quotes	Outcome Quotes
1977:193	'An efficacy expectation is the conviction that one can successfully execute the behaviour required to produce the outcomes.'	'An outcome expectancy is defined as a person's estimate that a given behaviour will lead to certain outcomes.'
1982:122	'Perceived self-efficacy is concerned with judgments of how well one can execute courses of action required to deal with prospective situations.'	
1989:1	'Among the mechanisms of personal agency, none is more central or pervasive than people's beliefs about their capabilities to exercise control over events that affect their lives. Self-efficacy beliefs function as an important set of proximal determinants of human motivation, affect and action.'	
1994:2	'Perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think motivate themselves and behave.'	'…a given course of behaviour will produce certain outcomes.' (p.5)
1995:2	"the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations"	
1995:179	'In self-efficacy theory, people's beliefs in their capabilities to manage environmental demands affect the courses of action they choose to pursue, how much effort they put forth in a given endeavour, how long they persevere in the fact of obstacles and failure experiences, how much anxiety and depression they experience in coping with stressors and the level of accomplishments they realize.'	
1997 Referred to in many articles	*'Perceived self-efficacy refers to beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments.*' (p.3) 'Beliefs of personal efficacy also regulate motivation by shaping aspirations and the outcomes expected for one's efforts. A capability is only as good as its execution.' (p.35). p.vii …'people's beliefs in their capabilities to produce desired effects by their actions'	
2006	'Bandura claims that self-efficacy operates in the same way no matter the culture. But how efficacy beliefs are developed and structured, the ways in which they are exercised, and the purposes to which they are put vary cross-culturally.' (p.175)	

Figure 2.3: Bandura's evolving definitions of self-efficacy

One of the claims behind self-efficacy theory is that it influences peoples' choice of behaviours such that those with higher efficacy are likely to put more effort into what they do, are more likely to cope with difficulties and are more likely to try new and challenging approaches in their work (Bandura, 1997), however it is not easily captured in a simple definition. For instance it can be seen from the examples in Figure 2.3 that between his seminal work on self-efficacy in 1977 and 1997, Bandura has defined self-efficacy in similar but slightly different ways which has contributed towards how it has been interpreted and measured. In his initial definition of self-efficacy Bandura states that 'An efficacy expectation is the conviction that one can successfully execute the behaviour required to produce the outcomes' (Bandura,

1977:193). This suggests that efficacy could be measured by developing tools that focus on strength of belief linked to particular behaviours and outcomes and indeed Likert-scale items have been devised and used in much self-efficacy research (Gibson and Dembo, 1984; Enochs and Riggs, 1990; Bandura, 1986). In later definitions Bandura provides some explanation about what these behaviours and outcomes are by indicating that they are linked to 'designated levels of performance that exercise influence over events that affect their lives' (Bandura, 1994:2), and '*…courses of action required to produce given attainments* ' (Bandura, 1997:3). Whilst these broad definitions provide a means of applying self-efficacy across a range of different contexts it still requires greater specificity for each individual context in order for it to be meaningful to those contexts. For instance in the case of ITT courses how should preservice teachers assess what a designated performance means, or what the given attainments should be when judging their own self-efficacy and how does this help them to address self-efficacy? Without this clarity, it becomes more difficult to understand the nature of self-efficacy and how it can be used towards the professional development of preservice teachers. Therefore, in the context of education the idea of teacher efficacy sounds promising but in fact highlights further complexities of trying to research such an individually defined but somehow generic construct using only quantitative methods.

Additionally similar terms are often used in reference to self-efficacy as indicated by Cramer *et al.* (2009) who suggest that self-efficacy and confidence despite being different are 'often used interchangeably' (p. 322). Bleicher (2006:166) concurs noting that confidence is an 'everyday term' for self-efficacy. Bandura, on the other hand, argues that synonomous terms such as confidence or self-esteem are more generic terms and 'rarely encompass all the important aspects of efficacy beliefs' (1997:11). Moreover, Bandura (1997) argues that self-efficacy is a stronger construct because it is situated in a conceptual framework supported by theory which describes how it is influenced, the multi-layered and contextual nature of self-efficacy, and how it can change and alter the way in which people behave, whereas terms such as confidence lack such an explanatory framework. Both Bandura (1997) and Stajokovic (2006:1208) agree that confidence is linked to a 'degree of certainty about handling something'. Self-efficacy, however, involves not just judgments about the strength of belief about capabilities to do something, but also judgments about whether people have the capabilities in the first place (Bandura, 1997). Therefore, confidence is only a part of self-efficacy not identical to it.

2.6.2 A brief history of teacher efficacy

A number of literature reviews have been completed regarding efficacy research in the context of education such as that by Tschannen- Moran *et al.* (1998) who reviewed teacher efficacy research from 1974-1997 and Klassen *et al.* (2011) who focussed on the years 1998-2009, and Wyatt (2018) who focussed on the years 2005-2016, with particular regard to language teachers' beliefs. Given that research has been conducted over the last 44 years, these reviews have provided a useful insight into how teacher efficacy is defined as well as how this has led to a range of approaches for measuring teacher efficacy. Reviews by Klassen *et al.* (2011) and Wyatt (2018) demonstrate that research into teachers' self-efficacy is largely based in North

America, Asia, and to a lesser extent in Europe. Tschannen-Moran *et al.* (1998) establish that the RAND researchers contributed to the birth of the construct of teacher efficacy through adding two statements to an extensive questionnaire dealing with reading programs in Los Angeles citing a report by Armor *et al.* (1976). According to Tschannen-Moran *et al.* (1998) these two statements reflect the work done by Rotter on Locus of Control (1966) in that the RAND researchers asked respondents to indicate to what extent they believed the teacher influenced student's motivation and performances as shown here:

RAND Item 1. 'When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his/her home environment' (Tschannen-Moran *et al.,* 1998:223).

RAND Item 2. 'If I try really hard, I can get through to even the most difficult or unmotivated students' (Tschannen-Moran *et al.,* 1998:223).

These two statements reflect two different aspects or factors that contribute to teacher efficacy. The first statement reflects general teaching efficacy (GTE), what teachers (all) can do, with the second reflecting personal teaching efficacy (PTE), what I (the teacher) can do. Teacher efficacy was determined by combining the scores for each statement and could be conceptualised 'as teachers' beliefs that factors under their control ultimately have greater impact on the results of teaching than do factors in the environment or in the student-factors beyond the influence of teachers' (Tschannen-Moran *et al.,* 1998:206). If teachers believed that they had a lot of influence or internal control, over students' motivation and performances then this reflected a high teacher efficacy, whilst teachers who believed that external issues had a greater impact on students' motivation and performances had a lower teacher efficacy. The RAND studies inspired further research in teacher efficacy based on internal/external control. For instance, Tschannen-Moran *et al.* (1998) cite research correlating teacher efficacy with aspects such as student outcomes, teachers' willingness to use new approaches as well as teacher stress. They cite references such as Ashton and Webb (1986) Guskey (1984) and Greenwood *et al.* (1990) (Tschannen-Moran *et al.,* 1998:207).

These statements thus provided some additional specificity to the construct of self-efficacy helping teachers to clarify their own beliefs about their own role in helping students' achievements and participation. Teacher efficacy as construed through Rotter's work (1966) could be defined in terms of teachers' beliefs about their impact on student outcomes and to what extent teachers have control over this. For instance, Cantrell and Callaway (2008) refer to general teacher efficacy as 'one's belief that teachers, in general, can and should greatly influence student performance in spite of barriers' (2008:1740) and personal efficacy as 'a teacher's belief that she or he has the ability to have a strong influence on student learning' such that 'those beliefs relate directly to their efforts and persistence with students' (2008:1740). Tschannen-Moran *et al.* (1998:137) cite other definitions which include: "the extent to which the teacher believes he or she has the capacity to affect student performance (Berman, McLaughlin, Bass Pauly and Zellman, 1977, p. 137), or as "teachers' belief or conviction that they can influence how well students learn, even those who may be difficult or unmotivated" (Guskey and Passaro, 1994, p. 4)'. The emphasis in these definitions places teacher

efficacy firmly with their impact on students' outcomes and motivation. Whilst this is a very important aspect of teaching, preservice teachers are still in the process of training and learning themselves, and as such their focus may be more on their own development and motivation initially, whilst they are honing their skills, knowledge and beliefs about becoming a teacher of primary science. Having a belief in yourself as a primary science teacher provides the initial stepping stone towards professional development, but having the motivation to seek out the necessary type of experiences for further development, reflects what is entailed in becoming an effective teacher IBeauchamp and Thomas, 2009; Avraamidou, 2014 Bembenutty, 2016)

A second approach to teacher efficacy research evolved out of Bandura's work on social cognitive theory (1986). In this context teacher efficacy is seen as 'the teacher's belief in his or her capability to organise and execute courses of action required to successfully accomplish a specific teaching task in a particular context' (Tschannen-Moran *et al.,* 1998:233). SCT asserts that people are actively involved in learning behaviours and not just imitators of previous observations. Ponton and Carr (2012) describe SCT as the theoretical framework exploring personal agency for behaviour through 'autonomous learning as well as self-directed learning' (p.1), managed through self-regulatory processes. Ponton and Carr (2012:3) regard the self-reflective capability of personal agency as self-efficacy, a major component of SCT and the 'foundation of human agency' (Bussey and Bandura, 1999:691 cited in Ponton and Carr, 2012:3). Schunk *et al.* (2014) argue that the emphasis in SCT is that people 'learn about the appropriateness of modelled actions by observing their consequences' (p.141). People experience many different opportunities for learning, but as a consequence of autonomous learning people choose to behave in particular ways by drawing on their 'thoughts, goals, beliefs and values' (p.141) that develop through these social influences. People may also create their own specific opportunities through self-directed learning to 'enhance efficacy and maintain motivation' (Schunk, 2003:162). Therefore, Schunk *et al.* (2014) argue that through observation of others, people learn many ways of coping with situations from which they make choices about which aspects they will use themselves in similar situations.

Bandura (1977; 1986; 1997) argues that self-efficacy has two components which are similar but slightly different to the two previously mentioned factors linked with research influenced by Rotter's work. Both approaches recognise personal teaching efficacy as one component, but Bandura refers to the second component as outcome expectancy because it is closely related to an individual's expectations and not to general teacher expectations. Outcome expectancy is a less useful predictive tool since it is closely linked with self-efficacy judgments in the first place. For instance personal teaching efficacy links closely to an individual's belief in their ability to act in a particular way, by partly drawing on their experiences and observations of similar situations. Outcome expectancy emerges from personal teaching efficacy in that it refers to whether a particular behaviour will result in particular outcomes. In making judgements about efficacy I would argue that individuals are already considering outcomes. Both the research work influenced by Rotter and that influenced by Bandura indicate that self-efficacy is affected by two factors but the differing understanding of each factor has resulted in creating a confusing and complex construct which

researchers have to unravel and address in order to make clear what is being researched and/or measured and how it can be specifically adapted to teaching and all the complexities involved there. In this thesis research question one looks at this aspect in more detail.

In practice, preservice teachers will have been exposed to a range of different opportunities to observe teaching from their own experiences as pupils in school, as well as assessed, and self-directed placements for teaching which occur during their training. Through self-regulatory processes such as reflection, preservice teachers can make their own decisions about their aspirations and capability for teaching science, thus taking responsibility for their personal agency in moving towards becoming a professional teacher (Beauchamp and Thomas, 2009; Avraamidou, 2014). However, they also need to take into account that the environment in which they will operate may constrain their choices because other aspects outside of their control, such as access to resources, may have a stronger influence on what teaching approaches they can actually use during placements. Thus becoming a teacher is not simply a case of imitating teachers they have observed, but reflects reciprocal interactions between the preservice teachers and their evaluation of the experiences they bring to the situation, the environment in which the learning to teach situation takes place, as well as the involvement of those involved such as the teacher-tutor, the children and the preservice teachers in the training experiences provided by placements. Tschannen-Moran *et al.* (1998) developed a new model to incorporate all these aspects to reflect the dynamic nature of efficacy and the relevance of context and subject specificity in impacting on the decisions made by teachers when making judgments about their own self-efficacy for teaching. In this thesis research question two addresses self-efficacy through the use of models initially influenced by Bandura's triadic reciprocal causation model (1997).

In the next section, I provide an example of one particular measuring tool used for measuring elementary teachers' science self-efficacy. This example has been chosen as it influenced work in the pilot study for this research. It is subject specific and aimed at the target group of participants for this thesis: science and preservice teachers.

2.6.3 Review of one particular measuring tool reflecting Bandura's work but which initially influenced the interview schedule for this thesis

One of the criticisms of teacher efficacy research is that it lacked specificity. In order to address this Enochs and Riggs (1990) designed **t**he Science Teaching Efficacy Belief Instrument Form A (STEBI A) for use with inservice elementary teachers, providing a subject specific measuring tool. Enochs and Riggs (1990) refined STEBI-A it in order to divide it into measuring self-efficacy and outcome expectancy of preservice teachers in the context of science teaching and learning, to form STEBI-B. These scales were tested for item and factor analyses and proven to be both valid and reliable and have been used in much teacher efficacy research work (Deehan, 2017 and Morris *et al.,* 2017). Whilst the study was based in the USA some of the rationale driving it is familiar to preservice teachers in the UK as issues raised by the Wellcome Survey (2017): lack of subject knowledge, lack of time, lack of focus on science, lack of experience in teaching science, lack of

effective modellers of science teaching. Enochs and Riggs were influenced by Bandura's (1977) work on self-efficacy which was also linked to outcome expectancy beliefs in which people believe that the behaviour they are capable of will lead to successful outcomes.

Bandura (1986) argues that self-efficacy is the stronger predictor of future behaviour since context will also impact and affect the final outcomes of the behaviour. Self-efficacy is context specific, and therefore, Enochs and Riggs (1990) argue that there was a need to draw up a science specific measure particularly as elementary teachers, like primary teachers have to teach a range of subjects which they may not be equally effective in. They cite Gibson and Dembo (1984) as designing a teacher self-efficacy measure which provided a model for Riggs (1984) to develop STEBI-A for inservice teachers, and finally for Enochs and Riggs (1990) to adapt this to the STEBI-B for preservice elementary teachers. These measures are designed to help teachers identify their beliefs about teaching and the impact of these beliefs on behaviour in the classroom. The STEBI-A consisted of 25 statements, 13 positive and 12 negative to cover both self-efficacy beliefs and outcome expectancy beliefs. They describe it as a five choice, Likert-type scale. IN STEBI-B the statements were changed to the future tense so 'Even if I try hard, I do not teach science as well as I do most subjects', became 'Even if I try hard, I will not teach science as well as I will most subjects' (p.5). STEBI-B was given to 212 preservice elementary teachers in the USA. Reliability was tested through Cronbach's alpha coefficient and an item-total item correlation was done. Construct validity was done through factor analysis of self-efficacy and outcome expectancy and through this testing the STEBI-B was considered to be 'a valid and reliable measure of personal scienc teaching efficacy and science teaching outcome for preservice elementary teachers'(p.13). By checking for reliability and validity the idea was to generate a scale to measure preservice teachers' self-efficacy and outcome expectancies for teaching science in elementary schools.

Enochs and Riggs (1990) argue that Bandura distinguishes between two dimensions associated with self-efficacy: self –efficacy and outcome expectancy. They also remind us of the context specific nature of self-efficacy which led to them developing a measuring scale focussing on science in particular. The questions were both positively and negatively phrased in order to check on reliability. The STEBI-B was organised to ask questions in the future as it was aimed at preservice teachers and how they perceived their self-efficacy for teaching science even if they had not yet taught any science. The questionnaire mixes up individual statements with general thoughts about teaching in its efforts to cover both self-efficacy and outcome expectancy beliefs. Thus it is seems a bit difficult to move from thinking individually to generally which in fact caused some issues when they were developing the questionnaire. However they did in fact use statistical approaches to measure the validity and reliability of the scale and such was the outcome that others have since used this scale or adapted versions within their own research on self-efficacy (Cantrell *et al.,* 2003, Aydin and Boz, 2010; Bautista, 2011).

Teacher efficacy scales had been put together before the most quoted is from Gibson and Dembo (1984) which was focussed on a more generic teacher efficacy and influenced by the work of Rotter whilst other tools addressed the two factors of self-efficacy and outcome expectations together. Certain issues with self-efficacy definitions concern me in that: It can be too specific and separating out self-efficacy from outcome expectancy seems complex as you are hardly likely to think about whether you can teach science without considering some aspect of what outcomes you are expecting. Enochs and Riggs (1990) raise issues with definitions and the confusion this can have on the analysis of results. They also criticise Teacher Efficacy Beliefs research as being generic and not context specific. They argue that since elementary teachers teach a range of different subjects they may have different self-efficacy beliefs in different subjects and therefore, it is very relevant to have a measuring instrument that can be used to specifically look at a subject area.

Riggs and Enochs (1989) scales were influenced by Gibson and Dembo (1984) and included the following changes: Context and subject specific focussing on elementary teachers and science, ensuring statements only measured self-efficacy or outcome expectancy rather than combining these. They added more items and provided balanced number of positive and negative statements in order to address acquiescence bias, a problem with Likert scales in which participants have a tendency to always agree with statements which may or may not reflect what they really believe (Oppenheim, 1992). Initially they began with 50 statements which were shared with 5 judges who contributed to testing for content validity. Each statement was linked to response statement which were then given a numerical result. Positive statements linked with strongly agree responses scored a 5 with strongly disagree scoring a 1. Negative statements were scored in reverse with strongly agree responses scoring a 1 and strongly disagree scoring a 5. The scores were collated for each dimension so a score for self-efficacy and a score for outcome expectancy were given.

They reduced the number of items further by doing an item analysis test and found that the self-efficacy dimension was acceptable the outcome expectancy was not. This resulted in doing a factor analysis but this still seemed to create issues for them with the outcome expectancy dimension and influenced them further on choosing the items that should be included on the scales. The issue that seemed to be the cause of the problem was that some items could be interpreted both in terms of outcome expectancy and in terms of self-efficacy depending on whether participants viewed the statement in terms of generic teaching or in terms of personal response to teaching. These items were removed. Further discussion of this can be found on p.9 in Riggs and Enochs paper 1989.

Items that were removed were analysed to explain why they were problematic which was: item measured both dimensions and was open to the interpretation of the participant, these items could score in both dimensions or be wrongly scored in an incorrect dimension, the item did not focus on teacher outcomes, the item did not fit any particular pattern. This resulted in a scale with no negative statements which they addressed by including additional items which were further analysed.

I include this detail to show the amount of work used to develop the instrument and the number of checks and analysis done to ensure reliability. They also did validity checks to ensure that items were about science teaching self-efficacy beliefs and not generic teaching beliefs. Further reliability checks were done resulting in a Personal Teaching Efficacy Belief Scale that contained items with an item-total correlation 0.5 and above and an alpha of 0.91. The Science Teaching Outcomes scale was more problematic but they eventually achieved a reliability alpha score of 0.74 and item total of 0.36 and above. They used these reliability checks, item-total checks, factor analysis checks to check for homogeneity within each scale and discreetness between the scales. Internal consistency checks were used throughout in the process of developing these scales, and any items that did not provide evidence of a high positive discrimination score were removed.

Nevertheless issues could arise because some questions may have been interpreted on many levels by the same participant and this may have led to inconsistencies with the Science Teaching Outcome (STOE) beliefs scale in particular. Additionally the STOE statements may have been interpreted by participants as less relevant to themselves because unknown external factors may be perceived to be causing the issues. In their conclusion they claim that the STEBI tool can 'lead to further understanding of teacher behaviour, which in turn can facilitate the development of strategies which may assist in teacher preparation' (Riggs and Enochs, 1989:16).

This is a scale that is still used by researchers today (Morris *et al.,* 2017a) despite the continuing issues associated with trying to measure teaching efficacy through quantitative methods such as Likert-scales which include both general teaching statements and personal teaching statements. Bandura (1997) has argued that teaching efficacy research should only focus on individuals' beliefs since generic views about how teachers behave have little impact on how a teacher will perform in the classroom. Researchers continue to add to Teacher Efficacy Definitions. For instance Wyatt (2018) provides an all encompassing definition that teachers' self-efficacy are 'teachers' beliefs in their abilities to support learning in various task-, domain- and context-specific cognitive, metacognitive, affective and social ways' (p.93). He argues that this reflects the clear distinction Bandura (1977) made between self-efficacy beliefs linked with agent-means beliefs, and outcome expectancy beliefs associated with means-ends-beliefs and that the two do not necessarily correlate with each other. For instance a preservice teacher may fully believe that using inquiry approaches for primary science is a successful way to motivate and improve children's understanding of science, a means-end belief, but that they do not have the skills or knowledge to carry this out successfully in the classroom, an agent-ends belief. Since self-efficacy beliefs are more predictive of behaviour (Bandura, 1977), this would indicate a low self-efficacy for teaching primary science through an inquiry approach. Wyatt's (2018) definition summarises the many aspects which contribute towards self-efficacy and reflects the dynamic nature of self-efficacy, however it also reinforces the complex multi-dimensional layers of self-efficacy judgements which may more usefully be researcher through qualitative approaches.

In this next section I move towards the use of conceptual models for visualising self-efficacy and how these may contribute to understanding how self-efficacy beliefs form and change over time.

2.6.4 Issues with ever-increasing self-efficacy and conceptual models

This section considers if preservice teachers are in a position to judge their self-efficacy.

It is followed by a section which explores more recent understandings of self-efficacy through the use of conceptual models. There are three sub-sections which follow the development of the conceptual model from Bandura's (1977; 2004) work through to the cyclical interpretation of Gist and Mitchell's (1992) work, and then to the seminal work of Tschannen-Moran *et al.,* (1998).

This is followed by a more recent interpretation supported by work from Bergman *et al.,* (2019). This provides a different perspective to interpreting and operationalizing the multi-dimensional aspects of self-efficacy, by linking the Triadic Causation Model from Bandura's work on SCT with agency.

The use of these theoretical conceptual models have been key in contributing to this thesis and developing an analytical framework to enable practitioners to potentially make greater use of self-efficacy for professional development reason.

2.6.5 What is high/low self-efficacy?

To recall self-efficacy is a comprehensive multi-layered and dynamic construct informed by many sources of information derived from a range of experiences (Bandura, 1977; 1986; 1997), altering with time and being different for individuals (Gist and Mitchell, 1992). Therefore, just as there is no one unique conceptualisation of defining self-efficacy through a set of statements as shown by the range of definitions associated with teacher efficacy research in the previous section, there is no generic concept of what high self-efficacy looks like since it alters depending on the experiences of the preservice teachers concerned, the contexts in which these experiences occur and the perceived impact these experiences have on the preservice teachers (Labone, 2004; Morris *et al.,* 2017). Furthermore In quantitative terms self-efficacy is seen as a continuous variable (Bandura, 1997), but as Wheatley argues it is often judged in terms of "positive, high or greater teacher efficacy and those with "low, lower, or lesser" teacher efficacy' (Wheatley, 2005:749). Additionally Mansfield and Woods-McConney (2012) citing Tuchman and Isaacs (2011), remind us that the formal and informal experiences of preservice teachers 'have a sustained influence on teacher efficacy even after years of teaching' (p.38). Therefore, being able to explore how preservice teachers interpret their experiences would be useful in better understanding how self-efficacy beliefs develop.

Self-efficacy research is often correlational making links between levels of self-efficacy and particular personal characteristics. In teaching, for instance, high self-efficacy is linked to qualities such as resilience and enthusiasm with low self-efficacy more associated with avoidance behaviour if presented with challenging situations (Bandura, 1997 and Glackin and Hohenstein, 2018). Whilst the idea of providing a tick list of self-efficacy characteristics may be a useful way of summarising how self-efficacy is operationalised by

teachers, it does not provide any understanding of how to influence changes in behaviour in order to increase personal self-efficacy beliefs. Additionally there is also a clear assumption that higher self-efficacy being aligned with stronger personal characteristics, is a positive aspect of self-efficacy beliefs (Tschannen-Moran *et al.,* 1998 and Wheatley, 2005).

Positive correlational links do appear in much of the literature, as can be seen in the lists found in Klassen and Durksen (2014) and Glackin and Hohenstein (2018). These correlational characteristics in turn, are also often associated with being an effective teacher (Muijs and Reynolds, 2002). This suggests that high self-efficacy is a desirable self-belief and that preservice teachers should somehow be aiming to achieve this as a main objective to provide evidence of success in their development as teachers (Mulholland and Wallace, 2001). Therefore, high self-efficacy may be seen to be a desirable quality to have because of its associations with success in various forms (Muijs and Reynolds, 2002; Palmer, 2011) but it can lead to over- or under-estimations of self-efficacy dependent on levels of experience, which in turn can lead to feelings of failure or complacency (Bandura, 1997).

2.6.6 Judging self-efficacy

Wyatt (2015) argues, therefore, that self-efficacy beliefs should not be seen as fixed constructs to be attained but 'open to growth' dependent on the context and experience of the individuals concerned. Furthermore, Wheatley (2005) suggests that being able to doubt self-efficacy beliefs enables teachers to continue to develop through reflective and reflexive cycles. However, in my opinion, this step requires teachers to know what their self-efficacy beliefs are, and an understanding of reflective approaches to teaching development which may be more developed in experienced teachers rather than preservice teachers (Schon, 1983). Preservice teachers, who are in the initial phases of professional development may have less, or no understanding of their self-efficacy beliefs due to lack of experience leading to naivety about the complexities of the tasks involved in teaching lessons, and lack of clarity about what attainments they are aiming for (Mullholland and Wallace, 2001). Preservice teachers are in less of a position to doubt beliefs,that they are still forming. Self-efficacy beliefs are seemingly more in a state of flux for preservice teachers (Bandura, 1997) not because of doubt but because of lack of experiences to draw on and the uncertainty that is associated with that (Mulholland and Wallace, 2001). Morris *et al.,* (2017), however, argue that it is not the amount of experiences that matter but how experiences are evaluated and reflected on which they refer to as, 'cognitively processed' (p.798), which have greater impact on self-efficacy.

For example, experienced teachers who perceive and have experienced that they can teach science successfully through the use of a transmission approach, may suddenly find that using an unfamiliar pedagogical teaching approach such as 'Working Scientifically' (DfE, 2013), may not lead to the same outcomes as the teachers have previously achieved. They can put this down to the fact that they know what they are doing and it works and no change in self-efficacy is required, or they can doubt their self-efficacy for teaching through inquiry and begin to initialise changes in order to develop this different pedagogical

approach so that they can achieve the same outcomes as before. Doubting their self-efficacy and addressing the doubts, enables them to incorporate a different pedagogical choice into their own set of skills and capabilities as Wheatley (2005) suggests.

Preservice teachers, on the other hand, may find it difficult to judge self-efficacy beliefs (Bandura, 1997). Preservice teachers with little experience of teaching science through an inquiry approach may naively over-estimate their self-efficacy because they are unaware of all the aspects involved in using this approach with a whole class of primary aged children (Mulholland and Wallace, 2001). The actual experience of carrying out this approach may lead to failure and this will have a detrimental impact on their self-efficacy beliefs for future events since failure can contribute to lowering self-efficacy beliefs (Bandura, 1997; Beauchamp *et al.,* 2019).

Alternatively preservice teachers in the latter part of their training courses may under-estimate their self-efficacy for teaching science through inquiry for other reasons such as a perceived lack of subject knowledge (Morris *et al.,* 2017), even though they can draw on more pedagogical experiences and strategies to increase their teaching options, to deal with challenges as they occur (Wyatt, 2016). The actual experience of carrying out this approach may reveal that the more experienced preservice teachers are able to cope well in the classroom despite their perceived lack of subject knowledge, which will lead to more successful outcomes and potentially increased self-efficacy for teaching science through inquiry. These examples illustrate that self-efficacy beliefs will alter dependent on the perspectives of the preservice teachers and whether they interpret the experiences in terms of success, failure or somewhere in between.

Efficacy research suggests that estimates of self-efficacy usually reflect the actual level of skills that individuals demonstrate when actually carrying out the required tasks (Gist and Mitchell, 1992; Bandura, 2006). If estimates and feedback from actual experiences do not match, this may lead to doubting self-efficacy judgements, when in fact the discrepancy may largely be due to lack of experience. Rather than doubting self-efficacy judgments it would be more beneficial if preservice teachers explored what has contributed to the mixed feedback between beliefs and practice, and use this to implement steps for understanding how their experiences contribute towards self-efficacy judgments (Beauchamp *et al.,* 2019).

Skinner (1996) identified that whilst theorists tend to associate self-efficacy beliefs with future specific events, there is no reason why self-efficacy beliefs shouldn't also be looked at retrospectively and in more general ways as 'these associations reflect only the decisions of theorists and are not intrinsic properties of the kinds of beliefs…. such as self-efficacy could be retrospective and general' (p.555). Ultimately this provides further evidence for investigating self-efficacy through greater understanding of the experiences preservice teachers bring with them, the diversity and complexity associated with the contexts in which they develop their experiences whilst on training placements or through self-directed experiences, and most importantly how they perceive and interpret these experiences which will impact on their self-efficacy beliefs for future events (Labone, 2004).

The way forward may be to use conceptual models in order to provide a visual understanding of self-efficacy.

2.6.7 Recent development of conceptual models for illustrating self-efficacy

This section seeks to review some conceptual models developed within self-efficacy literature and to consider whether these models contribute to further understanding of self-efficacy, or whether they simply add to the complexities already raised to do with definitions and measurement approaches. According to Wyatt (2016) conceptual models provide a visual framework to capture the essential determinants of the constructs being displayed. What is regarded as essential, and what is regarded as the key determinants open up opportunities for discussion, understanding and application of the construct being developed. Wyatt (2016) argues that this is particularly problematic for constructs such as teacher related self-efficacy as much of the research is 'conceptually confused' (p.114) and perhaps this accounts for the lack of conceptual models within self-efficacy research. This criticism of teacher efficacy research may contribute towards the difficulty for teachers and teacher educators to translate the theory underpinning self-efficacy into practical ways for developing professional practice (Wheatley, 2005). If conceptual models are to serve a purpose for users of the model they need to be 'learnable, functional and useable' (Wyatt, 2016) and this section looks at particular conceptual models and diagrams, which have influenced the direction of this thesis in seeking a bridge between theory and practice for practitioners. Models and diagrams are reviewed in terms of their organisation and the purpose they serve.

This first section reviews how Bandura used diagrammatic representations to clarify the difference between efficacy and outcome expectations, terms which he argues are often misused within self-efficacy research and have contributed towards some of the associated criticisms.

Bandura (1977) provided the model in Figure 2.4 to demonstrate how efficacy expectations differ from outcome expectancies, yet both contribute to personal efficacy beliefs and act as a mediator between what a person believes and how they eventually act.

Source information for Diagram (Bandura, 1977:193) found in:

Bandura, A. (1977) Self-efficacy: toward a unifying theory of behavioral change. Psychological Review, 84, (2), 191-215.

Figure 2.4: The 'diagrammatic representation of the difference between efficacy expectations and outcome expectations' in Bandura (1977:193).

In Figure 2.4 Bandura (1977) illustrates how personal efficacy is shown to act on behaviour and outcome through two distinctive steps which he divides into efficacy expectations: 'the conviction that one can successfully execute the behaviour required to produce the outcomes'(p.193); and outcome expectancies: 'that a given behaviour will lead to certain outcomes' (p.193). Bandura argues that efficacy and outcome expectations need to be differentiated to illustrate that both have an impact on the final choices for outcome performance.

For preservice teachers of primary science, Figure 2.4, may be interpreted to show: how they transfer their understanding of their own experiences and theoretical knowledge into practical application in the classroom; and whether preservice teachers choose to use inquiry approaches or not. Efficacy expectations may be influenced by preservice teachers' own successful experiences of doing science investigations, which may contribute to beliefs about being capable to do similar activities with children. These same preservice teachers may also know from educational theory that using inquiry approaches with children can contribute to their engagement and understanding of science (outcome expectations). Linking efficacy and outcome expectancies together there would be an expectation that using inquiry approaches for teaching primary science would result in successful outcomes. In reality, however, if preservice teachers' efficacy expectations reflect that they lack belief in their capabilities to carry out inquiry approaches then they are unlikely to attempt to carry out such approaches unless there are other factors involved. Therefore, efficacy expectations are a greater predictor of behaviour than outcome expectations though both are involved in the decisions and choices the preservice teachers make (Bandura, 1977; 1997).

The model is useful in separating out the two factors involved in personal efficacy beliefs. However whilst both expectancies contribute to what actually takes place, they do not have an equal impact on what happens according to Bandura (1977; 1997), and this is not reflected in the diagrammatic representation. Additionally as the model is presented in a linear fashion it appears to suggest a defined order of responses and actions, which in reality may be more iterative, cyclical and dynamic. Neither does the model reflect the relevance of the context or environment to efficacy expectations. For instance as preservice teachers begin to teach using inquiry approaches they may realise that they have to alter their expected outcome expectations, because the children they are teaching have never used inquiry approaches before. The preservice teachers' original outcome expectancies have turned out to be unrealistic and this raises issues about the preservice teachers' efficacy expectations and subsequently what behaviours are now necessary to cope with the change in outcome expectancies.

By 2004 Bandura had altered his model to show these connections more fully as can be seen in Figure 2.5 which he developed in relation to health behaviour.

Source information for Diagram (Bandura, 2004:146) found in:

Bandura, A. (2004) Health Promotion by Social Cognitive Means. *Health Education and Behavior*, 31, (2), 143-162.

Figure 2.5: 'Structural paths of influence for self-efficacy…' in Bandura (2004:146)

In Figure 2.5 self-efficacy beliefs again impact directly on behaviour (Bandura, 1997) but are also mediated through an additional route. This second route is influenced by outcome expectations and sociostructural factors. These factors contribute to the development of goals which influence behaviour, which is now seen as the outcome of self-efficacy beliefs by either route. This model like the previous model is concerned with

showing how self-efficacy and behaviour are linked but it does not give any indication of what contributes to the self-efficacy beliefs in the first place. It allows for context and environmental aspects through personal interpretation of what physical, social and self-evaluative outcome expectations might be, and what facilitators and impediments of sociostructural factors are. The layout does capture that self-efficacy beliefs have greater impact on behaviour, a criticism of the previous model. Again the structural path diagram is linear and shows behaviour as an outcome of self-efficacy and outcome expectations but not how the behaviour reciprocally impacts on these two aspects.

2.6.8 CYCLICAL MODELS OF SELF-EFFICACY Part 1

In this section I look at two cyclical models of self-efficacy which reflect the influence of Bandura's work including the sources of self-efficacy and its dynamic nature. Development of the conceptual model was taken up by Gist and Mitchell (1992) and later drawn up in the context of teacher efficacy by Tschannen-Moran *et al.* (1998).

These two models have been chosen in the context of this thesis because they have been influential in addressing the research questions, the methodology and the data analysis and findings.

2.6.9 Model 1 Gist and Mitchell (1992)

The model in

Source information for Diagram (Gist and Mitchell, 1992:189) found in:

(Gist, M. and Mitchell, T. (1992) Self-efficacy: A Theoretical Analysis of its Determinants and Malleability. *The Academy of Management review,* 17**,** (2), 183-211.

Figure 2.6 appears in Gist and Mitchell's article entitled: Self-efficacy: A theoretical analysis of its determinants and malleability, and is in the context of organisational behaviour and management literature. It was the first model that I read which influenced my approach towards analysing the data for research aim 2 as it also focussed on how individuals form efficacy judgments from the four experiences outlined by Bandura (1977; 1997) and what factors from these experiences contribute to efficacy judgements. This model is based on the theoretical assumptions of Bandura (1977) that enactive mastery, vicarious, verbal persuasion and physiological arousal form the four influential experiences which contribute towards how people develop their self-efficacy judgments.

Source information for Diagram (Gist and Mitchell, 1992:189) found in:

(Gist, M. and Mitchell, T. (1992) Self-efficacy: A Theoretical Analysis of its Determinants and Malleability. *The Academy of Management review,* 17**,** (2), 183-211.

Figure 2.6: Gist and Mitchell (1992:189) diagram to show influences on and consequences of self-efficacy beliefs

Source information for Diagram (Gist and Mitchell, 1992:189) found in:

(Gist, M. and Mitchell, T. (1992) Self-efficacy: A Theoretical Analysis of its Determinants and Malleability. *The Academy of Management review,* 17**,** (2), 183-211.

Figure 2.6 is in two halves with the left hand side focussing on what experiences influence self-efficacy judgements and how the information from these experiences are analysed to identify the factors that are most likely to inform self-efficacy estimates. These experiences provide people with the ability to judge whether they have the skills to perform a particular task, whether they have the right attributes for completing the task and what additional personal resources and constraints may affect their estimation of self-efficacy, thus illustrating how to interpret the outcome expectancies and sociostructural factors from Gist and Mitchell's model (1992).

The right hand side of the model in

Source information for Diagram (Gist and Mitchell, 1992:189) found in:

(Gist, M. and Mitchell, T. (1992) Self-efficacy: A Theoretical Analysis of its Determinants and Malleability. *The Academy of Management review,* 17**,** (2), 183-211.

Figure 2.6 provides less detail but in conjunction with the left hand side, it can be seen that Gist and Mitchell's model (1992) places self-efficacy within a cyclical format showing that what informs the estimation of self-efficacy leads to consequences and performance. These in turn contribute to the feedback loops that subsequently continue to inform self-efficacy judgements through analysis of the four sources of influence as outlined by Bandura (1977). Gist and Mitchell (1992) appear to have drawn the model to illustrate that feedback may occur at different times such as concurrently during performance, immediately after performance or there may be some time gap between the performance and self-efficacy estimations which agrees with ideas from Bandura (1977; 1997).

In Gist and Mitchell's model (1992) the assessment processes used to evaluate past experiences occur before the estimation of self-efficacy. Initial self-efficacy estimations impact on the goals, persistence and motivation necessary for future performances. In the case of preservice teachers, the performance could be teaching whole classes or perhaps small groups within a class but whichever occurs the model allows for 'in the moment' adaptations. As performance occurs one of the feedback loops links back into the system and may cause immediate changes to self-efficacy estimations as people find they have to adapt to new and unexpected challenges as the task happens. This is evident when preservice teachers working on placement with unfamiliar classes and pupils suddenly realise that they have under- or over- estimated what the children can do. In order 'to respond to the strengths and needs of all pupils' as expected in the Teachers' Standards (DfE, 2021:11), preservice teachers are likely to draw on their self-efficacy beliefs in order to make teaching and learning adjustments that preservice teachers feel they can cope with. Feedback also

contributes to the four sources of efficacy, from which further analysis and evaluations are made through self-assessment to continue to feed forward into self-efficacy judgments for future events (Gist and Mitchell, 1992).

The model in

Source information for Diagram (Gist and Mitchell, 1992:189) found in:

(Gist, M. and Mitchell, T. (1992) Self-efficacy: A Theoretical Analysis of its Determinants and Malleability. *The Academy of Management review,* 17**,** (2), 183-211.

Figure 2.6 is useful in providing a 'simplified' (Gist and Mitchell, 1992:189) visual representation to show how the sources of efficacy can be assessed and evaluated in order to estimate self-efficacy judgments for future events, but it requires a lot of understanding and raises questions at every point such as: What are enactive mastery experiences, how do I know I have had them? What is an attributional analysis of experience and how do these transfer to self-efficacy beliefs? How does the estimation of self-efficacy result in consequences?

Gist and Mitchell (1992) do address these questions and highlight the links with other theoretical research such as Attribution Theory (citing Weiner, 1974), in which people try to provide causal explanations for past experiences. Whilst it is not possible to go into this theory in depth in this thesis, it is worthwhile understanding Gist and Mitchell's interpretation of its links to self-efficacy, and how this then relates to preservice teachers' self-efficacy beliefs for primary science.

For example, when preservice teachers are attempting to reflect and understand how their own experiences of teaching primary science contribute to self-efficacy (Bandura, 1977), they are likely to explain why successes or failures occurred, in terms of attributes. These attributes may be linked to how much effort they used in planning their lessons, or to how well they coped when the children did not understand what they were being asked to investigate, or how much was dependent on their own subject knowledge to make the lesson successful, or perhaps how much luck was involved such as being in the school when they were running a science week (Weiner, 1974). Additionally these attributions can be categorised as being internally driven such as effort, or externally driven such as choice of environment in which to teach science. In any case how preservice teachers perceive these factors and what amount of personal agency was involved contribute to the weighting and meaning these attributes have towards developing self-efficacy estimates. Therefore, attributions which '… are assessments about causes of past behaviour…'(Gist and Mitchell, 1992:192), provide evidence for the operationalisation factors which contribute towards self-efficacy estimates, estimates which mediate between past experiences and future behaviours or performances (Gist and Mitchell, 1992).

Gist and Mitchell's model (1992) captures a great deal of the cyclical formation of self-efficacy judgments but they acknowledge that each box contains sets of complicated constructs which need a great deal of understanding, which Wyatt (2016) sees as flaw in the usability of these types of models.

2.6.10 Cyclical Models of Self-Efficacy: Part 2

In this section I compare the models to highlight similarities and differences of interpretation from the more generalised approach used by Gist and Mitchell (1992), to its application with teacher efficacy created by Tschannen-Moran *et al.,* (1998).

2.6.11 Model 2 Tschannen-Moran, M., Woolfolk Hoy, A. and Hoy, W. (1998)

In 1998 Tschannen-Moran *et al.,* produced a seminal paper (Wyatt, 2016) called 'Teacher Efficacy: Its Meaning and Measure' in which they proposed an integrated model to address '…the conceptual confusion surrounding teacher efficacy…' (Tschannen-Moran *et al.,* 1998:227). This model, as shown in

Source information for Diagram (Tschannen-Moran *et al.,* 1998:228) found in:

Tschannen-Moran, M., Woolfolk Hoy, A. and Hoy, W. (1998) Teacher Efficacy: Its Meaning and Measure. *Review of Educational Research*, 68**,** (2), 202-248.

Figure 2.7, has similarities to the Gist and Mitchell (1992) model but it is specific for teacher efficacy, and places the analysis steps later in the cycle. Tschannen-Moran *et al.,* (1998) referred to it as an integrated model because they argue that it incorporates the two conceptual strands which have influenced teacher efficacy research, citing Rotter (1966) (the extent to which teachers believe they are responsible for students successes), and Bandura's (1977) view of self-efficacy in which teachers make judgements about their capabilities 'to perform at a given level of attainment' (Tschannen-Moran et al, 1998:202). Both models contribute to understanding self-efficacy though Tschannen-Moran *et al.,* (1998) apply the model specifically to teacher efficacy, which is seen as a 'sub-category of self-efficacy' (Glackin and Hohenstein, 2018:272).

Source information for Diagram (Tschannen-Moran *et al.,* 1998:228) found in:

Tschannen-Moran, M., Woolfolk Hoy, A. and Hoy, W. (1998) Teacher Efficacy: Its Meaning and Measure. *Review of Educational Research*, 68**,** (2), 202-248.

Figure 2.7: 'The cyclical nature of teacher efficacy' in Tschannen-Moran *et al.* (1998:228)

As in the Gist and Mitchell (1992) model the four sources of efficacy informatio: Enactive Mastery, Vicarious, Physiological Arousal and Verbal Persuasion, indicated by Bandura (1977), are listed on the left hand side(LHS) of the model and although Tschannen-Moran *et al.,*(1998) use similar terms the list is organised differently. Gist and Mitchell (1992) list the sources in order of greatest influence on self-efficacy, as indicated by Bandura (1977) and so enactive mastery and vicarious experiences occur at the top of the list. In the Tschannen-Moran *et al.,* model (1998) they start the list with verbal persuasion, placing mastery

experiences at the bottom of the list. The reason behind this is unclear since these authors also agree that mastery experiences are '…the most powerful source of efficacy information' (Tschannen-Moran *et al.,* 1998:229). Whilst this might seem a trivial point it indicates that these models are processing self-efficacy theory slightly differently in a way that is specific to the authors that have created them. This lack of consistency between models which are representing similar constructs, contributes towards what Wyatt (2016) refers to as an already 'conceptually confused' (p.114) background to self-efficacy.

Further inconsistencies may be evidenced by looking at the way these authors define self-efficacy. Gist and Mitchell (1992) do so by stating that self-efficacy '… refers to beliefs in one's capabilities to mobilize the motivation, cognitive resources, and course of action needed to meet given situational demands. (Gist and Mitchell, 1992:184 citing Wood and Bandura, 1989a: 408). It can be seen from their model that Gist and Mitchell (1992) try to encapsulate this definition by placing the estimation of self-efficacy box in the middle of the model. Judgements of self-efficacy are then influenced by the analysis and interpretation of previous experiences (LHS of the model), which provide the beliefs that influence the actions required to carry out tasks in particular contexts (RHS of the model). The feedback loops, one directly linking to self-efficacy and one contributing to the sources of experience box, illustrate the dynamic nature of the process and how each aspect of the cycle can alter and change self-efficacy estimates in the short and longer term.

Meanwhile Tschannen-Moran *et al.*(1998) attempt to integrate the different conceptual backgrounds which underpin teacher efficacy research. In the process they bring the ideas together in one model, linking the work of Rotter (1966) and Bandura (1977). To recap from previous sections Rotter's (1966) work is about teachers' beliefs and the extent to which teachers are influential in helping students to achieve these outcomes despite external issues. On the other hand, research influenced by Bandura's (1977) work links teacher efficacy to definitions derived from self-efficacy theory and SCT (Bandura, 1986). From this perspective teacher efficacy becomes defined as: 'a cognitive process in which people construct beliefs about their capacity to perform at a given level of attainment' (Tschannen-Moran *et al.,* 1998:203). By integrating these two conceptual strands Tschannen-Moran *et al.* (1998) help to illustrate how both aspects contribute towards self-efficacy judgements. Bandura's work and definition are evident within themodel through the inclusion, and order of the steps involved in developing self-efficacy judgments. Therefore, the model incorporates the sources of efficacy information which influence the cognitive processes used to develop personal capability beliefs, which contribute towards teacher efficacy. Rotter's influence in the model is seen in the section where teaching task and personal teaching competence are co-joined as these seem to more directly reflect beliefs about teacher influences on student outcomes.

Summary of Cyclical Models

Both models provide a visual cyclical display of the processes which contribute towards self-efficacy beliefs and how these beliefs mediate and impact on their choices. The Gist and Mitchell (1992) model provides more detail regarding the cognitive processes which underpin the development of self-efficacy beliefs

whereas Tschannen-Moran *et al.* (1998) focuses more on integrating two conceptual strands which continue to impact on issues associated with self-efficacy research. In their discussion of their models, both Gist and Mitchell (1992) and Tschannen-Moran *et al.* (1998), indicate that the interaction between these cognitive processes is iterative and weighted dependent on personal experiences and task requirements. However, the way in which the authors define each of these processes is slightly different. For instance Tschannen-Moran *et al.,* (1998) place assessment of resources and constraints within the analysis of the teaching task, whilst Gist and Mitchell (1992) place this within the self-appraisal section dealing with personal and situational issues.

Additionally the Tschannen-Moran *et al.* (1998) model seems to suggest a step-by-step process in the development of teacher efficacy much like the Bandura diagrams in the previous section. The authors deal differently with how performance contributes to self-efficacy judgments with Tschannen-Moran *et al.* (1998) linking performance with new sources of information for making efficacy judgments in their model, whilst Gist and Mitchell (1992) deal with this through the double use of their feedback loops. The use of these feedback loops illustrates a more dynamic view of the sources of self-efficacy judgments. Cyclical models contribute to understanding the operationalisation of self-efficacy more fully and separating it into component parts such as attributes and task analysis. Nevertheless, I concur with Wyatt (2016) that it also needs to be seen from a more holistic perspective if it is to be more functional and useable for practitioners.

2.6.12 Using a different perspective: Linking Self-efficacy and Agency through the Triadic Reciprocal Causation model (Bandura, 1986).

Self-efficacy which includes sub-sets such as teacher efficacy and personal efficacy beliefs are a core aspect of SCT (Bandura, 1986). SCT (Bandura, 1986) deals with human agency and that people are actively involved and influence how they think and behave through a 'reciprocal interplay of three constituent factors-personal, environmental and behavioural determinants-referred to as triadic reciprocal causation' (Ponton and Carr, 2012:1). The triadic reciprocal causation (TRC) model as outlined by Bandura (1986) is illustrated in Figure 2.8 and demonstrates the interaction between the three determinants and the bi-directional influences involved.

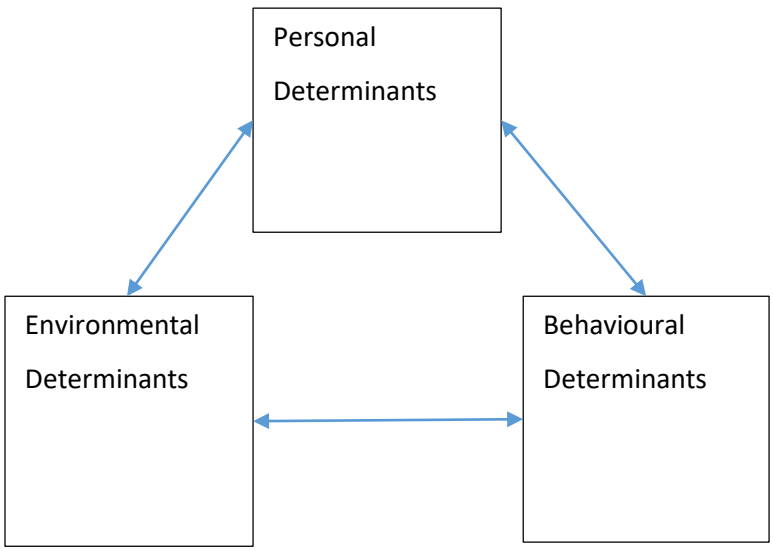


Figure 2.8: Bi-directional relationships between the three determinants of the Triadic Reciprocal Causation Model by Bandura (1997:6)

From an SCT view, people are proactive, intentionally initiating action and reflecting on the consequences of that behaviour and that this is influenced by self-efficacy beliefs (Bandura, 1997). Thus, efficacy beliefs are core to human agency as they are central to the belief that people have the power to produce change by their actions (Bandura, 2006). Preservice teachers are trainees and as they learn their profession they become more agentic in developing their identity (Beauchamp and Thomas, 2009). This is not straightforward since over a period of time they will be exposed to a range of diverse influences including working in different school environments and with different mentors during their assessed placements (DfE, 2012). What the preservice teachers make of these experiences with differing contexts and environments, influences their self-efficacy beliefs, pedagogical teaching choices and level of agency which Buchanen (2015) defines as '…reflected in whether or not they could teach the way they wanted to teach within their local school context.' (p.709). Furthermore Pandee *et al.* (2020) illustrated that the TRC model could be used to explore the dynamic nature of self-efficacy beliefs of preservice teachers. In their qualitative study they discussed how the weighted interaction between the determinants varied between mastery teaching experiences for the preservice teachers, affecting their self-efficacy beliefs and their senses of agency for teaching (Pandee *et al.,* 2020). Bandura's (1997) model is open to interpretation, and therefore, I consider that each determinant needs further descriptors in order to apply it to a specific context such as teaching primary science, and this partly needs to be done through an understanding of agency, its' constraints and facilitators, as outlined by Bergman *et al.* (2019) and Bandura (1997).

2.6.13 Agency and self-efficacy

Human agency is the extent to which people influence what they do. Bandura describes it as 'the power an individual has to take control for making something happen; (Bandura, 1997:3), and the choices people make in doing so are influenced by self-efficacy beliefs.

Agency operates through determinants**:** intentionality shown through planning goals and the strategies to achieve them, forethought shown through anticipation/prediction of likely outcomes which in turn influences effort and motivation, self-reactiveness through self-regulation which mediates effort and motivation to work towards and monitor plans, goals and ideas, self-reflectiveness which contributes to self-efficacy judgments (Bandura, 2006,). One aspect of the process of training is about enabling preservice teachers to become more agentic in their pedagogical choices to transform from being trainees, supported in the classroom to becoming teachers responsible for their own actions and choices (Zwozdiak-Myers, 2012). Agency 'is always informed by past experience…is orientated towards the future…enacted now' (Biesta *et al.,* 2015:627). Therefore, preservice teachers will draw on past experiences to inform their current beliefs about their capabilities, which will inform, though not limit, how they might act in the future.

Bandura (2006) argues that personal efficacy is core to personal agency as it is central to the belief that people have the capability to alter situations through their behavioural choices. In the context of preservice

teachers the extent of their personal agency is impacted by both facilitating aspects as well as constraints (Gist and Mitchell, 1992; Bergman *et al.,* 2019), which they take into consideration when they are making choices about what, who and how to teach whilst on placement. Bandura argues that if people believe they lack agency in making something happen they 'will not attempt to make things happen' (Bandura, 1997:3). Therefore, it is important through the training process that preservice teachers are given opportunities to develop their personal/self-efficacy since it impacts on the decisions they make in terms of the sort of teaching experiences that they are ready to try out. As mentioned previously, self-efficacy is influenced by four factors: mastery, vicarious, verbal persuasion, and physiological and affective response. Mulholland and Wallace (2001) argue that vicarious experiences are particularly valuable for preservice teachers who have had little science teaching experience, however, mentors can provide both positive and negative role models in terms of teaching primary science and their input can contribute to facilitating and/or constraining self-efficacy development and agency (Bergman *et al.,* 2019).

For example**,** in the context of teaching science, as indicated before, preservice teachers may well believe that inquiry approaches are the best way of teaching primary children science, but if preservice teachers lack self-efficacy beliefs for developing inquiry approaches, perhaps due to lack of experience, they may choose to opt out of using more challenging teaching approaches (Osbourne and Dillon, 2010). Additionally if teacher-mentors perceive that preservice teachers do not have a strong belief in their capability to organise and execute a science lesson in order to get particular results, that is the preservice teachers lack self-efficacy (Bandura, 1977), the mentors may choose to limit the agency the preservice teachers have. Whilst this can be seen as a supportive step for inexperienced preservice teachers, the mentors may also be choosing to do this because they have little experience in these approaches themselves (Mulholland and Wallace, 2001). Therefore, despite preservice teachers having aspirations for carrying out inquiry lessons they may find that they spend much more of the lesson completing worksheets or similar tasks. Preservice teachers' lowered sense of self-efficacy has reduced their agency and choices (Bandura, 1997), which in this example has been supported by the teacher-mentors who themselves have encouraged avoidance of more challenging pedagogical choices.

From this discussion, it can be seen that there are categories of agency which can be applied to teaching. Using literature based on constructs to do with Human agency and mobility done by Bergman *et al.,* (2019) and Bandura's model of personal agency (2001) the three sub-categories are proxy, individual and collective agency. These are illustrated below with reference to preservice teachers' experiences when completing assessed placements within their training.

Proxy: where the participant recounts experiences where they have relied on others to take charge or direct events. For instance when a teacher provides the planning sheets for a lesson and a preservice teacher follows the guidelines with little adaptation, or where the interviewee recalls doing investigations provided by the teacher.

Individual: where the interviewee recounts experiences demonstrating their autonomy through taking responsibility and the initiative to make things happen. For instance when a preservice teacher chooses the way in which they will teach science which might include using an inquiry approach rather than a provided worksheet.

Collective: where the interviewee recounts experiences of working with others to achieve a shared goal. For instance, this might include recalling class experiments where they worked with others to complete an investigation or where a preservice teacher developed planning in conjunction with the teacher rather than have a plan imposed upon them.

Therefore, agency is mediated by the degree of empowerment preservice teachers experience through their training as well as environmental facilitators and constraints. Each TRC determinant affects each of the other determinants bi-directionally (Bandura, 1986). Hence, it can clearly be seen from Figure 2.9 that internal personal factors, along with external factors linked to the degree of agency and the type of environment in which people work will impact on self-efficacy beliefs to a greater or lesser extent. Theoretically successful experiences are linked to higher levels of self-efficacy (Bandura, 1997), and preservice teachers feel more successful when they perceive that they have greater agency in their choices during teaching experiences (Zwozdiak-Myers, 2012). Consequently, it could be assumed that higher levels of self-efficacy are associated with greater agency and preservice teachers should work towards achieving greater agency within their placements. As indicated previously this is not such a straightforward connection since environmental issues and preservice teachers' own perceptions of their experiences, skills and knowledge, as well as the perceptions and beliefs of the mentors with whom they work, will also impact on the choices that they can make. If the indicators in Figure 2.1: Summary showing some examples of theoretical indicators linked to high/low self-efficacy, can be interpreted in relation to practice it may be possible to develop a framework which practitioners could find useful for determining and using self-efficacy for professional purposes (Rowston, *et al.,* 2021).

TRC	Descriptors
Personal Determinants including Self-efficacy beliefs	Cognitive processes which include memories and perceptions of those memories, and physiological responses to those memories which contribute towards self-efficacy beliefs
Behavioural Determinants	Degree of agency demonstrated by proxy, individual or collective agency which guides the choices of behaviours used in teaching
Environmental Determinants	**Social environment**- all the different groups of people who may be involved **Physical environment-** resources, place and space in which the teaching occurs. Environment choices are selected/constructed/or imposed.

Figure 2.9: Interpretation of the TRC model (Bandura, 1977; 1997) in the context of education descriptors, influenced by the work of Bergman *et al.* (2019) and Rowston *et al.* (2021)

Summary

This whole section set out initially to highlight the difficulty of preservice teachers in estimating self-efficacy about teaching, when they may have very few experiences to draw on and little understanding of self-efficacy in general. I then went on to explore how conceptual models can be used to illustrate the operationalisation and interpretation of self-efficacy. This led to the conclusion that the models themselves vary and require a great deal of clarification of terms in order to determine how they might be more 'learnable, functional and useable' (Wyatt, 2016:114). Whilst the models do contribute towards conceptualising self-efficacy theoretically (Markova, 2021 and Wyatt, 2016) they are still not in a form that practitioners are likely to find useable (Wyatt, 2016). By using Bergman *et al's.,* (2019) work linking agency to the TRC model it is intended to develop an analytical framework bridging the gap between theory and practice and contributing towards the professional development of practitioners.

CHAPTER 3 - METHODOLOGY

3.1 Introduction: Choosing the approach

Crotty (2013:7) defines research methodology as 'the research design that shapes our choice and use of particular methods'. In this chapter I seek to outline the methodological decisions made and the rationale behind those decisions.

The choices behind the research methodology for this thesis developed from the literature review which indicated that there was a gap in qualitative approaches used in self-efficacy research, itself much embedded in quantitative research (Labone, 2004; Wyatt, 2014; Glackin and Hohenstein, 2018). Grix (2010) argues that quantitative research is often, though not always, linked to a set of characteristic phases which begin with identifying variables that are associated with the construct under study. This is followed by operationalizing these variables in such a way that allows some form of measurement which in turn is used to seek patterns that provide further understanding of the construct. In the case of self-efficacy research a number of quantitative measuring tools have been developed for that purpose, such as the STEBI-B by Enochs and Riggs (1990) and the Teacher's Sense of Efficacy Scale developed by Tschannen-Moran and Woolfolk Hoy (2001). These tools continue to be adapted and refined as evidenced in more recent work such as that of Bleicher (2006), Velthuis *et al.* (2014) and Clarke and Newberry (2019). Indeed quantitative approaches have contributed to the theoretical background of self-efficacy and strengthened its perceived value as an influence and predictor of teachers' behaviours, classroom practices and impact on children's outcomes (Bandura, 1997; Appleton and Kindt, 2002; Morris *et al.,* 2017; Cansiz and Cansiz, 2019). However, such approaches have had less applicability for supporting practitioners, of any level of experience, who are looking to improve their teaching (Wheatley, 2005; Wyatt, 2014). Qualitative approaches which focus on 'contextual experience and emergent meaning making' (Brinkmann, 2012:64; 2018:590), may be more beneficial in making self-efficacy research useful to practitioners (Wheatley, 2005). Additionally qualitative approaches may lead to more insightful understanding of the influences and operationalisation of self-efficacy (Klassen *et al.,* 2011; Wyatt, 2014; Markova, 2021). Therefore, qualitative approaches are seen both as a way of enriching the theoretical background of self-efficacy research, and as a means of providing practitioners with greater understanding of how to identify and use self-efficacy to develop their own teaching.

As someone whose background is in science I came to this research very much with a positivist ontological stance which was reflected in epistemology that initially focussed my research towards the identification of self-efficacy through variables, statistical analysis and graphical representations. I did in fact trial questions from the STEBI-B (Enochs and Riggs, 1990), as mentioned above, in the pilot study, which highlighted the need to rewrite the questions to reflect preservice teachers' present-day experiences of primary science. As I progressed on my research journey I began to realise that if I continued to use this approach, then the focus of the research would be on narrowing the construct of self-efficacy to measurable variables which was not

my intention. I was really interested in capturing the contextual richness of participants' experiences of the construct of self-efficacy in order to seek ways for enabling preservice teachers to draw on it to support their development in primary science teaching. Additionally, influenced by the outcome from the pilot study leading to this research, I gained insights into the complexity of the construct of self-efficacy and the relevance of context which contributed towards my final decision to focus on using only a qualitative design. In this study I felt that it was more significant to make use of participants' voices to explore self-efficacy, than analysing their responses to pre-conceived generic questions about self-efficacy. On a personal level this created a number of tensions as I shifted from a quantitative approach that I was more familiar with, to engaging with a qualitative approach in which I would be a novice researcher. Nevertheless I felt that this was a justified journey, if I was to contribute towards developing research that could potentially add to the usability of the construct of self-efficacy, which in much of the exisiting research has been heavily based in the quantitative world. I therefore made methodological decisions that from my perspective, provided a way of scaffolding the steps I needed to take to engage with a qualitative approach that could augment key elements identified in quantitative studies within this field.

Therefore, in this thesis the methodology was influenced by the choice of using a qualitative approach to answer the aims and research questions as shown in Figure 3.1. In line with using a qualitative approach the focus is on using a constructivist approach (Best, 2012), the purpose of which is to understand individual accounts provided by the participants, with myself as the researcher being involved and part of the meaning making process (Savin-Baden and Howell Major, 2012).

Research Aim 1

To explore the operationalization of self-efficacy within primary preservice teachers' reflections on their experiences of science teaching through a thematic analysis approach.

Research Aim 2

To adapt Bandura's Triadic Reciprocal Causation model to explore the factors that contribute to the development of preservice primary teachers' self-efficacy.

Research Aim 3

To explore the application of using a qualitative research approach to inform understanding of the nature (operationalisation) of self-efficacy and the development of self-efficacy through contributing factors.

Figure 3.1: The aims and research questions of this thesis

3.2 Trustworthiness

Denzin and Lincoln (1998, 2003) identify that all research whether influenced by qualitative or quantitative approaches needs to demonstrate its quality through procedures that are suitable for that purpose. In the

case of quantitative research rigor is established through the processes of validity and reliability (Cohen *et al.,* 2007) which is often achieved through statistical processes that others can repeat to confirm the level of quality in the work (Wyatt, 2016). As mentioned in the literature review the correlational links between self-efficacy and other constructs such as teacher burn-out (Skaalvik and Skaalvik, 2014) or teacher persistence in difficult situations (Gibson and Dembo, 1984) has contributed to the continued interest in self-efficacy research. These outcomes are often attributed to the use of quantitative approaches, the quality of which is measured in terms of validity, reliability and generalizability of the findings (Gibbs, 2007). In the context of self-efficacy research statistical approaches have been used to support claims of validity and reliability, in order to show that the questionnaires used to gather the data are in fact measuring self-efficacy (validity), that the processes used in data collection and data analysis can be repeated to obtain similar results (reliability), and that the outcomes can be used in different contexts to predict similar results (generalisability) (Gibbs, 2007). For instance in a study designed by Opperman, Brunner and Anders (2019) involving the assessment of 'preschool teachers' self-efficacy beliefs in teaching science' (Opperman *et al.,* 2019:90), the researchers used statistics to show that in developing their own measuring tool that the 'scale reliability was good' (Opperman *et al.,* 2019:90), as well as making use of descriptive statistics to discuss their results. The impact of this was to reduce the number of questions they used and to limit the available responses that could be given, thus narrowing their focus in order to increase reliability. The question of whether a multi-faceted construct such as self-efficacy along with the process of teaching science, can be reduced to a list of confidence statements relevant across a range of different contexts, has already been raised in the literature review (Labone, 2004), as well as identified as an issue in the pilot study leading to this research.

In contrast to the requirements of quantitative research Denzin and Lincoln (1998, 2003) argue that qualitative paradigms such as constructivism are better assessed for quality through criteria which contribute to the trustworthiness and authenticity of the work. These criteria include credibility, transferability, dependability and confirmability (Lincoln and Guba, 2013). Credibility is the degree to which the findings can be trusted. Transferability refers to the applicability of the findings to other settings. Dependability explores how self-assessment tools that may have been developed could be used in different settings. Confirmability is to what extent the researcher provides an audit trail to justify and explain the methodological decisions and changes made as the process went on. Figure 3.2 summarises how I have adapted these critieria to match the processes I have used.

3.2.1 Application of trustworthiness and criteria to this thesis

Trustworthiness Criteria	Specific links to this research
Credibility	The data is based on the voices of the participants who are preservice teachers. The interpretation uses their words to develop the vignettes, the language is of preservice teachers talking primary science experiences. Participants agreed the transcription accounts which were used to develop the data analysis and findings. The researcher includes a section on her positionality within the research.
Transferability	The findings are particular to this inquiry but are likely to have applicability elsewhere with similarly situated preservice teachers teaching in primary schools, as well as with teacher educators, practitioners and mentors for preservice teachers. The vignettes provide a vicarious experience which in itself has the potential to contribute towards other preservice teachers' self-efficacy.
Dependability	The processes used in the data collection and data analysis procedures are clearly described and supported by the rationale for decisions that were made.
Confirmability	The focus is on using the participant's interviews to develop the vignettes so that their voices are represented in the analysis and findings. An audit trail is included in this research to show how the analysis was developed from the interviews. I kept a number of journals throughout the process of the research in order to explore how my understanding of self-efficacy developed and how this impacted on the choices made. As a reflexive researcher this was ongoing from the beginning of the whole process even at the point of developing the original proposal. Was I good enough to do this, why abandon the mixed methods approach for a single qualitative approach, why did I adapt the semi-structured interview questions as I went along, what led to the development of the analytical tools, how have I developed over the research process itself.

Figure 3.2: A summary chart of how the trustworthiness criteria were applied to this research by the researcher

Having decided on the approach for this thesis and the steps required to assess the quality of the research I then decided to clarify the ontological and epistemological decisions that underpin this thesis and contribute towards the authenticity of this research (Denzin and Lincoln, 1998; 2003).

3.3 Constructivism

The literature review focussed on the use of constructivism as a theory of learning which has had major influences on approaches to teaching science (Harlen and Qualter, 2018). In this section the constructivist paradigm guides the methodological decisions used in this research (Grix, 2010; Lauckner *et al.,* 2012; Adom *et al.,* 2016). Guba and Lincoln (1998) define the research paradigm as 'the basic belief system or worldview that guides the investigator' (Guba and Lincoln, 1998:195) and reflects the researcher's philosophical principles of ontology (how we perceive the nature of reality), epistemology (how we come to know this), and methodology (how we go about finding out what we know). These principles influence the choices made

by the researcher in determining the approach to data collection and data analysis. Guba and Lincoln (1998) discuss the competing nature of the four major paradigms which they list as: positivism, postpositivism, critical theory and constructivism. Positivism is associated with a realist ontology and objectivist epistemology and a researcher working within this paradigm would seek to uncover knowledge and understanding of the world through the use of experimental or large scale survey methods commonly associated with quantitative approaches (Best, 2012). Whereas the constructivist paradigm is linked to a relativist ontology with multiple realities constructed by different people or groups (Lincoln and Guba, 2013). Cheu-Jey (2012) argues that multiple realities can be thought of in two ways. The first that there is one reality but multiple interpretations of it which supports more of a realist approach; the second, more indicative of a constructivist approach, that each person constructs their own reality resulting in multiple realities and interpretations (Crotty, 2013; Cheu-Jey, 2012). Crotty (2013) draws further attention to the relativist nature of constructivism in that when people discuss their experiences they do so relative to the historical, social and cultural environments in which these experiences take place and construct meaningful stories that make sense at that time, though these may alter in differing circumstances. Self-efficacy beliefs are individual, and influenced by personal evaluations of experiences and the contexts in which these experiences occur (Bandura, 1997) which in my view is compatible with a relativist ontology.

Constructivism is underpinned by a subjectivist epistemology in which the participants and the researcher are actively engaged in the process of developing viable and meaningful understandings of their experiences (Denzin and Lincoln, 2003; Charmaz, 2006; Lincoln and Guba, 2013). Doolittle (2003) argues that how this is done is influenced by three main types of constructivism influenced by the work of Piaget (1954), Vygotsky (1978) and von Glasersfeld (1995). Doolittle (2003) discusses that cognitive constructivists, associated with Piaget, seek to create individually accurate representations of experiences. Radical constructivists, associated with von Glasersfeld (1995), seek to create viable and personally meaningful accounts of experiences. Whereas social constructivists, influenced by the work of Vygotsky (1978), develop viable accounts through social interaction and co-construction of experiences. Bearing this in mind I am focussing on a constructivist approach in which meaning-making occurs through engagement with others and their experiences. I am not seeking a 'truth' out there (Stewart, 2010) or co-constructing a narrative (Clandinin and Connelly, 2000; Bold, 2012), but I am seeking to develop an informed interpretation of preservice teachers' experiences to contribute towards a deeper understanding of how qualitative approaches can add richness to self-efficacy research.

3.3.1 The role of the researcher

Constructivists agree that 'meaning is not discovered, but constructed' (Crotty, 2013:42) identifying the role of the researcher as integral to the research process rather than an external onlooker (Adoms *et al.,* 2016). These constructions, both of the participants and the researcher, are not fixed and finite but open to further interpretation (Guba and Lincoln, 1998) providing a very different insight to self-efficacy research from that used in the quantitative approaches outlined earlier. Additionally both the researcher and participants are

integral to the constructivist approach since constructivism acknowledges the major input of the researcher as the 'instrument' (Stewart, 2010:294; Adoms *et al.,* 2016) whose skills determine the credibility and trustworthiness of the research. It is the researcher who makes judgments about what approaches for analysis will be used and how analytical processes used in qualitative research, such as coding and theming are justified and carried out with appropriate rigor (Nowell *et al.,* 2017). Stewart (2010) argues the importance of reflexivity and that in the search for trustworthiness and transparency the researcher needs to signpost their own background as well as the processes and decisions they used through the data collection and data analysis part of the research. These considerations have contributed to the choice of methods used in this research.

3.3.1.1 Addressing my positionality

I am a novice researcher particularly in the qualitative field and whilst my original intention was to do a mixed method approach with all the inherent problems that entails e.g. time, how to link both aspects, qual/quan divide, I focussed on using interviews to explore the experiences and background of participants who were all in their final or only year of an ITT course. Participants were volunteer finalists from undergraduate ITT courses, or PGCE courses as these preservice teachers would potentially be in a position to be thinking about applying for their first teaching post, or who may have already acquired their first teaching role. I am also a lecturer on science modules that these participants had completed or were still in the process of completing. My own background is steeped in teaching science in a variety of schools and with a variety of age and ability groups. I am passionate about finding ways to enhance preservice teachers' experiences of teaching primary science and using these experiences to develop their self-efficacy for future opportunities. Throughout the research process I have kept reflexive notes and these have impacted on changes made as the process has continued.

3.4 Methods used for data collection: Interviews

I have chosen to explore the construct of self-efficacy through a qualitative approach through the use of semi-structured interviews in order to capture past experiences in relation to primary science education, and to explore how these experiences both reflect, and contribute towards self-efficacy. One of the strengths of doing interviews is to capture the voice of the participants (Braun and Clarke, 2013) as this will increase the trustworthiness and authenticity of the research (Denzin and Lincoln, 2018).

The interviewees who I will refer to as participants, come from a range of backgrounds and will have created their own trajectory through their ITT courses. They have a range of experiences to draw on, some of them will have taught primary science, some of them are science specialists and some of them will not have taught primary science, at the point of the interview. Thus each participant has a unique set of experiences to draw on. The interviews took place prior to the pandemic situation of 2020-2022, and thus reflect the type of experiences occurring in schools before the impact of the pandemic.

Therefore, in the process of data collection and data analysis I am looking to understand rather than generate causal explanations about self-efficacy (Charmaz, 2006), to explore how participants share the factors that may influence self-efficacy development, and to capture their multiple realities rather than generate 'systemised knowledge' (Charmaz, 2006:126) further emphasising the use of a constructivist paradigm.

3.4.1 The Interview Schedule

The research interview is carried out with a purpose in mind, in this case to contribute towards knowledge to add to the use of qualitative approaches used in self-efficacy research (Glackin and Hohenstein, 2018). Interviewees have volunteered their time and responsibility to ensure that the process is carried out with integrity (Savin-Baden and Howell Major, 2012; Braun and Clarke, 2013). Designing an interview schedule provides a useful framework to initiate, direct and finish the interview in an appropriate time scale, yet still ensuring that the main purpose of the interview can be achieved. To do this I spent some time making myself aware of the theoretical background around interviews and useful techniques to apply, as well as continuing to add to my theoretical knowledge of self-efficacy in order to ensure that the questions asked were relevant to the research questions set out at the beginning of this thesis.

Brinkmann (2018) makes a useful comment that interviews are not just a research instrument or a social interaction but a combination of both. Interviewees are only ever going to provide partial interpretations of their experiences because they cannot include all the things that have contributed to their interpretation partly because they choose to leave out some detail or that they are unaware of all the things that contributed to the experience. In the interview I want to know about their past experiences with science, their perceptions of these experiences, and how these experiences might contribute to their teaching of primary science.

According to King *et al.,* (2019:7) 'interviewing is one of the most frequently used methods when generating data' in qualitative research and is an opportunity in this research, to ask the participants to share their experiences, ideas and beliefs linked to primary science education and self-efficacy (Braun and Clarke, 2013). Interviews are a form of conversation and are a means of getting to know each other (Brinkmann and Kvale, 2018). Furthermore interviews enable the researcher to probe participants' responses in more depth, which may contribute to the richness of the data being collected (Cohen *et al.,* 2007). There are three basic types of interview: structured, semi-structured and unstructured (Braun and Clarke, 2013). Structured interviews involve using a pre-determined question and response framework and are largely led by the interviewer. In unstructured interviews the interviewer may introduce one or two themes as starting points and encourage participants to explore these ideas in their own way, but with minimal input from the interviewer. Semi-structured interviews fall somewhere between the structured and unstructured approach, such that there is some flexibility to explore participants' responses in more depth as they arise during the interview yet still guide the interview along the lines of the research themes (Braun and Clarke, 2013).

In the case of this research semi-structured interviews were chosen in order to give the participants the opportunity to use their own way of describing their experiences and interpretations of those experiences (Brinkmann, 2018). The flexibility of using a semi-structured approach also provided an opportunity for both participants, the interviewer and the interviewee (myself and the participants), to explore points more fully and to go beyond information-gathering to developing knowledge linked to self-efficacy (Holstein and Gubrium, 2011; Cohen *et al.,* 2007). Although the interview approach can vary whichever style is used, all interviews involve interaction between those involved (Holstein and Gubrium, 2011). This is very different from collecting survey responses based on Likert Scale questionnaires (Cohen *et al.,* 2007) which are completed through self-assessed, individual responses (Enochs and Riggs, 1990).

Whilst interviews may be familiar (Holstein and Gubrium, 2011), there are several issues to consider when choosing this approach. For instance the relationship between the interviewee and interviewer, the nature of the questions to be asked as well as the context in which the interview takes place (Cohen *et al.,* 2007). Braun and Clarke (2013) argue that face-to-face interviews have been considered the ideal way of interviewing but other approaches such as telephone interviewing or online interviewing may be useful in certain situations. In this case all interviews were done face-to-face and individually at an agreed time and place with each volunteer participant. Using individual interviews may have some impact on who chooses to take part, as some participants may feel more confident to share their views and beliefs within a group setting (Braun and Clarke, 2013). I did offer group or individual interviews in order to encourage participation in the research, however, all the volunteers chose to be individually interviewed. Individual interviews provided time to explore and revisit participants' experiences in more detail throughout the interview, and to develop additional points of interest as the interview progressed (Gibbs, 2007). Each interview lasted between 45-55 minutes and I was constantly aware of trying to create and maintain an environment in which the participants felt free to talk about events as they chose (Brinkmann and Kvale, 2018). It became clear that the interview process was not simply about asking questions and getting answers. It was about developing a dialogue between interviewer and interviewee (myself and the participants) which sought to maintain an ethical and professional respect for each other whilst providing opportunities to probe and clarify responses in order to gather knowledge for the research itself (Brinkmann and Kvale, 2018). In this process the interviewer is actively involved in developing meaning with the interviewees during the interview itself (Holstein and Gubrium, 2011). Additionally I felt that the whole process, whilst clearly of benefit to me as the interviewer, should have some benefit for the participants (Savin-Baden and Howell Major, 2012). Therefore, at the end of each interview I asked each participant to comment on the usefulness of the interview process.

The research interview is a specific type of conversation with different roles expected from the participants. So the interviewer may be seen as the active participator, guiding and directing the flow of the conversation and the interviewee might be seen as a more passive participator in the process as they respond to the questions and provide their insights and experiences around the chosen subject area (Holstein and Gubrium,

2011). This is not, however as straightforward as it appears and requires careful planning and thought prior to carrying out the interview. In the case of this research I went through a number of stages in order to set up the interview and encourage participants to take part in the research. The initial stage involved ethical considerations

3.5 Ethical Considerations

One of the ways in which Hammersley and Traianou (2012:16) define ethics is 'the set of ethical principles that should be taken into account when doing social research' which is an integral part of social science research. This research was planned and carried out guided by the General Data Protection Regulation (2018), BERA Ethical guidelines for Ethical Research (BERA, 2018) and the University of Winchester Ethics and Policy Procedures (UoW (academic institution), 2015). Ethical approval was obtained from the academic institution prior to any interviews taking part in order to ensure 'integrity, quality, and transparency' (Hammersley and Traianou, 2012:7). Further information can be found in the appendices. Potential participants were informed about the purpose of the research and how to volunteer to take part via email. Participants were given a project information sheet created by me (Appendix 1), which summarised the purpose of the research. This was referred to again during the interviews to ensure participants were fully informed of what the research entailed, how anonymity and confidentiality would be maintained throughout the procedure, and their right to withdraw at any time without consequence (Best, 2012; BERA, 2018).

Each interview took place at the academic institution at a time and place convenient for the participants and myself. Each participant signed a consent form agreeing to take part. It was explained that each interview would be audio-taped and later transcribed. All data was stored securely on a password encrypted storage device. Each participant received a copy of their transcription once completed and were asked to confirm that it represented the interview appropriately, and that the transcription could be used for the data analysis section of the research. The transcriptions were sent out, using the university password protected system, with an accompanying email which included the following statement: 'If you have already had the chance to teach science on your placement it would be useful to know how this experience went and what impact this may have had on your confidence to teach primary science. You might want to add some information about this on the transcript itself or make an appointment to have a chat' (Follow up email to interviews). Participants were also invited to 'redact any of [their] own commentary at this viewing and/or add additional comments' as indicated in the ethics form (Appendix 1:199), if they chose to, and without obligation. Subsequently several participants chose to include additional commentary by email or in one case by a further interview, based on their placement experiences that occurred after the interviews took place. It can be seen that ethical considerations were involved in the development of the organisational aspects of the interviews to ensure that the participants felt comfortable in taking part in the whole approach and were happy with the processes put in place (Best, 2012).

Ethical concerns arise at each stage of the research process (Savin-Baden and Howell Major, 2012), such as 'the asymmetrical power-relation of the interview' (Denzin and Lincoln, 2018:588) since the whole process of interviewing including the organisation and the interview schedule, is largely within the control of the researcher and may affect how the interviewees respond. Therefore, in preparing for the interviews it was necessary to consider my role as teacher-educator, researcher and interviewer, and what impact this may have on the volunteer participants who would have known me from their courses. At the time of the interviews I was a senior lecturer in science on both the undergraduate and PGCE ITT courses with responsibility for the development of primary teachers particularly with respect to teaching primary science. Therefore, I clearly had knowledge about the requirements of the courses involved and was involved in teaching on the courses. This led to some advantages such as the use of common terminology between the participants and myself. For instance when using the term 'placement' participants knew that this referred to the assessed teaching practices that they were required to do as part of the requirement to be recommended for QTS. Equally terms such as inquiry or hands-on activities were generally used to represent the process of working scientifically, a term used in the National Curriculum for Science (DfE, 2013). On the one hand this meant that more of the interview time could be spent on exploring the experiences and perceptions of those experiences with the participants which was an advantage. On the other hand, because of my role as teacher-educator, participants may have perceived this as a 'test' situation. This could contribute to short responses as well as participants choosing to only present themselves in a positive light, known as the Halo effect (Cohen *et al.,* 2007).

Brinkmann (2018) advises that careful thought and planning are needed to counter these situations and encourage the interviewees to explore their personal experiences more fully and openly. Holstein and Gubrium (2011) argue that there is greater awareness of the interview approach to contribute towards the 'production of meaning' (Holstein and Gubrium, 2011:13) which occurs when the participants are active in constructing meaning during the interview. For instance the interviewee and the interviewer contribute to the construction of meaning and knowledge as the interview progresses. The role of the interviewer is not as an outside participator and the role of the interviewee is not as a fount of all knowledge. They are both 'actively and unavoidably engaged in the interactional co-construction of the interview's content' (Holstein and Gubrium, 2011:14), to a more or less extent.

Therefore, I approached the interview as a professional rapport between two people at different points in their career as this enabled me to step back from my role of teacher-educator and move into the role of researcher and interviewer. My role as researcher and interviewer was to encourage participants to speak and to do this it was important to listen actively throughout the interview (Cohen *et al.,* 2007). So in some cases I repeated back points or summarised points in order to clarify that my interpretation of the participants' responses matched what they thought they had said. This also gave the participants the opportunity to add to, or change my interpretation should they wish to (Brinkmann and Kvale, 2018). At other times I limited my response to 'mmm' or made use of non-verbal responses such as eye contact, to

show that I was listening to the participants but also encouraging them to continue to speak (Savin-Baden and Howell Major, 2012; King *et al.,*2019). Thus the interview itself contributed to the development of knowledge through the interactions between the interviewer and interviewee and the semi-structured approach provided the flexibility to pursue and revisit points of interest (Brinkmann, 2018). After each interview I reflected on how the interview had gone in order to develop my interviewer approach as well as review the interview schedule.

3.6 Data Analysis Journey

Data analysis is an integral part of this research and the processes involved are dealt with in different chapters. In this thesis data analysis occurred through three distinct sections as outlined in

Figure 3.3. Chapter 3 deals with the semi-structured interviews and transcriptions. Chapter four deals with thematic analysis. Chapter five addresses research question one. Chapter six addresses understanding of self-efficacy and research question two.

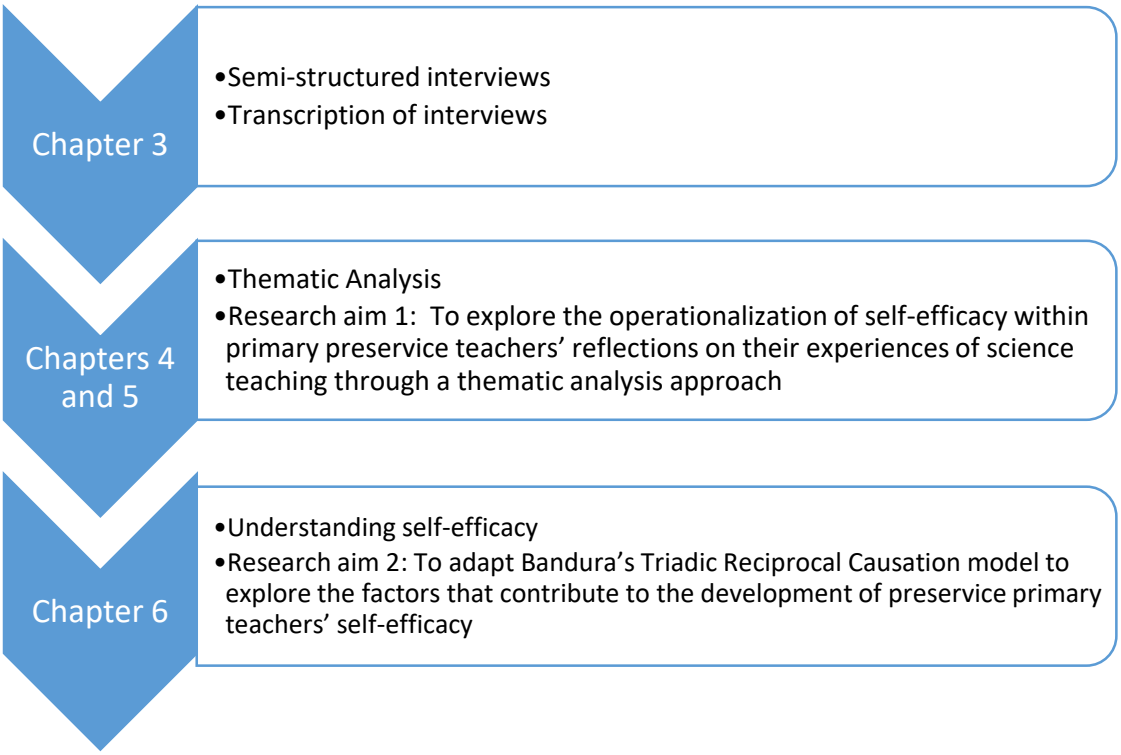


Figure 3.3: Flow diagram to represent the overview of the development of a qualitative approach to operationalisation of self-efficacy

3.7 Semi- structured interviews

I chose semi-strucured interviews because it transpired from the participants in the pilot study that the questions in the proposed Likert survey were open to interpretation and seemed more relevant for secondary science. Therefore, the questions from the Likert Survey (Enochs and Riggs, 1990) were adapted and used to develop a semi-structured interview schedule, more appropriately aimed at primary preservice teachers. The semi-structured interview questions were organised to enable participants to talk about their experiences as they chose to, as well as to inform the research purpose of exploring aspects of self-efficacy

through a qualitative and interpretive approach. Observations did form part of the original plan but the pandemic of 2020-2021 meant that these were unable to be carried out. Some participants, however, provided additional information via a second interview or emails to talk about their placement experiences of teaching science after the initial interview, which provided evidence to show how self-efficacy could develop over time.

The audio tapes obtained from the interviews, were transcribed and analysed at a later date to seek out themes and elements that were associated with self-efficacy. The semi-structured approach allowed for flexibility within the interview and I would agree with Braun and Clarke (2013) that data analysis starts from the point of carrying out the interviews. Each interview was transcribed and then sent to each participant for verification and agreement for use with this thesis

Semi-structured interviews, of under an hour, were completed with 11 volunteer participants over a period of time from May 2019-Feb 2020. The participants were all preservice teachers who were in their final, or only year of teacher training at a university, as indicated in Figure 3.4. In the first column of Figure 3.4 the participants are given a Group Letter but this is only to show that the participants were at different points in their course and on different courses, at the time of their interviews. There was no intention to make comparisons between groups at this stage because this research is being used to contribute insights into using qualitative approaches in self-efficacy research, however, this did add to the range of experiences shared by the participants who volunteered to be interviewed.

The different groups happened by chance since they were partly influenced by convenience and willingness of participants to take part in the research (Cohen *et al.,* 2007). For instance Group A was made up of three preservice teachers who had finished their respective courses and had teaching posts in place for their first teaching post, whereas Group C were made up of finalist students on a three year course leading to a B.Ed (Hons) course in Primary Education, who were all science specialists (SS). I found the use of labels rather than pseudonyms a useful means of separating myself from each of the participants, all of whom I had taught at some point during their courses. Therefore, throughout the data analysis the participants will be referred to by their participant identification code e.g. C1. This code was assigned to each participant in the order that the interviews took place and has no other specific relevance. As indicated earlier the same approaches for analysis were applied to each interview and this forms the main outcome of the research. However some participants also sent emails sharing their placement experiences following the interviews and one participant, C4, did a second follow up interview after completing her first placement in school (SE).

Group	Course title and point at which the participant(s) are being interviewed	Participant Identification code	Date of interview
A	Courses completed: BEd/BEd/MEd/ PGCE Interviewed before taking up teaching post	C1 C2 C3	June 2019
B	PGCE before first assessed teaching placement	C4 C5 C6	Oct. 2019 C4 second interview Feb. 2020
C	Y3 SS undergraduates before final assessed teaching placement	C7, C8, C9, C10	Nov. 2019
D	Y3 Non SS undergraduate before final assessed teaching placement	C11	Dec. 2019

Figure 3.4: Table summarising the different groups of interview participants

3.8 Transcription of interviews

Initially I transcribed the interviews but in later ones I used a transcriber due to time issues (Saldana, 2016). In this section I will pick up on a few insights into the process. Each transcription that I did required 10 hours of work (Denscombe, 2014). Whilst doing the transcription I was able to frequently check the interview and record what was said as accurately and consistently as I could in order to reflect the participant's voice (Best, 2012). This also began the process of analysis and familiarising myself with the data (Braun and Clarke, 2013). Additionally I generated a few rules for recording such as labelling myself as B: to distinguish myself from the interviewee who was recorded by their number, for instance 2: rather than using pseudonyms (Saldana, 2016). Consistency in spelling mattered and the pilot transcriptions and literature (Glackin and Hohenstein, 2018) influenced me to use the term and the spelling 'preservice teachers' for each of the participants.

Transcription had further issues in that recording a conversation down on paper does not capture the nuances of the conversation between two people exactly, but does attempt to provide as accurate an interpretation of what was said as possible (Saldana, 2016). Whilst I tried to capture moments when laughter took place or particularly long pauses occurred in the interview I realised that this was not a focus for my data analysis and in later transcriptions these were not recorded so much. Using a transcriber did save time, however, as the transcriber was another step away from the interview itself there were a number of 'typo 'errors and incorrect words recorded and so I spent another two hours on each of these interviews to adjust the transcriptions and provide a more accurate, but still interpretive, record of the interviews (Saldana,

2016). This time was useful as it gave me a chance to listen to the interviews again and start to build up ideas for further data analysis (Braun and Clarke, 2013).

Once the transcripts were completed and stored safely in a password protected stand alone computer, I uploaded each one to NVivo 12 pro. This is a qualitative data analysis package, in order to do CAQDAS (computer-assisted qualitative data analysis), which still requires the researcher to analyse the data yet also provides a means to manage, store and retrieve large amounts of data as needed during the data analysis process (Denscombe, 2014). Bazeley (2008) criticises the use of CAQDAS for distancing the researcher from the data and overfocussing on coding for data analysis. Braun and Clarke (2013:220) suggest that CAQDAS is only a tool in the researcher's data analysis kit, and does not replace the researcher in the process who must still be 'critical, thoughtful, creative and flexible' (Braun and Clarke, 2013:220).

As a first-time user it required some time to learn how to use NVivo 12 pro and its potential for analysis which inevitably added to the time required to data analyse the semi-structured interviews used (Saldana, 2016). Despite this I opted to use CAQDAS in order to keep a record of the processes involved in data analysis. It provided a systematic and organised approach to ensure credibility and trustworthiness, important criteria for qualitative analysis (Denscombe, 2014). NVivo 12 pro has a range of functions to support thematic analysis (Braun and Clarke, 2013) including coding procedures, word frequency charts and a query facility to analyse relationships between codes. I used some of these features, such as word clouds, although not all since I was aware that it was important to retain the voices of the participants in order to develop the analysis through a qualitative rather than a decontextualized quantitative approach (Nowell *et al.,* 2017).

Interviewing took place over seven months between May 2019 and November 2019. Transcribing and transcription approval took place over ten months between June 2019 and March 2020 as shown in Figure 3.5.

Participant	Interview Date	Transcription approval received
C1	May 2019	June 2019
C2	May 2019	July 2019
C3	May 2019	August 2019
C4	October 2019	January 2020
C5	October 2019	January 2020
C6	October 2019	February 2020
C7	October 2019	March 2020
C8	November 2019	March 2020
C9	November 2019	March 2020
C10	October 2019	March 2020
C11	November 2019	March 2020

Figure 3.5: Timeline for interviews and transcription approval

3.9 Reflection and Reflexivity

3.9.1 Reflections of my role as researcher and the processes I have used

I chose to use a constructivist approach rather than a social constructivist approach (Crotty, 2013) within this research. This is because I made the decision to develop the analysis from what was said in the interview and recorded in the transcript. Self-efficacy is a dynamic construct which may change in differing circumstances (Bandura, 1997) and I wanted to capture what the participants were thinking at the time of the interview not at a later date when their own experiences would have moved on. The participants are also constructivists because they are sharing their own versions of their experiences and the assumption is that their accounts are honest and trustworthy (Nowell *et al.,* 2017). Credibility was enhanced through ensuring that participants had the opportunity to address my understanding of their comments. For example, through the interview process there were moments of co-constructing understanding, such as around the meaning of self-efficacy, as well as checking that the participants agreed with my interpretation and summary of their experiences. Each participant approved their specific transcript as being an accurate copy of what was said in response to the questions asked. Some participants provided additional material which reflected science teaching that had occurred after the initial interviews. Therefore, the interviews provided the main source of

data for developing the outcomes of the research, as well as contributing towards adding insights to the use of a qualitative approach for addressing research into self-efficacy. As the researcher, I identified myself as the meaning-maker of individual accounts about experiences that may contribute to developing self-efficacy (Savin-Baden and Howell Major, 2012), but this is only one type of interpretation that I chose to use within this research. Others may choose to interpret the outcomes differently.

As I did not get the participants to agree my interpretation, this may be considered to be a weakness in the design of the research, however constructivism is underpinned by a relativist ontology in which no one reality exists out there (Denzin and Lincoln, 1998). Therefore, my interpretation represents the reality as I perceived it at the time of doing the analysis, which may well have been different if the interviews had been done at a later date. However, as stated earlier, what becomes important here is that I acknowledge why I am in a position to be able to provide a trustworthy interpretation. This is partly because my own training shared some similarities with the participants. Additionally I interviewed participants who I had previously taught, and some participants who were still actively on courses that I would continue to contribute to after the interview. Therefore, there was some expectancy that both the researcher (myself) and the participants shared an understanding of the constructs and professional experiences associated with ITT courses. This had some advantages but also some issues. For instance the interview questions were designed with the assumption that the participants were using a shared language associated with primary science teaching. The advantage of this meant that I could ask more perceptive questions to probe participants' responses during the interview, but it could also impact on how I asked the questions and direct participants to answer in a specific way (Oppenheim, 1992).

3.10 Summary

In this chapter I have outlined the rationale for choosing a qualitative approach situated in a constructivist paradigm. I have outlined the thought processes I used to account for the trustworthiness of the research, the applicability of constructivism towards researching self-efficacy, the ethical concerns that needed to be addressed and my role as researcher. I have outlined the rationale behind using semi-structured interviews as the prime data collection process and introduced the tools used for data analysis. In the next chapters I provide further detail about the research methods and processes used in order to contribute to a clear audit trail about the decision-making processes that led to the outcomes of this thesis.

CHAPTER 4 - Thematic Analysis

As indicated in

Figure 3.3 the data analysis journey occurred over three distinct sections. Chapter three dealt with the interviews and transcriptions, and this chapter focusses on thematic analysis and the decisions and processes that were undertaken to analyse the interview data into codes, sub-themes and themes (Braun and Clarke, 2006) to identify indicators for the operationalisation of self-efficacy.

Teddlie and Tashakkori (2009) argue that researchers should 'carefully describe how they measure theoretical constructs' (p.65) in order to operationalise the concept under scrutiny. In the literature review I have raised awareness that self-efficacy and teacher efficacy are defined in many ways leading to 'a lack of clarity about the concept' (Markova, 2021:2) resulting in researchers developing a number of different scales and numerical measurements of self-efficacy. According to Wyatt (2015) this has contributed towards some key problems in self-efficacy research which has relied largely on quantitative approaches. In this research the focus was to explore self-efficacy in the context of primary science, through the experiences and beliefs of the participants in this study. Therefore, one of the aims of this study was to explore the operationalisation of self-efficacy within the context of qualitative research through developing credible criteria (Denzin and Lincoln, 1998; 2003) as outlined in Section 3.2 of the methodology section. The data analysis process, begun in chapter three, is an important aspect of any research since it enables the researcher to demonstrate the outcome and quality of their work (Braun and Clarke, 2013; Maguire and Delahunt, 2017). In this chapter detailed discussion about the data analysis procedures used are included in order to further exploration of the potential contribution of qualitative approaches to self-efficacy research in the context of education (Labone, 2004).

As shown in the methodology section, qualitative research demonstrates quality through the trustworthiness of the procedures and processes used by the researcher (Gibbs, 2007; Nowell *et al.,* 2017). The researcher is 'inextricably part of the social reality being researched' (Grix, 2010:84). Thus it is up to the researcher to provide a clear rationale for the decisions made regarding the data collection and data analysis processes used, and to identify how the researcher contributes to the whole process (Stewart, 2010).The researcher is as much part of the process as the data provided by the participants and through reflexive processes should constantly review what they know and how they know it (Stewart, 2010). Throughout this chapter I hope to make the processes used for analysis transparent in order to establish the trustworthiness of my interpretations and outcomes from the data analysis which is underpinned by thematic analysis, an approach I have chosen to provide a bridge between quantitative and qualitative approaches (Braun and Clarke, 2006; 2013).

In this chapter I illustrate how I used the thematic analysis framework as outlined in Braun and Clarke (2006) to operationalise self-efficacy through the development of themes, sub-themes and associated coding. The sub-themes provided indicators of the operationalisation of self-efficacy inductively through the participants'

voices, and were supported deductively from theory, by similar sets of indicators such as those from Klassen and Durksen (2014) as shown in section 2.5.1.

4.1 Thematic analysis of interviews

The interview data collected in this study was analysed using thematic analysis. Willig (2013) defines thematic analysis as 'a method for recognising and organising patterns in content and meaning in qualitative data' (Willig, 2013:57). Braun and Clarke (2013) argue that whilst thematic analysis is not tied to any particular philosophical position, the researcher needs to clarify their theoretical and epistemological views as this impacts on how it is used (Willig, 2013).

Thematic analysis relies on coding raw data and generating themes from this (Braun and Clarke, 2006). While it is possible to use the coding process to generate word frequency counts sometimes more associated with content analysis (Cohen *et al.,* 2007), it is used in this thesis to generate themes which enabled me to 'examine the perspectives' of different participants (Nowell *et al.,* 2017:2), using a flexible approach guided by the work of Braun and Clarke (2006; 2013). Willig (2013) advises, however, that themes are not always easy to clarify or create, whilst Braun and Clarke (2013) argue that the process should aim for an analytical interpretation of the data rather than summarising the data into condensed packets of information. The flexibility of thematic analysis, whilst a strength, can also be seen as a criticism since it can lead to 'inconsistency and a lack of coherence when developing themes' (Nowell *et al.,* 2017:20). The decision to use thematic analysis in my research was underpinned by the work of Fereday and Muir-Cochrane (2006) who demonstrated its flexibility through using a hybrid approach of inductive and deductive analytical approaches.

Braun and Clarke (2006) argue that thematic analysis is a particularly useful approach for first time researchers, such as myself, seeking themes within the data and suggest using a 6-phase approach as outlined in Figure 4.1. This contributes towards the trustworthiness and transparency of the research by providing a systematic and auditable trail of the process used in the analysis section of the thesis (Nowell *et al.,* 2017; Lincoln *et al.,* 2018). Figure 4.1 summarises the steps involved in each phase of thematic analysis (Braun and Clarke, 2006:87; and Nowell *et al.,* 2017:4) and how this was interpreted for use in this research.

Phases *(Headings from Braun and Clarke, 2006:87)*	**Description of the process** *(Headings from Braun and Clarke, 2006:87)*	**Interpretation of each phase with relation to this thesis in note form**
1. Familiarising yourself with your data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.	Data collected via semi-structured interviews. Each interview transcribed. Transcription process involved close working with interview data and listening again and again to the data. Initial ideas impacted on subsequent questions used in following interviews.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire	Used NVivo 12 pro to generate word clouds for each interview. This supported open coding of interesting ideas linked with science, science teaching,

Phases *(Headings from Braun and Clarke, 2006:87)*	**Description of the process** *(Headings from Braun and Clarke, 2006:87)*	**Interpretation of each phase with relation to this thesis in note form**
	data set, collating data relevant to each code	being taught science, memories and experiences which might provide cues for the operationalization of self-efficacy. Coded using a mixture of data-driven ideas and theory-driven ideas. Braun and Clarke (2006:89) suggest coding for as many patterns as possible. At this stage, extracts can be coded in many sections, and the process of coding should be open and clear. Coding sheet generated using NVivo 12 pro but also manually created codes from reading through the transcripts
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.	Recursive process used between Phases 2 and 3. Rather than doing all the data before searching for themes I focussed on the interviews in small groups. So initially began with C4, C5 and C6 first. These were all PGCE interviewees who had yet to go on their first placement on the course. Coded each interview into initial codes and added additional codes from new interview. After completing this for C4, C5, and C6 went through collating codes together to reduce, refine process and create categories and progressed from there.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.	Focussed on self-efficacy themes initially though other thematic areas emerged. Some of my ongoing thoughts at the time: Background/ Influences/ Beliefs Subject specific pedagogy/ subject knowledge/ Layers of self-efficacy Focus on layers of self-efficacy codes suggests that I am not finding new/different outcomes to quantitative results at this stage. Have decided to break layers of self-efficacy into: Understanding of term Evidence of indicators associated with self-efficacy Experiences that may influence self-efficacy. Feelings about these influences on self-efficacy Miscellaneous. However it is leading me to look at self-efficacy more holistically especially as interviewees do not use the language of self-efficacy or focus on individual points when discussing their memories. Explore the use of thematic maps but not sure if I will use them.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis told, generating clear definitions and names for each theme.	In the context of this thesis the focus of the themes were linked to self-efficacy theory.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.	A focus on key themes and sub-themes as indicators, which were found both through this analysis and from previous research in self-efficacy. Development of vignettes to address research aims.

Figure 4.1: Interpretation of Braun and Clarke's (2006:87) six-phase framework for thematic analysis with notes showing how I applied it to this research

4.1.1 Familiarising yourself with the data

The process of familiarising myself with the data began in the interview itself as I made notes during it so that I was able to return to or probe ideas more fully following the interview (Brinkman and Kvale, 2018). This activity continued into the transcription process which involved listening and playing back the interview tape many times in order to provide as accurate a representation of the interview as I was able to. Transcription involves some interpretation since there are several issues which become apparent as the transcript is created. For instance in all the interviews the participants did not talk in full sentences and went from one idea to another in a free flow of ideas. Therefore, I made a decision not to focus on grammatical accuracy but to capture the flow of conversation between myself and the participants (Saldana, 2016).

Some early impressions from listening to the initial interviews and looking at the transcripts, identified that the term self-efficacy was not clearly, if at all understood. I have since realised the importance of this finding which impacted on the way the subsequent interviews were carried out and, how I considered ways of operationalizing self-efficacy through indicators of self-efficacy. The interviews and transcripts of those interviews highlighted that the participants understood the term confidence more readily than the term self-efficacy. This influenced subsequent interviews in that I chose not to focus on the term self-efficacy until the very end of the interview when I found it was useful to provide participants with a brief summary of what self-efficacy meant and asked them to consider whether they could relate to it having discussed their own experiences beforehand. This seemed to work well and participants were able to estimate their self-efficacy in relation to future practice whilst reflecting on the ideas that they had shared in the interview. This highlighted the importance of familiarising myself with the data as soon as I started to collect interview data and continued as I re-listened to recordings in the process of developing the transcripts of each interview (Nowell *et al.,* 2017).

4.1.2 Generating initial codes

In this phase I initially generated codes through manually going through the transcripts as shown in the extract in Figure 4.3. The colour-coded parts of the interview were assigned to particular descriptors influenced by advice on coding from Saldana (2016). The key for the colour coding for initial codes is in Figure 4.2.

Colours	**Descriptions identifying what colour codes were seeking**
Yellow	Using exact phrases used by participants
Purple	Emotional responses shared by participants
Red	Influential modellers both positive and negative
Green	Actions participants undertook to support their understanding of science

Figure 4.2: Key for colour coding for initial codes

For instance, I used yellow highlights to identify exact phrases or words used by the participant in the interview in relation to his/her own background and views towards science. I also looked for other ways of coding and identified emotive responses to science such as enjoyment, highlighted purple. I identified experiences that had had a positive or negative influence on the participant in terms of science which are highlighted red and titled influences (Saldana, 2016). In the initial round of coding I tried to be as open about coding as possible and chose to opt for an inductive approach working from the data itself (Gibbs, 2007). However, I also needed to ensure that the research questions were addressed and this led to engaging in the process of using a spiral inductive and deductive approach (Cresswell, 2007). Deductive coding was used in order to seek out constructs associated with self-efficacy research and thus I moved to coding that drew on themes from literature (Braun and Clarke, 2013). I also made notes and have included an example of a memo in Figure 4.3.

Transcript from C1	**Coding Headings**
C1: Ok. Well I've always been a very curious person, that's what I like to carry forward into my practice. I was always quite good at science. I was quite er an academic student. At GCSE I got an A*s in chemistry and physics, an A in biology. I got a B in A level Chemistry so I've been quite engaged in science all through my studies, before I came to the university. Um I really enjoyed GCSE science, not so much A level but that was more due to bad teachers rather than not enjoying the material. Um yeah it's always fascinated me. Even outside the standard biology, chemistry, physics I think that just having more of an understanding of how the world works and things like that um have always been encouraged in my family. My brother's a geographer, he's studying vulcanology of all things so we're very scientifically inclined and it's always been encouraged by my parents, for me to get involved. I used to do like little science projects in the summer holidays and things you know so…	Exact Phrases: Very curious person, quite good at science, an academic student, quite engaged in science, really enjoyed GCSE science, it's always fascinated me Emotion Coding: Engagement Enjoyment Fascination Influences *Negative influence*: bad teacher affects enjoyment but not the enjoyment of the subject material *Positive influence*- family- role model, involvement Action Coding: Completing science projects, having more of an understanding of things carrying forward own traits into practice achieving recognised exams **Memo:** This student has very positive attitude to science supported by family. She identifies particular personal qualities which are implicitly linked with being able to do science e.g. curiosity, enjoying what was studied, distinguishing between different subject areas in science and linked to science, as well as being involved in science in and out of school. It is interesting to note that though her A level teachers reduced her enjoyment in science It did not stop her enjoying the science content and passing the required exam. In this case this participant is demonstrating a positive self-efficacy in reflection in that she believed in her ability in science to see her through the exam situation regardless of the type of input she received.

Figure 4.3: Example of initial coding using C1 as an example influenced by Saldana, 2016

Decisions about what to code and changes in coding occurred over time in line with my developing understanding of self-efficacy. I used some extracts in more than one code as the content might be interpreted in more than one wayas this was both an acknowledgement of the constructivist approach (von Glasersfeld, 1995), and the subjective nature of coding (Braun and Clarke, 2013). As more data was added I moved from manual coding to using NVivo 12 pro because of the convenience and flexibility of being able to

store and revisit all the transcripts and to enable the complexity of coding used in the data analysis approach (Gibbs, 2007). This impacted on code headings. For example, I changed the emotive coding heading linking to extracts that showed engagement or enjoyment, to affective coding heading. The affective coding heading was related more directly with the research question concerned with influences affecting self-efficacy as well as reflecting the language of Bandura (1977). Using Nvivo pro 12 I initially created 34 codes which increased to 84 codes once all the interviews had been coded. I then went back on the initial interviews and checked them against the final total of codes.

Figure 4.4 shows an example of an initial coding sheet exported from NVivo 12 pro. It summarises some of the initial codes and notes that I used to look for factors and influences which contribute to self-efficacy, in the context of experiences with science. Codes such as 'activity leads to children raising questions' and 'inquiry active science learning with children' were created to gather chunks of data (Saldana, 2016) from the interviews to show the participants use and views of the constructivist approach to teaching science (Biesta, 2016; Harlen and Qualter, 2018).

Some intial coding was carried out to broad themes such as experience, with a view to further refine these broader themes into specific types of experience that the participants shared in the interview. I also included a code referring to each of the participant's 'belief about me as the researcher' in order to capture any interview responses which might provide evidence of potential researcher impact on the findings such as the 'Hawthorne effect' (Cohen *et al.,* 2007). As I coded I made notes as a reference to the steps taken and the rationale behind my choices. For instance, an example of code convergence was that I initially used two separate codes related to identifying priorities for teaching science: 'goal setting' and 'targets'. These codes were then combined and the code name was developed based on Charmaz's (2006) idea of using code names that involved being actively engaged such as the code, 'choosing goals for future practice'.

Code	Description and notes made during coding
Activity leads to children raising questions	Evidence of constructivist approach active learners asking questions.
Inquiry active science learning with children	Refers to children doing science activities using primary resources e.g. rocks not pictures of rocks. Done in a range of environments. Practical investigations inquiry working scientifically
Experience	Anything related to experience –will need refining
Experience as a student	References to experiences of science as a school pupil. References to experience gained in part-time job as a student. Need to distinguish between school pupil and student beyond school e.g. university.
Belief about teaching primary science	Reflects on experiences that may impact on teaching primary science
Choosing primary teaching	Own decision based on experience/Own decision based on encouragement by others
Affective	Feelings linked to personal responses to being taught/ to teaching/ to subject areas. May do this more fully by separating into sections about reaction towards being taught and reactions towards teaching science.
Belief about me the researcher	Comments referring to the role of the researcher.

Figure 4.4: Example of early codes exported from NVivo 12 pro

It was also possible to generate word clouds of commonly used words using the query setting on NVivo 12 pro. Using only the words used by the participants and excluding my own commentary, I was able to create word clouds for each participant. These word clouds summarised the frequency of words used by the participants which were longer than six letters long, thus eliminating words such as 'the' as well as 'and'. This was done to seek further useful coding areas which I may have missed. In the example for C4 shown in Figure 4.5 this generated a code which showed links between science and geography which I subsequently coded as 'linking science to other subjects'.

As I had used a semi-structured interview schedule, which was adapted partly to acknowledge where the participants were in their ITT courses, I chose not to use the word clouds to make comparisons between

participants since the clouds reflected the focus of each individual interview. However, they were useful in picking up additional areas for coding.

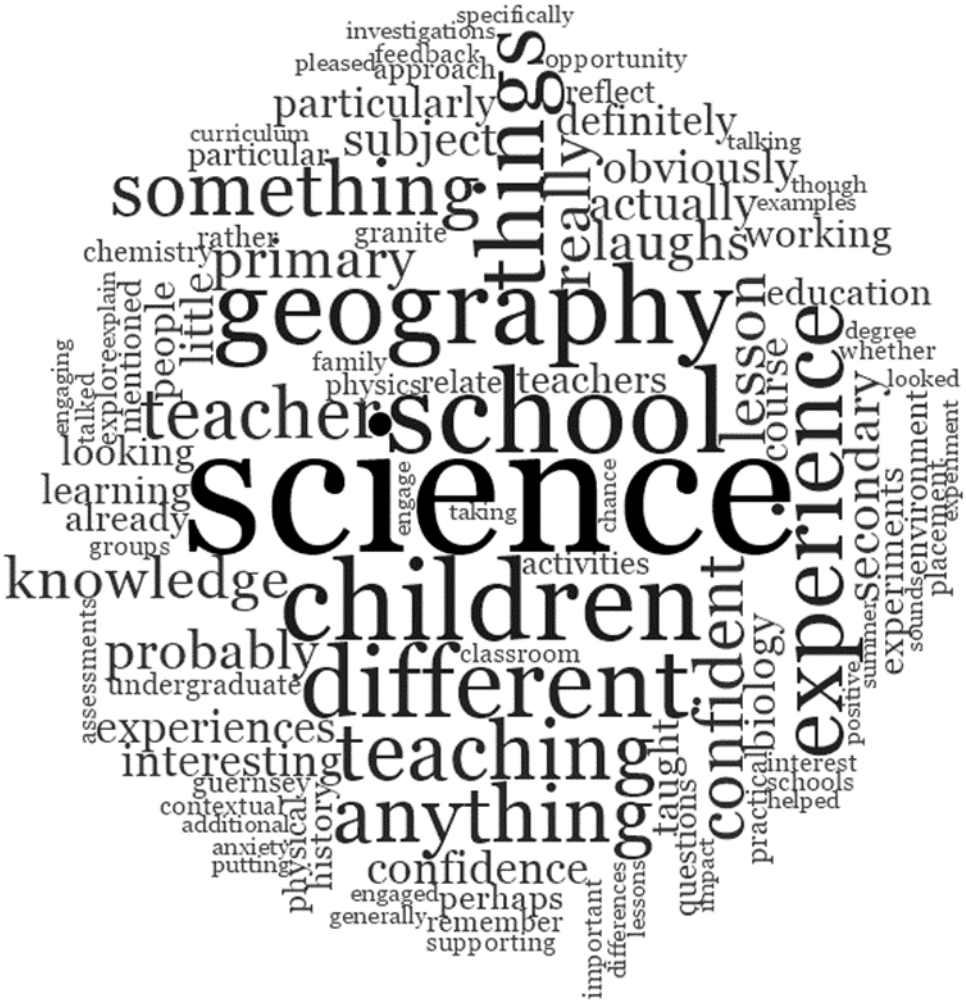


Figure 4.5: Word Cloud summarising the most frequent words used in C4's interview

The coding process was ongoing from August 2020, with the majority of it being carried out between March 2020 and February 2021. During this period of time my theoretical knowledge of self-efficacy grew and I then also used this knowledge to further review coding. Figure 4.6 illustrates the initial coding process with the final list of codes. I began with 34 codes initially and this increased to 84 codes once all the interviews had been coded.

Initial Codes	**Final Codes**	**Number**
	active science learning with children	1
activity leads to children raising questions	activity leads to children raising questions	2
affective	affective	3
	aspirations for teaching science	4
	assessment	5
	basic science	6
belief about me the researcher	belief about me the researcher	7
belief about teaching primary science	belief about teaching primary science	8
	children's understanding of science	9
	children's views of approach	10
children working in groups	children working in groups	11
choosing primary teaching	choosing primary teaching	12
	confidence	13
	constructivist approaches	14
	encouraging children to explore	15
	engaging children using own ideas for recording	16
	enthusiasm	17
	evidence of resilience	18
	evidence of self-motivation	19
	evidence of some risk taking	20
	evidence of teaching leading to increased confidence	21
experience	experience	22
experience as a student	experience as a student	23
	exploring self-efficacy	24
	feedback from children you have taught	25
	feedback from link tutor	26
feedback from modelled lesson	feedback from modelled lesson	27
feedback from teacher model mentor	feedback from teacher model mentor	28
feelings re: going to teach primary science	feelings re: going to teach primary science	29
	having time to teach science	30
	helping children to persevere	31
	holiday jobs whilst on course	32
	I can	33
identifying that learning had taken place	identifying that learning had taken place	34
influence of course	influence of course	35
	influences on subject	36
	influential modellers	37
lack of confidence	lack of confidence	38
linking science to other subjects	linking science to other subjects	39
	making connections between different areas to science and science teaching	40
	managing behaviour in science	41
	memorable Topics	42
memories	memories	43
reflection		43a
thinking		43b
modelling a lesson to peers	modelling a lesson to peers	44

Initial Codes	Final Codes	Number
	modelling to children	45
not taught primary science	not taught primary science	46
	own observation in schools lesson	47
	observation of a lesson	48
organisation	organisation	49
own background	own background	50
	perseverance	51
	personal	52
	placement experience	53
	planning with others	54
	potential tensions	55
pre-placement experience	pre-placement experience	56
primary science	primary science	57
qualification	qualification	58
qualities of a good teacher-beliefs	qualities of a good teacher-beliefs	59
	resilience	60
science	science	61
secondary science	secondary science	62
seeking support	seeking support	63
	seeking ways to enhance children's engagement with science	64
self-efficacy definition	self-efficacy definition	65
	sensitivity to environment and children	66
	sharing the wow with children	67
similarity between primary and secondary	similarity between primary and secondary	68
subject knowledge	subject knowledge	69
	subject specific pedagogy	70
	suggestions for future work on course	71
	support provided by new school	72
targets	targets	73
	teacher-led activities	74
	teaching in a laboratory	75
	teaching in a primary classroom	76
	teaching in a specific environment like a science fair	77
	teaching more important than observing	78
	teaching outside	79
	teaching the same topic to different year groups on different placements	80
	tvinput	81
	usefulness of interview	82
	using others' plans to teach	83
	working with support of teacher mentor	84
34 initial codes from C4 24th August 2020		Saturation of coding 84 codes after all interviews coded Feb. 3rd 2021

Figure 4.6: List of initial and final codes

Nowell *et al.* (2017:1) state that 'researchers must demonstrate that data analysis has been conducted in a precise, consistent, and exhaustive manner through recording, systemising and disclosing the methods of analysis with enough detail to enable the reader to determine whether the process is credible'. Throughout the coding process I kept notes to systematically apply the codes to the interviews. I also kept notes to provide a rationale for why some codes were merged together. I revisited the interview data frequently to ensure that the coding had been applied consistently, adding to the coding table until saturation of codes had been reached and no additional codes were found (Charmaz, 2006). Once I had completed the coding as in Figure 4.6 I continued to focus on the processes used for theme development.

4.1.3 Searching for themes

The purpose of thematic analysis is to seek patterns in the data (Braun and Clarke, 2013) and to reduce the number of codes into themes and sub-themes or categories. Initially, I scanned through the codes and merged similar ideas together to refine the coding. For instance, the code 'using other teachers' planning' was merged with 'using others' plans to teach' to incorporate the range of ways in which participants collaborated in the planning process. This meant that I could include extracts in which participants referred to using peers' planning or using school planning, without specifically limiting it to teacher planning.

Rather than wait until I had coded all the data from the interviews (Braun and Clarke, 2013) I used a recursive process between the phases for thematic analysis shown in Figure 4.1 and worked on groups of interviews using the groups shown in Figure 3.4. This was done because I found that coding the interviews could easily result in 50 or more codes which can be difficult to manage as a lone researcher, and difficult to keep linked to the voice of the participants, a criticism of thematic analysis and CAQDAS (Saldana, 2016).

I initially coded Group B which contained the three PGCE participants who were about to go on their first placement and therefore, were the group most likely to have had least classroom experience, compared with the other groups referred to in Section 3.7, Figure 3.4. Therefore I anticipated that this group would have the least number of codes related to self-efficacy development for teaching science. Coding of transcripts from Group B resulted in the initial set of codes which I then used to sort sub-themes and initial themes. This was then followed by coding of Group A which consisted of three participants who had all finished their course and were about to start their first teaching posts which they referred to as NQT (Newly Qualified Teacher) year. Group A were the group to have had the most experience in teaching though not necessarily in teaching science. Therefore I anticipated that this group would have a greater number of codes related to self-efficacy development for teaching scienc. I then coded the transcripts for Group D which comprised of a single participant with art as her specialism and limited science teaching experience. Finally I coded the transcripts for Group C which contained a number of science specialist participants who were likely to have had the most science teaching experience. The grouping of the participants in this way helped in the coding process but was not intended for use in making comparisons between participants since the purpose of the

research aims was to inform understanding of the operationalisation of self-efficacy and the development of self-efficacy through a qualitative approach.

Initially I coded the interviews through open coding (Saldana, 2016). Then I sought ways of merging codes together to create ideas for sub-themes, followed by grouping the new codes into initial themes (Braun and Clarke, 2006) as can be seen in the examples in Figure 4.7. Some of these initial themes such as Background included sub-themes such as 'enthusiasm' and 'feelings re: going to teach primary science' which I later merged and placed in a potential sub-theme called 'affective responses to science' which was directly related to factors and influences associated with self-efficacy according to Bandura (1977; 1997). I arrived at the initial ideas for sub-themes and themes by exploring ways of grouping the codes to reflect the research aims. Figure 4.7 shows a very early attempt showing the initial ideas I had for developing sub-themes and themes, whilst coding was still ongoing and naming still in development. Once coding had finished I revisited and refined the themes and sub-themes several times.

Potential ideas for themes or sub-themes	Potential ideas for initial grouping of codes to create ideas for sub-themes using NVivo 12 pro
Subject specific pedagogy	activity leads to children raising questions
	children working in groups
	assessment
	identifying that learning had taken place
	organisation
	active science learning with children
	constructivist approaches
	children's views of approach
Background	own background
	qualification
	experience
	memories
	not taught primary science
	experience as a student
	feelings re:going to teach primary science
	enthusiasm
Influences	choosing primary teaching
	pre-placement experience
	influences on subject
	influence of course
	experience as student
Beliefs	qualities of a good teacher
	belief about me the researcher
	belief about teaching primary science
Subject knowledge	similarity between primary and secondary
	secondary science
	primary science
	science
	basic science
	linking science to other subjects
Layers of self-efficacy	definition
	I can…
	lack of confidence
	potential tensions
	evidence of resilience
	perseverance/persistance despite setbacks
	evidence of self-motivation
	seeking support
	targets became choosing goals for future practice
	goal setting became choosing goals for future practice
	modelling a lesson to peers
	feedback from modelled lesson
	influential modellers
	feedback from teacher model mentor
	tvinput-modeller
	affective
	feelings re: going to teach primary science
	enthusiasm
Cross-curricular	linking science to other subjects
Children autonomy	children's views of approach

Figure 4.7: Initial stages in the process of considering ways of grouping codes for themes and sub-themes

4.1.4 Reviewing themes

The procedure for reviewing and refining themes developed through the coding process, section 4.1.3, and required ongoing reflection with the research aims, in particular the factors that might contribute to the participants' self-efficacy beliefs and why the participants might aspire to these particular beliefs. Through this process I referred back to the aspects of the literature review relating to indicators associated with self-efficacy such as the work by Glackin and Hohenstein (2018) and Klassen and Durksen (2014) as well as

Bandura (1977; 1997). To illustrate this I will use the example of 'layers of self-efficacy', as seen in Figure 4.7. Initially I intended to create a potential theme of 'layers of self-efficacy' and it contained a number of codes. Figure 4.8 illustrates how I began to group the codes in 'layers of self-efficacy' together. However, influenced by the focus of the research aims I later placed 'layers of self-efficacy', 'influences' and 'subject knowledge' into one of the main themes called 'indicators of self-efficacy and factors that influence self-efficacy', shown in Figure 4.9. This resulted in a large number of codes in the main theme, which were then regrouped to form a number of sub-themes reflecting specific characteristics. For instance, in the final sorting of the codes for 'indicators of self-efficacy and factors that influence self-efficacy', I grouped all the codes referring to feedback together. It is not a straightforward process and I have included this example to illustrate initial steps taken in theme and sub-theme development.

Possible Theme	**Initial grouping and reorganisation of codes**
Layers of self-efficacy	definition
	I can…
	lack of confidence
	potential tensions
	evidence of resilience
	perseverance/persistance despite setbacks
	evidence of self-motivation
	seeking support
	targets became choosing goals for future practice
	goal setting became choosing goals for future practice
	modelling a lesson to peers
	feedback from modelled lesson
	influential modellers
	feedback from teacher model mentor
	TVinput-modeller
	affective
	feelings re: going to teach primary science
	enthusiasm

Figure 4.8: Example of grouping initial ideas into sub-themes of layers of self-efficacy

Moving between coding, theme development and theme reviewing was ongoing and iterative and the following reflective notes illustrate some of the decisions I made on the way in developing the sub-theme 'Affective responses to science':

> *'I have affective responses to science listed as a sub-theme with physiological responses to experience as a further sub-theme. This too needs sorting so refer to literature to define term…..*
>
> *Affective is about the emotive responses such as anger, interest, enjoy, being disappointed, being excited, wow, boring, worry, nervous, but physiological is the body reaction such as deeper breathing, going red, laughing response to the affective (Kim et al., 2018).'*Coding notes from EB Jan, 2021.
>
> *So originally I had enjoying science with physiological responses I have now more accurately placed this under the affective responses to science. I have moved all the codes from physiological to codes linked to affective responses as on the whole the interviews do not focus on the physiological responses. I have merged the physiological coding into the affective responses and will review these later'* Coding notes EB Jan, 2021.

Figure 4.9 is an example of how the thematic framework continued to be developed for analysing the factors and influences that impacted on participants' self-efficacy. At this stage I continued to check that the data extracts within each theme and sub-theme captured the voices of the participants in a coherent and representative manner. The headings for themes and sub-themes were still being refined and reviewed.

Theme	Sub-Themes Examples	Codes
Factors and influences associated with self-efficacy		
	Affective responses to science	enjoying science
		feelings re: going to teach primary science
		impact of secondary science
		sensitivity to environment and children
	Aspects impacting on Confidence	aspects that have impacted on lowering confidence
		aspects that have influenced confidence positively
		evidence of teaching leading to increased confidence
		I can….
		modelling a lesson to peers
		subject knowledge
	Reflecting on feedback	feedback from children you have taught
		feedback from link tutor
		feedback from modelled lesson
		feedback from teacher model mentor
		reflections which might influence beliefs about teaching
	Resilience	coping with challenges
	Teaching environment	teaching children you already know
		teaching in a laboratory
		teaching in a primary classroom
		teaching in a specific environment like science fair
		teaching outside

Figure 4.9: Example of ongoing refinement of themes and sub-themes

4.1.5 Defining and naming themes

Each theme needed clarification and defining to know what it contained and what it did not contain (Braun and Clarke, 2006). I found this to be an ongoing process during the coding and development of the thematic framework.

For instance, 'Teaching Environment' became the sub-theme 'Influence of teaching environment' with a number of codes. Initially the only codes were 'teaching outside' and 'teaching in a primary classroom' but as further interview material was coded, other codes were added. For instance, since children are a part of the 'teaching environment' I added a code 'teaching children you already know' as participants indicated that this had a bearing on their confidence in preparing to teach science and thus impacted on their self-efficacy beliefs. This sub-theme, then, formed part of the theme 'indicators of self-efficacy and factors that influence self-efficacy', because the interview data suggested that this was a factor in supporting participants' self-efficacy for teaching science.

I revisited codes to check that the content of each was representative of the code descriptor. I merged or removed codes that no longer stood on their own such as a code for 'Basic Science' which was merged into the sub-theme 'Comparing beliefs about types of science'. As I went along I made some slight changes to headings influenced by the work of Braun and Clarke (2013) and Morgan (2018). This reduced the codes down to 70 which were subsequently organised into 4 main themes made up of 19 sub-themes as shown in Figure 4.10.

Themes	Sub-themes	Codes
Background sharing		own Background
		personal qualities
		qualification
Beliefs that impact on teaching	**Aspirational beliefs compared with theoretical beliefs about teaching**	aspirations for teaching science
		aspirational beliefs about the teaching primary science
		choosing primary teaching
		qualities of a good teacher
	Comparing beliefs about types of science	primary science
		science
		similarity between primary and secondary science
	Contributions of course and research	belief about the researcher
		suggestions for future work on course
		usefulness of interview
	Personal beliefs	reflections which might influence beliefs about teaching
Indicators of self-efficacy and factors that influence self-efficacy	**Understanding self-efficacy**	defining self-efficacy
	Confidence	aspects of subject knowledge that impact on confidence
		aspects that have impacted on lowering confidence to teach science
		aspects that have impacted positively on confidence to teach science
		evidence of teaching leading to increased confidence
		I can
		modelling a lesson to peers
	Affective	enjoyment and enthusiasm for science
		feelings going into teach primary science
		secondary science
	Elements from research associated with self-efficacy	choosing goals for future practice
		evidence of motivation to seek out challenges
		resilience to overcome issues
		willingness to take risks
	Opportunities to teach, observe and take part in science with children	additional opportunities through self-directed or volunteering opportunities
		experience as a student
		not taught primary science
		observation in schools
		placement
		pre-placement experience
		science specialism experience
	Additional influences affecting teaching	conflicting aspects that influence teaching science
		influence of course
		influence of modellers
	Feedback and reflections	feedback from children you have taught
		feedback from link tutor
		feedback from peers
		feedback from teacher model mentor
		working with support of teacher mentor
	Influence of teaching environment	teaching children you already know
		teaching in a science laboratory

Themes	Sub-themes	Codes
		teaching in a primary classroom
		teaching in a specific environment like a science fair
		teaching outside
	Making use of support	planning with others
		seeking support from peers, teacher, head of science
		support provided by teacher, school, head of science
		making use of other people's plans
Teaching science approaches and issues	**Seeking ways to enhance children's engagement with science**	helping children to persevere
		modelling to children
		considering how children cope with investigation disappointment
		sharing the wow with children
		engaging children using own ideas for recording
	Constructivist approaches	active science learning with children
		activity leads to children raising questions
		children working in groups
		elicitation activity
		encouraging children to explore
	Identifying that learning had taken place	assessment
		children's responses
	Influence of course	tvinput
	Making connections	linking science to other subjects
	Subject specific pedagogy	children's understanding of science
		managing behaviour in science
		influence of subject knowledge
		reflections on being able to teach the same topic to different year groups on different placements

Figure 4.10: Steps in the process of creating the final coding table

A summary of the steps taken to create the final coding table (Figure 4.10) was developed by using the thematic analysis framework (Braun and Clarke, 2006) applied to all eleven interviews until the point of saturation of coding had been reached (Charmaz, 2006). This process was time consuming but led to complete immersion in the interview data (Braun and Clarke, 2013) and enabled inductive identification of themes which informed the findings and analysis approaches used to address research aim 1 and research aim 2. Further refinement resulted in the final coding table.

4.1.6 Reflections and reflexivity notes made during the thematic anaysis stage of the data analysis process

In this section I will provide some insights into the decision-making process that affected my methodological decisions.have provided examples of notes that I made during the coding process and the issues that were occurring.

I am working this week on the analysis of candidates 4, 5, 6 with the express purpose of coding, categorising and theming transcribed interviews with the intention of developing a qualitative approach to analysing self-efficacy. The purpose is to apply the qualitative approach I have chosen: semi-structured interviews, transcribed and input into NVivo and analysed using a thematic analysis. I know I am not using grounded theory because of the need to engage deductively with theoretical perspectives to provide an analysis of the influences which can contribute to self-efficacy. I have to acknowledge my role in the whole process as I am not outside of this research. I am actively involved with the participants in that I lecture on their courses and am aware of the taught content that they have received. EB notes 16th June 2020

Throughout the data analysis approach I did in fact frequently review other possible approaches to data analysis. In this extract I decideded against using grounded theory as outlined by Charmaz (2006) because I wanted to use an inductive-deductive approach (Fereday and Muir-Cochrane (2006) reflecting participants' voices in relation to the theoretical background of self-efficacy. In other notes I took this further and rejected content analysis (Best, 2012) as I did not think that the development of frequency charts addressed the research aims. Additionally I also rejected narrative analysis (Bold, 2012) since I felt that this did not really bridge the gap between quantitative approaches and qualitative approach in the way that thematic analysis did (Boyatzis, 1998; Braun and Clarke, 2013; Denscombe, 2014). I am also constantly aware of my positionality in relation to the participants and try to address this by ongoing reflexivity to consider the impact of my own positionality on the data analysis process. One way in which I address this is to use symbols instead of names to distance myself from the data reflecting my science background. However, within a constructivist paradigm the researcher is as much part of the process as the participants and I am constantly aware of justifying and sharing each step taken in the methodological decisions to ensure trustworthiness in the final outcomes (Savin-Baden and Howell Major, 2012; Nowell *et al.,* 2017).

4.1.7 Producing the report

Figure 4.11 provides an example of some initial use of the inductive-deductive approach to coding and data analysis. Through the use of thematic analysis (Braun and Clarke, 2013) I coded interview responses from the participants which showed enthusiasm, engagement and enjoyment towards science, based on their individual experiences. This initial coding was done inductively from the participants' responses and as shown in earlier sections describing thematic analysis, was used to contribute to the main theme of factors and influences associated with self-efficacy. I also approached the analysis of the transcripts from a deductive approach in which theory suggests that high self-efficacy is associated with enthusiasm (Glackin and Hohenstein, 2018). The process of coding involved both inductive and deductive approaches to ensure

the voices of the participants were used inductively to identify the initial codes, and subsequently link these to theoretical indicators associated with self-efficacy research. This process was ongoing throughout the data analysis in which I was particularly focussing on the indicators associated with self-efficacy. I then used the participants' fragments to provide 'descriptive vignettes' (Erikson, 1985:150) to summarise how individual indicators were illustrated by the participants' responses.

Operationalisation from theory Theoretical indicators to inform enthusiasm	**Operationalisation from interview data** Insights from participants' own descriptions of their behaviours that facilitate operationalisation of enthusiasm associated with the construct of self-efficacy
Mitchell (2013) Two tables listing enthusiasm: exhibiting genuine pleasure working with students, good preparation and modelling of enthusiasm, investing time and energy into the delivery of lessons, promoting positive outcomes. Included a tool for assessing enthusiasm	Excitement in how they speak, describe in more detail what they did – My notes Evidence of indicator from interviews: C6, C4 and C5 C6: I kind of think, like, its, I've got a very big, sort of, I want to be able to teach it well and I want to be able to, like, let children have the same enthusiasm I got from my teach.. my, sort of, science teaching when I was at primary school C6: Chemistry was one of those things that I think in secondary I got lucky with the Y7 teacher I had in that they were very enthusiastic and quite ridiculously passionate about chemistry and, sort of C6: You know when people get really animated on a topic. He just, he sort of came alive in the, like, Chemistry lessons and I think it's, sort of, just stuck. That enthusiasm sort of was like "ok, he's really excited about this so I'll be really excited about this" and it just sort of grew from there. C6: So I'm hoping that I can sort of take the fact that obviously that teacher sort of sucked all the fun out of it for me and I'd like to flip it on its head so that I can try and be a bit more enthusiastic about teaching it and a bit more, get the children a bit more engaged with it and try and get that fun element into it cos I think the key thing for me with Science is, it is fun and it it's just.. love it so I want the kids to love it as well so I'm hoping that I can get that sort of fun and excitement and the experimental side into it ok. C4: I'm quite excited, in a way, to carry out different experiments with the children and enquire with the children. C4: Um, to make science like, fun, um, something…contextual, something that I was able to relate to. Um, someone who was enthusiastic about teaching the subject to me. C5: Chemistry I loved, so I thought Chemistry was great and we had a.. and the fundamental difference was we had a fantastic teacher and he happened to be the teacher who ran the Duke of Edinurgh scheme and so he was, yea, he was engaging and he made Chemistry.

Figure 4.11: Linking theory and participants' responses to the indicator enthusiasm

Example of vignette illustrating enthusiasm

Figure 4.11 provides some example commentary from participants 4, 5, and 6 in which they are reflecting about enthusiastic and engaging experiences they have had with their own teachers of science. These experiences appear to influence how the participants want to teach science themselves and provides some evidence of the influence of vicarious modelling (Bandura, 1977; 1997) and its effects on the participants even though in some cases these events would have taken place 'a long time ago' C5.

The participants use terms such as 'animated' or 'fantastic' to describe their teachers and suggest that the approach used by their teachers contributed to making science fun. C6, however, experienced the opposite from one of their teachers as can be seen here:

> '*So I'm hoping that I can sort of take the fact that obviously that teacher sort of sucked all the fun out of it for me and I'd like to flip it on its head so that I can try and be a bit more enthusiastic about teaching it and a bit more, get the children a bit more engaged with it and try and get that fun element into it cos I think the key thing for me with Science is, it is fun and it it's just.. love it so I want the kids to love it as well so I'm hoping that I can get that sort of fun and excitement and the experimental side into it ok.'* C6.

C6 loves her science and wants the children she teaches to love science as well. She uses her reflections to identify that she does not want to teach in a way that stifles that love of science and in the process is demonstrating secure self-efficacy beliefs that if she tries she has the capability to enthuse and engage the children.

In this way I ensured that theory and the participants' responses were linked in order to develop short 'narrative vignettes' (Erickson, 1985:145) to address the research questions. At the same time I was aware that these were my constructions of the interview responses that the participants shared, and did not include the perceptions of others involved in the same experiences, such as the teacher-mentors (Clandinin and Connelly, 2000).

Chapter four has summarised how I used thematic analysis to explore the eleven interviews which resulted in the final coding table. This was the starting point for analysing and interpreting participants' responses in more detail from which I could both inductively and deductively illustrate how the participants provided the cues to recognise indicators of self-efficacy through an inductive-deductive approach (Fereday and Muir-Cochrane, 2006). I then used these indicators to operationalise self-efficacy in order to address research aim 1, which is discussed in greater detail in Chapter 5.

The final coding table as shown in Figure 4.10, also underpinned the approach for addressing research aim 2 where I adapted Bandura's Triadic Reciprocal Causation (TRC) model (Figure 4.12) to explore the factors that contribute towards self-efficacy.

Source information for Diagram (Bandura, 1997:6) found in:

Bandura, A. (1997) *Self-efficacy: the exercise of control.* New York: W. H. Freeman.

Figure 4.12: Bi-directional relationships between the three determinants of the Triadic Reciprocal Causation Model (Bandura, 1997:6)

CHAPTER 5 - Operationalisation of self-efficacy

This chapter presents the findings for Research Aim 1: To explore the operationalization of self-efficacy within primary preservice teachers' reflections on their experiences of science teaching. Additionally it explores participants' understanding of the term self-efficacy and their beliefs about primary science.

The findings are presented in three sections as follows:

Section one explores participants' understanding of self-efficacy and challenges with establishing a shared understanding, reinforcing the complexity of the construct as discussed in section 2.5 (Bandura, 1997). This leads into section two, the focus of which explores operationalising self-efficacy through identifying and analysing indicators of self-efficacy, to enable researchers and practitioners to visualise what these indicators 'look like' in practice.

Section two explores the approach that I used to operationalise self-efficacy, through an inductive-deductive iterative process in order to demonstrate qualitative rigour and trustworthiness (Fereday and Muir-Cochrane, 2006; Gioa et al., 2012). The approach made use of thematic analysis which enabled me to deconstruct self-efficacy into characteristic indicators identified from the theme 'indicators of self-efficacy and factors that influence self-efficacy'. The indicators themselves are complex constructs and required additional operationalisation through theory. Vignettes were then constructed from the analysis of the interviews to provide examples of how participants illustrated specific indicators associated with self-efficacy. I continued to refine the processes used following Braun and Clarke's (2006) six phase framework (Figure 4.1) in order to deepen understanding of the indicators that reflected how I interpreted the operationalisation of self-efficacy as discussed here.

Phases three to four (Figure 4.1): During the thematic analysis I deconstructed the raw data into themes and sub-themes. Additionally I gathered indicators from theory that reflected how self-efficacy could be operationalised (Figure 2.1). I linked the theoretical indicators with sub-themes developed from thematic analysis, thereby continuing to proceed in an inductive-deductive approach. The purpose of matching indicators from coded sub-themes with explicit links to theoretical indicators, was to provide a means of code checking to illustrate the trustworthiness of the data analysis process (Guba and Lincoln, 1998 and 2003; Braun and Clarke, 2006).

Phases four to five (Figure 4.1): I refined the process further by deepening the understanding of each construct through additional literature underpinning the indicators.

Repetition of phases three to five (Figure 4.1): I continued to code check through in an iterative cycle to achieve qualitative rigor (Gioa *et al.,* 2012).

Phase six (Figure 4.1): I reconstructed the coding to develop interpretative vignettes focussed on individual indicators, to illustrate how self-efficacy can be operationalised in practice. I developed the analysis for

different audiences. I have shown how to develop an inductive approach for classroom practitioners wanting to explore their own practice. Additionally I have illustrated a deductive approach for teacher practitioners wanting to take a theoretical approach. The purpose of this final stage was to provide 'rich descriptions' which could be evaluated for their transferability into different situations (Lincoln *et al.,* 2018)

Part three explores the participants' beliefs about science and their aspirations for teaching primary science and leads into chapter six where a more holistic analytical approach is taken.

5.1 Part one: Exploring participants' understanding of self-efficacy and issues with defining it

In this section I have illustrated participants' varied understanding of the term self-efficacy, at the time of the interviews.

5.1.1 Findings

The majority of the participants did not have a clear understanding of what self-efficacy meant, though several attempted to describe it using synonomous terms.The most common terms used were self-confidence or confidence, followed by efficient/efficiency as in Figure 5.1.

'…mm (pause)…I guess it's probably to do with like well self, is to do with me obviously but it's to do with my confidence and my abilities um as a practitioner (pause)… um all I can think of is efficiency which is not the same word but and obviously not really ideal. Self-efficacy.. I don't really know actually, not coming to me at all…'C1

'…Kind of how efficient you think you are in something?'C10

'…I guess it's that being able to reflect on how well I can.. or how effective I can be teaching, I guess? To some degree.' C6

Figure 5.1: Extracts from participants comments about self-efficacy

The rest of the participants either did not know or guessed what it meant using terms such as self-esteem, self-reliance and self-sufficient, as in Figure 5.2.

'…Is that like, I just think of self-esteem, when I think of that…Like, how efficient. Maybe efficacy, efficient. I don't actually know what it means. I'm not going to lie. [laughs]…' C2

'…I don't know. I'm assuming like self-sufficient because it sounds similar, but I don't know…' C11

Figure 5.2: Extracts from participants comments about self-efficacy

The majority of participants provided an estimate of their self-efficacy for teaching primary science, though still used the term confidence synonymously with self-efficacy.

Figure 5.3 illustrates that the way in which C1 and C6 interpreted the educational goals they wanted to achieve, impacted on their perception of their self-efficacy judgements to achieve them, C1 through enjoying science and C6 through subject knowledge.

Estimate of self-efficacy

'…whether I'll be an effective teacher of the outcomes of the science curriculum is perhaps a question that's yet to be determined (laughs). Whether I'll be effective in delivering the skills of inquiry or um engagement and enjoyment in science I think, well I believe that I'm pretty confident that I'll be able to do that because of my own engagement and enjoyment…C1

'I think reasonably strong….I think I'm fairly confident…I think I'm fairly sure that I could…say I was given a task to do a lesson on an aspect of like you know habitats or something. I think I could probably do it and I think I could probably. I think I could pitch it at the right level and hopefully be able to sort of get the goals that they want to attain…' C6

Figure 5.3: Extracts illustrating participants' self-efficacy/confidence judgments

It can be seen in Figure 5.4 that C3 also indicated an understanding of self-efficacy which she linked closely to confidence. C3 had used self-efficacy theory in a short study for a Personalising Learning task (specific module on ITT course), in which she supported a child, who C3 described as a good student that needed some help. This was partly motivated by her own experiences that if people perceive that you are confident, that there is a tendency to let you get on with things when in fact you would prefer to receive some help. As shown in Figure 5.4 C3 identified similar issues reflecting a lack of awareness that self-efficacy is a dynamic construct. For C3 this lack of awareness was through the eyes of others who observed that she was doing well then assumed that she did not need help.

'I would say that, I think, people's perception of my self-efficacy is higher than it probably is. If that makes sense.' C3

'Yeah, I think people think that I'm a bit more able to do things. Cos they think "oh, we'll just leave her to get on with her own thing; she's clearly doing well". Um, but then I, kind of, think that is sometimes a downfall because then people don't realise that I do need some help. But then, I also need to be able to say "I need a bit of help with something". Even if it's just, um, like, time-management or a bit of planning, or just…can you help me out with my….lesson and things like that' C3

Figure 5.4: Extracts to illustrate issues with fixed views of self-efficacy

Additional evidence of the dynamic nature of self-efficacy is also reflected in

Figure 5.5 where C7 also illustrated that self-efficacy beliefs would vary dependent on the context, the day of the week and the amount of experience you already have. C10 illustrated that her self-efficacy beliefs could

be altered in the moment of teaching. In further responses C10 would have addressed these concerns had they occurred.

> '…Gosh, it depends what day of the week it is….Oh, I don't really know. I guess, maybe, if you're more confident in something, like if I was teaching plants again, I'm a bit more confident in teaching plants than I am teaching materials, maybe. But then, I think, the more you teach something, the higher your self-efficacy would become…C7
>
> '…I think it depends what the topic of science is… But I definitely think if they're not enjoying the lesson, I think my confidence would definitely be knocked. Yeah. If they're not as engaged as I'd like them to be maybe…C10

Figure 5.5: Extracts from participants illustrating what influences their self-efficacy

All the participants illustrated some understanding of self-efficacy. In the examples C1, C3, and C6 used confidence as an everyday term for self-efficacy (Bleicher, 2006), however as discussed in section 2.6.1, Bandura considered confidence to be a generic term that provides a limited view of the complexities and multi-layered nature of self-efficacy (1997). Participants were able to estimate some level of self-efficacy but it was clearly a term that they little used. Therefore, I had to define self-efficacy in the interview. Subsequently participants were quickly able to estimate their level of self-efficacy for future teaching opportunites, in some cases making use of their perceptions and evaluations of the experiences they discussed in the interview (Mulholland and Wallace, 2001). Participants were also aware that self-efficacy beliefs were not fixed (Tschannen-Moran *et al.,* 1998; Wyatt, 2015) and could be altered dependent on a number of different issues as outlined in the findings. Self-efficacy beliefs involve judgments about having the capability to do a task, as well as having the skills to do the task successfully which dynamically varies as contexts and task difficulty alter (Bandura, 1997).

5.1.1 Reflections on defining self-efficacy with participants with varying degrees of experience for teaching primary science

Labone (2004), Wheatley (2005) and Wyatt (2016) have all raised issues about the complexity of trying to clearly define self-efficacy within an educational context. I experienced this myself in the interviews as can be seen in this piece of reflective writing I did about trying to define self-efficacy and how my own understanding of its complexities altered during the research process.

> I defined self-efficacy specifically linking it with primary science, though in one case I referred to primary teaching in general, because that particular participant had yet to do her first teaching placement and she was not sure what science would be involved. This was to reflect that self-efficacy beliefs are context specific (Bandura, 1997). I emphasised the individual nature of self-efficacy beliefs and I linked expected outcomes within the definition. This concurs to some extent with Skaalvik and

Skaalvik (2014) who identified teacher efficacy as the 'individual teacher's beliefs about their own abilities to plan, organise, and carry out activities required to attain given educational goals' (p.69).

As the interviews progressed I realised that each participant would have different outcome expectancies dependent on how much science they had observed or actually taught as well as whether outcome expectancies were linked to personal goals or curriculum goals (Mulholland and Wallace, 2001). Outcome expectancy is very varied and dependent on what individuals are seeking to do as well as being influenced by the external expectations of others such as teacher-tutors. Skaalvik and Skaalvik (2014) refer to attaining 'educational goals', which is very open to interpretation. In the interviews I defined outcome expectancies in terms of 'achieving outcomes you intend to achieve', equally open to interpretation but directing participants to think about their own goals.

It became clear in the interviews that the outcome expectancy for each participant was very individual. Therefore, I wanted the participants to place their judgment of self-efficacy within a context but let them interpret outcome expectancies according to their individual choices, rather than be based on some generalised view about what teachers would be expected to achieve. In this way I focussed on individual beliefs which Pajares (1992) and Bandura (1997) identified as major influences on teachers' behaviours. Additionally Enochs and Riggs (1990) identified that personal teacher efficacy aspects were more reliable than general teacher aspects, further emphasising the relevance of focussing on individual judgements.

I think defining self-efficacy raised all sort of issues for me, particularly given the time constraints within an interview. I wasn't sure that my interpretation of teacher efficacy would be understood given that most participants indicated a lack of understanding of the term. I wasn't sure that they would focus on their own beliefs about themselves in making judgments about self-efficacy. I could see that without including outcome expectancy, rather loosely described here, that self-efficacy did not have a clear enough focus for them to provide an estimation for future practice. I also needed to provide some background behind self-efficacy in some cases, because it involves more than personal confidence (Bandura, 1997). For instance with one participant I moved it from just talking about being confident in a generic way (Bandura, 1997), to explaining that you needed to be aware of why you felt confident e.g. feedback from mentors, how you felt about taking small groups for teaching science. The scientist in me looking for evidence.

Consequently part one confirms that self-efficacy is complex to unravel and in order to develop understanding of its multi-faceted nature there is a need to deconstruct it in a way that it can be visualised more easily. I believe the way to do that is to identify indicators of self-efficacy which are relatable to practitioners which leads into part two.

5.2 Part two: Exploring approaches that support the operationalisation of self-efficacy

In order to operationalise self-efficacy I identified indicators that could provide a 'tangible' way of recognising elements of self-efficacy (Best, 2014). These indicators were identified inductively through thematic analysis and corresponded to the sub-themes in the final coding table. To inform the deductive element of the final coding, I referred to a selection of indicators of high self-efficacy presented in theory and research findings from literature (refer to Figure 2.1). Using an inductive-deductive approach Iidentified the following six indicators: Affective, motivation, making use of support, resilience, target setting and confidence. These six indicators were linked to codes that contained extracts from the interviews providing information about how participants' comments reflected each indicator. The code headings also acted as descriptors to illustrate what to look for in the interviews. Figure 5.6 summarises the indicators identified through this process.

Indicators from theory **Bandura (2006)** **Glackin and Hohenstein (2018)** **Klassen and Durksen (2014)** **and Brigido et al., (2013)**	**Indicators from thematic analysis (which I interpreted as providing evidence for operationalizing self-efficacy)**	**Descriptors developed during the coding process**
Optimistic Stress-excitement Enthusiastic Positive rapport with children Positive beliefs leading to a feeling of competency for teaching and supporting science learning	Affective	Enjoying science (feelings about science as a subject) Feelings about teaching primary science Enthusiasm (wanting to share their enjoyment of science with children}
Opt for challenges Puts in the required effort to achieve goals Challenges seen as obstacles to be overcome Willingness to achieve new ideas and new pedagogical approaches	Motivation	Willingness to take risks and engage with challenges
Strategic thinker Seeking help as support	Making use of support	Seeking support from peers, teacher, head of science Using others' plans to teach
Perseverant and resilient Challenges seen as obstacles totbe overcome Awareness of limitations but looking to challenge these and learn from experiences	Resilience (Incorporated perseverance within sub-theme)	Addressing difficulties
Committed to achieve goals	Target Setting	Choosing goals for future practice

Indicators from theory **Bandura (2006)** **Glackin and Hohenstein (2018)** **Klassen and Durksen (2014)** **and Brigido et al., (2013)**	**Indicators from thematic analysis (which I interpreted as providing evidence for operationalizing self-efficacy)**	**Descriptors developed during the coding process**
Puts in the required effort to achieve goals		(involves personal and pedagogical choices)
Good science subject knowledge Open-ended questions used Willingness to try new ideas and new pedagogical approaches Focus on children's ideas and their learning Positive rapport with childrenFigure 5.6 resulting in a willingness to go with children's ideas for inquiry Positive beliefs leading to a feeling of competency for teaching and supporting science learning	Confidence	Aspects of subject knowledge that impact on confidence Evidence of use of some constructivist approaches and their impact on confidence I can- statements

Figure 5.6: Stage one illustrating the inductive-deductive links for operationalizing self-efficacy

The indicators were in themselves complex constructs and needed additional clarification in order to 'generate clear definitions' (Braun and Clarke, 2006:87) (Figure 4.1) supported by further literature relative to the specific indicator. Figures 5.7-5.12 identified how I selected extracts to code from the interviews to operationalise self-efficacy for each of the indicators. To inform the deductive aspect of each indicator, I drew on literature to reflect the inductive aspect. For instance, I drew on Mitchell (2013) to aid coding with enthusiasm and enjoyment for science in the affective response. As the lone researcher I wanted to demonstrate that I used this process of cross checking between interpreting interview responses with theory, to ensure that rigorous analysis of the data had been established through providing an audit trail for the processes used (Gioia *et al.,* 2012; Klassen and Durksen, 2014; Nowell *et al.,* 2017). Figures 5.7-5.12 illustrate how I did this with each of the six indicators.

Approach to operationalisation	Affective response indicator
Inductive operationalisation from interviews	Excited response in the interview Statement of being excited or enthusiastic in the context of teaching science Expression of enjoyment in relation to teaching science
Deductive operationalisation from theory linked to construct	Exhibiting 'genuine pleasure' working with students Modelling of enthusiasm Investing 'time and energy' into the delivery of lessons (Mitchell, 2013:20)

Figure 5.7: Operationalisation of affective responses

Approach to operationalisation	Motivation indicator
Inductive operationalisation from interviews	Extract provided evidence of willingness to take on a challenge Level of what counted as a challenge depended on participant Extract provided reasons for wanting to have a go at the challenge Extract provided evidence of the actions undertaken for challenge Extract indicated perception of level of success with the challenge
Deductive operationalisation from theory linked to construct	'To be motivated means to be moved to do something' (Ryan and Deci, 2000:54) 'doing something because it is inherently interesting or enjoyable' (Ryan and Deci, 2000:55) 'doing something because it leads to a separable outcome'(Ryan and Deci, 2000:55)

Figure 5.8: Operationalisation of motivation

Approach to operationalisation	Making use of support indicator
Inductive operationalisation from interviews	Extract indicated how teaching support was sought from others Extract indicated what resources were used to support their teaching e.g. use of teachers' plans Extract indicated how they felt about seeking support Extract indicated perception of received support
Deductive operationalisation from theory linked to construct	'reported using a variety of resources for locating new literacy strategies, including professional literature' '…discussed connections to colleagues as important resources for new strategies' '…using the internet to find new strategies' Cantrell and Callaway (2008:1746) .

Figure 5.9: Operationalisation of making use of support

Approach to operationalisation	Resilience indicator
Inductive operationalisation from interviews	Extract provided examples of challenging situations which included preparation and delivering science lessons, working in unfamiliar settings, working with unfamiliar children Level of what counted as a challenge depended on participant Extract identified concerns, and how they were dealt with Extract shared what had been learnt Extract shared perceptions of the level of success in dealing with challenge
Deductive operationalisation from theory linked to construct	'Resilience includes the skills and abilities that, along with knowledge and experience, contribute to a person's ability to meet challenges, cope with those challenges, and overcome them.' (Rolbiecki *et al.,* 2017:90) 'Learning from past experiences increases available resources and thus improves one's resilience for dealing with future circumstances' (Bobek, 2002:202) Resilience is ' the capability of individuals to cope successfully in the face of change, adversity and risk' (Stajovic 2006:1211) 'Risk and protective factors have been shown to influence levels of resilience' (Arnup and Bowles, 2016:231)

Figure 5.10: Operationalisation of resilience

Approach to operationalisation	Target setting indicator
Inductive operationalisation from interviews	Extract identified long term targets for science Extract identified more immediate goals as some participants were preparing for assessed placements Extract indicated that science targets had not been set
Deductive operationalisation from theory linked to construct	'Specific goals also promote efficacy because it is relatively easy to evaluate progress toward an explicit goal.' Schunk 2003:164 Schunk 2003:163: 'Self-evaluations of progress raise self-efficacy and sustain motivation.' 'Goals that are perceived as moderately difficult raise motivation and convey a clear sense of progress, which raises efficacy'. Schunk, 2003:164

Figure 5.11: Operationalisation of target setting

Approach to operationalisation	Confidence indicator
Inductive operationalisation from interviews	Extract provided personal estimates of confidence in subject knowledge Extract provided evidence of whether strategies were in place to support gaps in subject knowledge Extract provided examples of having used, or wanting to use, a range of inquiry based strategies when working scientifically Extract provided evidence of managing the science lesson Extract provided examples of supporting others with strategies for teaching science Extract provided examples of how to cope when things do not go according to plan
Deductive operationalisation from theory linked to construct	Effective teachers of science…'will draw on sound subject knowledge and adopt an eclectic mix of organisational strategies, teaching techniques and philosophies to make decisions about the best way to engage the learners 'interests and enhance their knowledge and understanding of science.' (Howard, 2018)

Figure 5.12: Operationalisation of confidence

I then continued to work iteratively between phases three to five from the thematic analysis framework, to make sure that my coding of each sub-theme was dependable (Braun and Clarke, 2006) (Figure 4.1) and could be be used to identify the data necessary for developing the vignettes for producing the report. The entire process required 'prolonged engagement' with the raw data and led to indepth knowledge of the content of the interviews and transcriptions (Nowell *et al.,* 2017:3).

Finally I developed analytical tools to illustrate how the operational descriptions outlined in Figures 5.7 to 5.12 could be interpreted to construct rich descriptions through illustrative vignettes (Best, 2014). The vignettes provided the final stage of the analysis and the production of reports in which I selected 'extracts, relating back of the analysis to the research question and literature' (Braun and Clarke, 2006:87).

The indicators motivation and resilience were chosen as the focus for the illustrative vignettes because they contained most coded responses from the thematic analysis of the interviews, and because they are often identified in Bandura's work (1997; 2006). Additionally I used C8 and C9 accounts to construct the vignettes because they had the most coded responses for providing insights into two of the indicators of self-efficacy: motivation and resilience.

I developed two analytical tools to scaffold the development of the vignettes; one to illustrate the inductive approach, and the other to illustrate the deductive approach. I used the descriptors linked to motivation to create the analytical inductive tool and then repeated the same process for the second indicator, resilience. Figure 5.13 is a blank example of the analytical inductive tool that I used to scaffold the inductive approach to constructing an illustrative vignette for motivation.

Operationalisation of motivation as an indicator of self-efficacy	
Context summary of experience	
Evidence of willingness to take on a challenge; identifies challenges involved	
Evidence to show actions undertaken for challenge	
Perception of level of success with the challenge	

Figure 5.13 Example of analytical inductive tool (generic)

Figure 5.14 illustrates a similar scaffold for applying a deductive approach for constructing illustrative vignettes to illustrate the operationalisation of self-efficacy.

Theoretical underpinning of the specific indicator	**Operationalisation of indicator from this source of theory**	**Extract from participant's responses to illustrate evidence of indicator for operationalisation of self-efficacy**

Figure 5.14: Example of analytical deductive tool to operationalise motivation as an indicator of self-efficacy

I chose to present the findings in this way because an aspect of this research was to explore ways of making self-efficacy more useable to practitioners (Wheatley, 2005). For instance, the inductive approach might be more useful for classroom practitioners as a way in which to analyse their own experiences through indicators of self-efficacy. The deductive approach might be useful to teacher-educators in demonstrating how theory can drive interpretations of classroom practice through specific indicators that operationalise self-efficacy.

5.2.1 Application of the analytical inductive tool for operationalising motivation as an indicator of self-efficacy

The analytical inductive tool, Figure 5.15, was used to summarise some of the extracts identified through coding that showed how C8 operationalised self-efficacy through motivation. Motivation was shown through C8's personal drive to take up opportunities for becoming involved with a science fair, and showing commitment towards achieving this successfully. I then used the analytical inductive tool, Figure 5.15, to construct the interpretive vignettes. The quotes are taken from participants' transcriptions as they had been recorded.

C8 illustrating motivation as an indicator for the operationalisation of self-efficacy	
Context summary of experience	C8 accepted this challenging goal of doing the Science Week for the whole school. She was placed in this position when her second-year placement teacher indicated that she did not really like teaching science. This was not the first time C8 had come across this sort of view- … 'And I've only really had teachers who have had very negative views of science…' C8 '…You've got a science week," and then by the time they filtered in their assemblies and everything else, it ended up being three mornings, the whole morning up until lunchtime…' C8 C8 said that R, Y1 and Y2 were mixed up together to form mixed-age and ability groups.
Evidence of willingness to take on a challenge; identifies challenges involved	'And when she found out that I was a science specialist, I got to do the Science Week for the whole school because none of them liked doing it.' C8 B: … you're a trainee, you're a year two, you've just been asked to do something quite complex. 8: 'Yeah, it was.' 8: 'I felt confident in being able to do it within my own classroom. The fact that it was on a whole school scale was really scary, but I did have that other teacher there and she was really supportive and really helpful.' 'I do not think I would have been able to plan the whole thing on my own at the level that I was at, especially because I'd only been in only one class within the school. I had no idea how the-- because it was a three form entry as well, how the other people just in my cohort I knew a little bit, but we planned this quite early on in my placement, how the year twos were doing and how reception were doing, how to make the knowledge accessible to everyone and to also meet all the different areas that they would need to be doing within a lesson was quite tricky when you'd have all of them in one classroom at once. It was a lot to kind of have to factor in.'
Evidence to show actions undertaken for challenge	'…luckily, the science lead of the school was only next door…'C8 '…together, we planned the whole of the Science Week for the whole school, which was great. She gave me a lot of lead on it, which was fantastic. But if I had any questions kind of thing,…she was helping me out with them…' C8 'So I sat down with the science subject leader and said, "We've got this science week," and the theme that was ongoing in the school was flight, so sort of how can we link the science to the idea of flight. And so I suggested doing something about rockets and forces and all of that, and so we did rockets, because unfortunately, we finished the placement on the Thursday and the Friday was the final day, so I also had input on what they were doing on the Friday but I wasn't there to see it executed. So we did So we did rockets, stuff about aeroplanes…'C8
Perception of level of success with the challenge	'my feedback from that was actually my best lesson that I had taught. I know my teacher had obviously taken into consideration that I don't know the children and there was a lot more children in our room than it normally would be in that that it was mixed age group, but it was—I personally think it was my best lesson that I taught on placement, and I think it was because partly because I'd had a lot of input in the planning, so I felt very confident' C8 'I actually really enjoyed it. And I think it made me-- like I said, it was the best lesson I taught. I felt most comfortable doing it. The teacher I had was very supportive in making that sure everything linked. Yeah, it was terrifying the whole way through, but I absolutely loved it. ' C8

Figure 5.15: Application of the analytical inductive tool to analyse motivation as an indicator of self-efficacy for C8

5.2.2 Development of interpretive vignette one making use of the analytical inductive tool for the indicator motivation

Figure 5.15 provides insights into the analysis of motivation as an indicator of self-efficacy from C8's interview data. C8 shared evidence of motivation to seek out challenges whilst on an earlier assessed school placement, when she had the opportunity to become actively involved in *'Science Week for the whole school'* C8, the theme of which was flight.

At the time of the interview, C8 was in her final year and yet to complete her final placement. C8 was also a science specialist on her ITT course and stated more than once in her interview that she has *'…a love for the*

subject…' C8. This may partly have been the drive for her self-motivation in getting involved in a science week, along with being able to extend her own experiences in teaching science. C8 shared some of her concerns regarding the science week and what it entailed. For example, she said that '*the fact that it was on a whole school scale was scary…'* C8, particularly as the different classes involved such as reception, year one and year two were mixed up together in teaching groups. This did not deter C8 who was motivated to seek support as shown in Figure 5.15. In

Figure 5.16 C8 is being realistic in using self-assessment to identify what she needed to plan and organise a complex event such as a science week. The challenges that she identified included her own lack of experience particularly with being aware of the level of knowledge that the different age groups would have, and the challenges she would have in managing to support children's investigations.

> *'I do not think I would have been able to plan the whole thing on my own at the level that I was at, especially because I'd only been in only one class within the school. I had no idea…how the year twos were doing and how reception were doing, how to make the knowledge accessible to everyone and to also meet all the different areas that they would need to be doing within a lesson was quite tricky when you'd have all of them in one classroom at once. It was a lot to kind of have to factor in.'* C8

Figure 5.16: Extract from C8 analytical inductive tool

C8 was motivated to seek support from the science lead in the school as and when she needed it, which provided C8 with the confidence to carry out the science week as can be seen in Figure 5.17.

> *'…luckily, the science lead of the school was only next door…'* C8
>
> *'…together, we planned the whole of the Science Week for the whole school, which was great. She gave me a lot of lead on it, which was fantastic. But if I had any questions kind of thing,…she was helping me out with them…'* C8
>
> *'…I'd had a lot of input in the planning, so I felt very confident….'* C8.

Figure 5.17: Extract from C8 analytical inductive tool

Further evidence of C8's motivation to do well was provided by the fact that C8 had her final observation whilst teaching science. The feedback from the teacher and C8's self-assessment showed that it was a very successful experience as indicated in her own words: *'…it was the best lesson I taught'* C8.

Surprisingly C8 indicated that in the past, she had *'…had quite a negative feeling toward science…'* C8, due to feeling that she *'didn't have enough scientific knowledge to be able to teach it'* C8. As her undergraduate course proceeded, however, she enjoyed science much more and has motivational aspirations to *'potentially be a science subject lead in a school'* C8. As she prepared for her final placement C8 indicated that she *'would love to teach all the science'* C8 and considered that she was *'very capable of teaching science'* even though there were still areas for her to learn, such as assessment of science. C8 also was aware of her limitations as a trainee and identified the need for more opportunities to observe '*fully qualified teachers'* teaching science so that she could learn *'what engages them [the children], what doesn't and what would [she] do differently'* C8.

5.2.3 Application of the analytical deductive tool for the self-efficacy indicator: motivation

In this case the analysis was driven by a priori coding (Liguro *et al.,* 2018) based on theoretical underpinning of the components of motivation as shown in Figure 5.18, column one. Column two shows how I interpreted the theoretical underpinning of the components of motivation to seek descriptors which might illustrate the operationalisation of motivation. Column three links the raw data with these responses.

Application of the analytical deductive tool for the self-efficacy indicator: motivation		
Theoretical underpinning of the indicator motivation	**Operationalisation of motivation from this source of theory**	**Extract from participant's responses to illustrate evidence of motivation as an indicator for operationalisation of self-efficacy**
'To be motivated means to be moved to do something' (Ryan and Deci, 2000:54)	Evidence that the participant has been motivated to take on a challenge and what actions she took to support this.	'and then all of a sudden it was like, you're teaching science, but you're also teaching science to children that you don't know who they are, and they're all in different year groups, which was really scary. And I was terrified before it happened' C8 '…So I sat down with the science subject leader and said, "We've got this science week," and the theme that was ongoing in the school was flight, so sort of how can we link the science to the idea of flight. And so I suggested doing something about rockets and forces and all of that, and so we did rockets, because unfortunately, we finished the placement on the Thursday and the Friday was the final day, so I also had input on what they were doing on the Friday but I wasn't there to see it executed. So we did rockets, stuff about aeroplanes…' C8 'B: So you needed a mentor to support you through. 8: I do not think I would have been able to plan the whole thing on my own at the level that I was at, especially because I'd only been in only one class within the school. I had no idea how the-- because it was a three form entry as well, how the other people just in my cohort I knew a little bit, but we planned this quite early on in my placement, how the year twos were doing and how reception were doing, how to make the knowledge accessible to everyone and to also meet all the different areas that they would need to be doing within a lesson was quite tricky when you'd have all of them in one classroom at once. It was a lot to kind of have to factor in.' C8
Intrinsic Motivation - 'doing something because it is inherently interesting or enjoyable' (Ryan and Deci, 2000:55).	Evidence as to why the participant has become involved	'…but once we started, I absolutely loved it. But I think that is just my love of the subject coming through…' C8 '…and then obviously, my love of the subject as well really helped with delivering it to the children and being enthusiastic. But it was still very nerve-wracking to teach to all those different children.' Participant 8

Intrinsic Motivation '… positive performance feedback enhanced intrinsic motivation' (Ryan and Deci, 2000:59)	Evidence of successful feedback. This can be from the children, the teacher and through self-evaluation of her own performance.	'…I think because they were responding so well, and I think-- my teacher said to me at the end she went "I would never have been able to do that the way you just did", which again I think was to do with her relationship with the subject. But I think just, just the whole way through it just felt good [laughter].' C8 'Yeah, I don't know how else to describe it. You know when you can hear children using all that scientific language and they're really getting what you want out of the session. I had one pupil who was like, "I'm going to stick the wings on the front and the back of my rocket," and one of them was like, "Oh no you can't do that, because it won't fly properly." And he was like, "Well why not?" And so he did it anyway, and he still explored what was going on there for him.' C8 'And my feedback from that was actually my best lesson that I had taught. I know my teacher had obviously taken into consideration that I don't know the children and there was a lot more children in our room than it normally would be in that that it was mixed age group, but it was—I personally think it was my best lesson that I taught on placement, and I think it was because partly because I'd had a lot of input in the planning, so I felt very confident. And I knew what the structure of the lesson was going to be. I knew what was going on—' C8 Yeah, it was terrifying the whole way through, but I absolutely loved it. B: Did the children enjoy it? 8: Loved it.'
Extrinsic Motivation- 'doing something because it leads to a separable outcome' (Ryan and Deci, 2000:55).	Evidence of external rewards linked to being observed by people whose views and opinions matter to the participant and contribute towards her final report from the placement.	'I knew it was a good lesson. Yeah, she just was really happy with it and I think, yeah, because she said that wasn't anything she would've done differently, and she also saw what the science subject lead had given everyone and the way that I had adapted it she said was fantastic and it really suited the needs of the children. You've obviously really considered angling this more towards investigation rather than just feeding that knowledge.' Participant 8 'It was also my final observed lesson.' Participant 8

Figure 5.18: Application of the analytical deductive tool to analyse motivation as an indicator of self-efficacy for C8

5.2.4 Development of interpretive vignette two making use of the analytical deductive tool for the indicator motivation

Figure 5.18 provides insights into the analysis of motivation as an indicator of self-efficacy from C8's interview data. C8 provided evidence of being involved with a science week as a challenging, hands-on task (Harlen and Qualter, 2018) as can be seen in

Figure 5.19

.

Being *'terrified before it happened'* C8

Being aware that *'… to meet all the different areas that they would need to be doing within a lesson was quite tricky when you'd have all of them in the classroom at once.'* C8

Figure 5.19: Extract from C8 analytical deductive tool

C8 was, however, motivated enough to take action to become involved with the science week (Ryan and Deci, 2000). C8 sought support to help her involvement in the science week. C8 demonstrated some ownership and agency of what she would like to do which contributed to her motivation to do it (Nilsen, 2009). She also showed a sense of responsibility to ensure that whatever was planned for the science week could be continued by others, despite the fact that she would not be present on the last day as her placement would have finished. C8 clearly has *'a love of the subject'* which helped in *'delivering it to the children and being enthusiastic'.* This provided some evidence of intrinsic motivation (Ryan and Deci, 2000) since it could be inferred that the science week is of value to C8 because it gives her the opportunity to share her enjoyment of science with the children, which is important to her in her role as a teacher. This in turn added to increased motivation to do it well (Nilsen, 2009). Additionally there is evidence too of extrinsic motivation (Ryan and Deci, 2000) in that C8 reveals that this lesson contributed towards her assessed observations for this placement. Her feedback would be linked to the Teachers' Standards (DfE, 2012) in which she would be expected to demonstrate high expectations, good subject knowledge and well-planned lessons among other requirements. The feedback provided confirmation of a successful experience.

In the operationalisation of self-efficacy through motivation (Pajares, 2003), efficacious students are more likely to set challenging goals and to be motivated to achieve these goals as agents in their own learning (Pajares and Schunk, 2001). Stronger self-efficacy beliefs may lead to more motivation to do something, which in turn influences the amount of initial effort that is involved and how much effort must continue to be involved, in order to ensure successful outcomes (Schunk, 2012). Therefore, self-efficacy promotes and sustains motivation to do something, the outcomes from which will in turn contribute to how self-efficacy beliefs are influenced (Schunk, 2003). The analytical deductive tool provided a means to illustrate how the indicator, motivation, could be used to operationalise self-efficacy using C8's experiences.

In both vignettes, C8 demonstrated her motivation through seeking support in planning and carrying out a successful science week (Ryan and Deci, 2005, and Klassen and Durksen, 2014). Through revisiting the interview responses and looking for indicators of motivation I was able to develop a richer picture interpreted through the use of the participant's own words (Teddlie and Tashakkori, 2009). C8 demonstrated her willingness to use and take responsibility for teaching science using challenging approaches (Glackin and

Hohenstein, 2018). She also provided evidence of continued motivation and enthusiasm to ensure that the experience was successful (Brigido et al., 2013; Klassen and Durksen, 2014). Therefore, C8 provided evidence of high levels of self-efficacy for this particular indicator (Muijs and Reynold, 2002; Cantrell and Callaway, 2008; Dunne and Peacock, 2015). Additionally, through developing the deductive approach to analyse C8's experience it could be seen that C8's motivation was driven by both intrinsic and extrinsic rewards (Ryan and Deci, 2000) which also contributed towards suggestions of increasing self-efficacy (Bong and Clarke, 1999) for this particular indicator.

My construction illustrates how the use of both analytical tools, can be used to show that the indicator, motivation, provides a means of operationalizing self-efficacy. It would be advised that participants would explore their experiences through all the indicators before making any perceived judgments of self-efficacy (Bandura, 1997). In the next section I apply the same inductive and deductive processes to C9 to illustrate the indicator resilience.

5.2.5 Application of the analytical inductive tool for the indicator resilience

Figure 5.20 illustrates the application of the analytical inductive tool, for C9 to illustrate how self-efficacy can be operationalised through resilience. From this analysis an interpretive vignette was constructed.

C9 illustrating resilience as an indicator for the operationalisation of self-efficacy	
Context summary of experience	Teaching experiences during science specialism modules. C9 worked with her peers to plan and carry out teaching science activities with a Year 6 group in a local school. This occurred on three different occasions covering different science content such as electricity and light.
Evidence providing examples of challenging situations which included preparation and delivering science lessons, working with unfamiliar children	I hadn't worked with year six teaching them. I'd been in the classrooms with year six just sort of as more as a TA role just as you do in pre-course placement, you're sort of sat back just helping them sharpen pencils…' C9 '…Even though I'm not really very good in it, I quite enjoy giving the children the opportunity to do it…'C9 '…quite hard and requires a lot of planning…'C9 '…you have to think of risk assessments for most lessons, you have to think about all the equipment you'll need, and if you don't have the equipment, what you could use in substitution. You have to think about the time you've got, you have to think about the tidying up, you have to think about the space…'C9 '…I think the planning, you require a lot more planning... But I feel it's beneficial if you can think of all these things.' C9
Evidence of identified concerns and how they might be dealt with	'… I feel like having lots of back up sessions and back up ideas and teaching was really good…'C9 '…I think that we overestimated sometimes the knowledge of the children but that was because we didn't know them' C9 '…I felt like the time we went in after that we toned it down. We knew the level we should pitch it at…' C9
Evidence of what had been learnt Perception of level of success with the challenge	'…but I feel like that really helped because it gave me a chance to plan without knowing the children, which I would find really tricky, but obviously, you have to do when you're an NQT. You won't know your class at all. You'll have met them for maybe an afternoon so you'll have information about them but you won't actually know what they're like as a whole. So I felt like that was quite a useful experience, going in and finding out what worked and what didn't work and you know yeah.' C9

Figure 5.20: Application of the analytical inductive tool for the self-efficacy indicator: resilience

5.2.6 Development of interpretive vignette three making use of the analytical inductive tool for the indicator resilence

Figure 5.20 illustrates the application of the analytical inductive tool for C9. C9's science specialism teaching experience to illustrate the degree of resilience required to cope with new teaching challenges with an unfamiliar year group. The science teaching experience was designed in conjunction with a local school, to provide the science specialists with opportunities to develop their own plans and choice of resources, rather than have to work from prescribed plans provided from the teacher. Whilst this example is not about dealing with adverse situations, it does require C9 to draw on her resilience to cope with a new teaching challenge and the level of commitment involved in planning for such a challenge. Prior to this experience C9 recounted that she had observed science being taught through worksheets and videos as can be seen in

Figure 5.21.

Pre-course experience: *'… it was one of the things where he handed out a worksheet and it was watching videos…'*C9

First-year placement experience: *'…again, it was a lot of worksheets and they didn't really take the children outside when they could have done a lot more outside…'* C9

Figure 5.21: Extracts from C9 analytical inductive tool

From her response in the interview C9 indicates that she enjoys teaching science, however, as can be seen in

Figure 5.22 she is aware of the challenges involved in teaching science.

'…Even though I'm not really very good in it, I quite enjoy giving the children the opportunity to do it…'C9

'…I hadn't worked with year six teaching them. I'd been in the classrooms with year six just sort of as more as a TA role just as you do in pre-course placement, you're sort of sat back just helping them sharpen pencils…' C9

'…quite hard and requires a lot of planning…'C9

'…you have to think of risk assessments for most lessons, you have to think about all the equipment you'll need, and if you don't have the equipment, what you could use in substitution. You have to think about the time you've got, you have to think about the tidying up, you have to think about the space…'C9

'…I think the planning, you require a lot more planning... But I feel it's beneficial if you can think of all these things.' C9

Figure 5.22: Extracts from C9 analytical inductive tool

Challenges that can be inferred at this point refer to confidence with science itself, though not specified, the effort entailed in preparing to teach primary science, teaching unknown children and teaching an unfamiliar year group science. C9 illustrates a level of perseverance to cope with all the issues entailed in planning a science lesson because she feels that the outcomes will be beneficial. In Figure 5.23 it can be seen that C9 addressed the challenges by working with her peers and ensuring that she had over planned both subject content and teaching activities. In the process she learnt about pitching the lesson according to the needs of the children.

‘… I feel like having lots of back up sessions and back up ideas and teaching was really good…’C9

‘…I think that we overestimated somemes the knowledge of the children but that was because we didn't know them’ C9

‘…I felt like the time we went in after that we toned it down. We knew the level we should pitch it at…’ C9

Figure 5.23: Extracts from C9 analytical inductive tool

Additionally, as shown in

Figure 5.24, C9 also intends to draw on her resilience for coping with unfamiliar situations, as she considers her future role as an NQT (Newly Qualified Teacher).

‘…but I feel like that really helped because it gave me a chance to plan without knowing the children, which I would find really tricky, but obviously, you have to do when you're an NQT. You won't know your class at all. You'll have met them for maybe an afternoon so you'll have information about them but you won't actually know what they're like as a whole. So I felt like that was quite a useful experience, going in and finding out what worked and what didn't work and you know yeah.’ C9

Figure 5.24: Extracts from C9 analytical inductive tool

5.2.7 Application of the analytical deductive tool for the self-efficacy indicator: resilience

As before the analysis was driven by a priori coding (Liguro *et al.,* 2018) based on theoretical underpinning of the components of resilience as shown in Figure 5.25 column one. Column two shows how I interpreted the theoretical underpinning of the components of resilience to seek descriptors which might illustrate the operationalisation of resilience. Column three links the raw data with these responses.

Application of the analytical deductive tool to operationalise the self-efficacy indicator: resilience		
Theoretical underpinning of components of resilience	**Indicators to enable the operationalisation of resilience**	**Extract from participant's responses to illustrate how resilience provided evidence of operationalisation of self-efficacy**
'Resilience includes the skills and abilities that, along with knowledge and experience, contribute to a person's ability to meet challenges, cope with those challenges, and overcome them.' (Rolbiecki *et al.,* 2016:90) 'Learning from past experiences increases available resources and thus improves one's resilience for dealing with future circumstances' (Bobek, 2002:202)	Identifying concerns and dealing successfully with them	'…I feel that the teaching we did on specialism last year was really good because I hadn't worked with year six teaching them. I'd been in the classrooms with year six just sort of as more as a TA role just as you do in pre-course placement, you're sort of sat back just helping them sharpen pencils…'C9 '…I feel like having lots of back up sessions and back up ideas and teaching was really good, and I feel that talking to the TA and learning their classroom routine was really good, and the practical side of what they did and getting them to move around the classroom in an organised fashion and making sure that you were explicit in what you wanted them to do was very useful…'C9 '…I feel like there were too many adults in the room but that was just obviously because we had-- but other than that I feel it went quite well…'C9 '… I think that we overestimated sometimes the knowledge of the children but that was because we didn't know them, so I felt like the time we went in after that we toned it down. We knew the level we should pitch it at…'C9
	Awareness of how the experiences can contribute to future situations	'…but I feel like that really helped because it gave me a chance to plan without knowing the children, which I would find really tricky, but obviously, you have to do when you're an NQT. You won't know your class at all. You'll have met them for maybe an afternoon so you'll have information about them but you won't actually know what they're like as a whole. So I felt like that was quite a useful experience, going in and finding out what worked and what didn't work and you know yeah…'C9

Figure 5.25: Application of the analytical deductive tool for the self-efficacy indicator: resilience

5.2.8 Development of interpretive vignette four making use of the analytical deductive tool for the indicator resilience

Figure 5.25 illustrates the application of the analytical deductive tool for C9. C9 shared her views about teaching experiences that she undertook as part of the science specialist modules in the second year of her course. In this case C9 along with the other science specialists planned and prepared to teach primary science to year six classes at a local primary school. Teaching took place within the classroom and the specialists, working in teams, took turns in leading aspects of whole class input as well as supporting groups of children in different activities.

Whilst C9 does not explicitly state issues that she dealt with, planning and working with a year group which are unknown to her could be seen as a potential source of threat (Biesta, 2016), yet she was able to take part in the experience and emerge from it successfully as illustrated in

Figure 5.26.

‘…I feel that the teaching we did on specialism last year was really good because I hadn't worked with year six teaching them. I'd been in the classrooms with year six just sort of as more as a TA role just as you do in pre-course placement, you're sort of sat back just helping them sharpen pencils…C9

‘…I feel like having lots of back up sessions and back up ideas and teaching was really good, and I feel that talking to the TA and learning their classroom routine was really good, and the practical side of what they did and getting them to move around the classroom in an organised fashion and making sure that you were explicit in what you wanted them to do was very useful…’C9

‘…I feel like there were too many adults in the room but that was just obviously because we had-- but other than that I feel it went quite well…’C9

‘… I think that we overestimated sometimes the knowledge of the children but that was because we didn't know them, so I felt like the time we went in after that we toned it down. We knew the level we should pitch it at…’C9

Figure 5.26: Extracts from C9 analytical deductive tool

C9 demonstrated through the process of teaching science that she increased her understanding of working alongside a TA (Teaching Assistant), and as result was able to learn more about the year six children and their routines (Klassen and Durksen, 2014). C9 was able to manage busy practical science lessons whilst working with the other science specialists in the room. In C9’s view the experience was successful, if a little crowded, and has likely contributed to the positive way in which she summarised her learning experiences (Bandura, 1997). This demonstrates that she is resilient in meeting new challenges, and though a bit concerned, was able to cope and deal with these challenges (Rolbiecki, *et al.,* 2016).

C9 also demonstrated that the teaching experience has contributed to her resources and resilience for coping with similar situations (Bobek, 2002), such as when she begins her first teaching post as shown in

Figure 5.27.

‘…but I feel like that really helped because it gave me a chance to plan without knowing the children, which I would find really tricky, but obviously, you have to do when you're an NQT. You won't know your class at all. You'll have met them for maybe an afternoon so you'll have information about them but you won't actually know what they're like as a whole. So I felt like that was quite a useful experience, going in and finding out what worked and what didn't work and you know yeah…’C9

Figure 5.27: Extract from C9 analytical deductive tool

Figure 5.20 and Figure 5.25 illustrate how both the inductive and deductive analytical tools can be used to operationalise self-efficacy through the indicator resilience, which Gibbs argues is one of ‘the key attributes that we expect of effective teachers’ (2002:2). Resilience is associated with how well someone responds to

challenging situations (Stajovik, 2006). Consequently teachers who cope with difficult situations reflect resilience, an indicator of high self-efficacy, whereas teachers who avoid situations or blame difficulties on others reflect low self-efficacy (Bandura, 1997). Arnup and Bowles claim that both 'Risk and protective factors have been shown to influence levels of resilience' (2016:231). In this example with C9 the element of risk was provided by teaching science using hands-on activities. The protective factor was provided by giving time for pre-planning as well as working with other science specialists to deliver the lesson together in a non-assessed situation.

In both vignettes C9's responses provided some evidence of her resilience to cope with, and learn from new teaching challenges (Bobek, 2002, Rolbiecki, 2017). She demonstrated an awareness of the commitment to achieve goals by being actively involved, as well as providing a sense of feeling prepared through her planning, and evidence of feeling competent for future teaching opportunities, all descriptors linked to resilience as an indicator of high self-efficacy (Bandura, 2006, Bridgido *et al.,* 2013 and Klassen and Durksen, 2014).

5.3 Part three: Beliefs about science and teaching primary science

In part three I have presented some illustrative excerpts summarising participants' beliefs about primary science as shown in Figure 5.28 and their reflections of their experiences, aspirations and concerns for teaching primary science as shown in Figure 5.29. The comments reflected the contexts and situations that existed when the interviews were undertaken in June-December 2019, prior to the impact of Covid 19 restrictions. The comments also provided further links with the six indicators from the thematic analysis which I used to operationalise self-efficacy. Self-efficacy beliefs are influenced by the perceived challenges that preservice teachers have about the level of skills and subject knowledge required to work scientifically with children (Pajares, 1992; Appleton and Kindt, 2002; Blonder *et al.,* 2014). The participants have shared many such challenges and illustrated some of the indicators that operationalise self-efficacy.

For instance, it can be seen from Figure 5.28 that some participants had positive memories of primary science, involving the use of resources and different teaching spaces. These responses are associated with the affective indicator and may reflect how the participants aspire to teach science in the future, perhaps through modelling enthusiasm (Mitchell, 2013). Conversely, negative responses such as one participant's view that she felt primary science was boring, represented affective responses that are associated with low self-efficacy and limited approaches to teaching (Bandura, 2006).

C1…When I was at primary school I certainly remember like the experiments most so… Going outside and sticking a ruler on the playground and measuring the shadows throughout the day or… building an electric circuit and being excited when your light bulb worked and being disappointed (laughs) when it didn't because your light bulb was broken or your battery didn't have any power in it…

C3…quite enjoyable but almost seems as if it was a rarity. When I was in school like you were really excited for it

C7…Engaging

C10…very hands-on, lots of questions, curiosity, active learning, I think

C11… it's not as exciting as kind of like secondary science or when you move up and you progress to-- and you start doing biology and chemistry and all that stuff. I feel like primary science is very boring. I don't want to say boring but that's-- because I know it can be exciting but I think my experience has been all… well it's all the same and it's not exciting

Figure 5.28: Illustrative excerpts of participants' beliefs about primary science

In Figure 5.29 some participants associated primary science with active learning and working in different environments beyond the classroom (Harlen and Qualter, 2018). This provided some evidence for potential aspirations for future practice. Furthermore, participants identified these challenges for teaching primary science as; issues with the level of subject knowledge, issues with planning, and issues with coping with the variation of resources between settings. Participants who perceived that these challenges could be addressed and overcome, reflected motivational and resilience indicators, also associated with high self-efficacy (Klassen and Durksen, 2014). Conversely, participants who perceived the challenges as stressful, reflected indicators linked to low self-efficacy (Bandura, 2006).

C2… Questioning I think's really important. I also think you need to know your stuff…photosynthesis, they're all like science words… you don't really use them in any other kind of subject.

C3… being involved in several lessons and having the chance to teach it I feel more equipped and have different resources and different ways to teach the… aspects of science that may be perceived to be boring and…have some good ideas on how I would be able to teach that and how I can implement science in like a fun and engaging way.

C6…I want to be able to teach it well and I want to be able to…let children have the same enthusiasm… sort of science teaching when I was at primary school

C7…difficult but not in a negative way...I think it's difficult depending on what resources you've got… like experiencing different settings to settings that have got loads of resources, to some that have got nothing.

C10… obviously subject knowledge is a very big thing. I think that's why teachers get a bit nervous teaching it… but I think it helps if you've got a passion and enthusiasm for the subject because I definitely believe…they'll be enthusiastic if you're enthusiastic

C11…stressful….I don't want to go teach science and either not do it right or not have good enough subject knowledge. I just want to go, be able to do it and do it well.

Figure 5.29: Illustrative excerpts of participants' reflections of experiences, aspirations and concerns for teaching primary science

5.4 Summary

In this chapter I identified that participants had a limited understanding of self-efficacy equating it with similar terms such as confidence. Bandura (1997) argues that using terms like confidence misrepresents the complex nature or self-efficacy. In order to support understanding of self-efficacy I then explored approaches to illustrate how self-efficacy could be operationalised into indicators. I identified six indicators that were developed from thematic analysis and demonstrated that these six indicators could be compared with similar terms, though not identical, from research findings such as those of Klassen and Durksen (2014), to illustrate how self-efficacy could be operationalised. Furthermore, I developed two analytical frameworks to illustrate how the indicators of motivation and resilience, both complex theoretical constructs in their own right, could be operationalised through the participants' experiences (Ryan and Deci, 2000 and Rolbiecki *et al.,* 2016). I provided two approaches, inductive and deductive, to suggest potential ways of using these analytical tools for different teaching practitioners. I will elaborate more on usability in Chapter 7. I have also provided a brief section about participants' beliefs, aspirations, and challenges for primary science to illustrate how these responses also reflect indicators of self-efficacy. Clearly, this needs further development but provides a brief window into the sort of beliefs that participants may draw on when next considering their self-efficacy beliefs for teaching science.

I concur with Glackin and Hohenstein (2018) that caution must be advised about operationalizing self-efficacy through individual indicators. I think it is a useful approach to support scaffolded understanding of what might contribute to self-efficacy beliefs. However, it may lead to describing self-efficacy in terms of similar constructs. For instance, Williams and Rhodes (2013) argue that self-efficacy should be renamed as 'can-do motivation' (p.122). Additionally individual indicators may be specific to different participants. For instance, the indicator 'making use of support' was particularly relevant to these primary practitioners, because they often work with, or alongside other adults on their assessed placements. Therefore, primary and secondary preservice teachers may need different lists of indicators to illustrate operationalisation in the different contexts in which they will work (Wheatley, 2005). However, as can be seen by the length of the list of indicators in the authors' table, Chapter 2, Figure 2.1, it can be seen that self-efficacy needs to be a weighted integration of these indicators if it is to reflect the multi-dimensional construct put forward by Bandura (1977; 1997).

In chapter six I continue the data analysis journey by taking a more holistic to further develop and explore approaches for understanding self-efficacy.

CHAPTER 6 - Exploring understanding of the influences on self-efficacy through: the adaptation of the TRC model; and the development of the TRC Integrated Cyclical model

This chapter presents the findings for Research Aim 2: To adapt Bandura's Triadic Reciprocal Causation (TRC) model (Figure 4.12) to explore the factors that contribute to the development of preservice primary teachers' self-efficacy.

I also introduce the final phase of this thesis in which I have explored approaches to inform understanding of the nature and development of self-efficacy through the use of cyclical models, a more recent development for self-efficacy research (Wyatt, 2016).

In this chapter I make use of an analytical framework which was created through the development of Bandura's TRC model (1997) to explore changes in self-efficacy of two participants, C4 and C11. These two participants provided additional data, following the interviews, about their experiences of teaching science on their assessed placements. Their pre-placement interviews had provided rich data adding insights into the factors that can contribute towards self-efficacy development. There was four months between the interviews taking place and doing a follow-up interview with C4, and receiving an email from C11. C4 had been on her first assessed teaching placement and C11 had been on her final teaching placement in different schools.

The analytical framework (Triadic Reciprocal Causation) will be referred as AF(TRC) which I have used as an exploratory tool to further understand the influences and factors that impact on self-efficacy judgments. AF(TRC) 1 and 2 are identical but were used at different times. AF(TRC) 1 was used to analyse the interview responses prior to a school experience, and AF(TRC) 2 was used to analyse the follow-up interview and email from C4 and C11, post a school experience. Vignettes were then constructed to facilitate reflection on the insights gained into changes in self efficacy through application of the AF(TRC) frameworks.

Thematic analysis of the interview data enabled identification of factors contributing to the development of self-efficacy and an overview of this analysis is presented in Figure 6.1. providing a means for visualising components of self-efficacy.

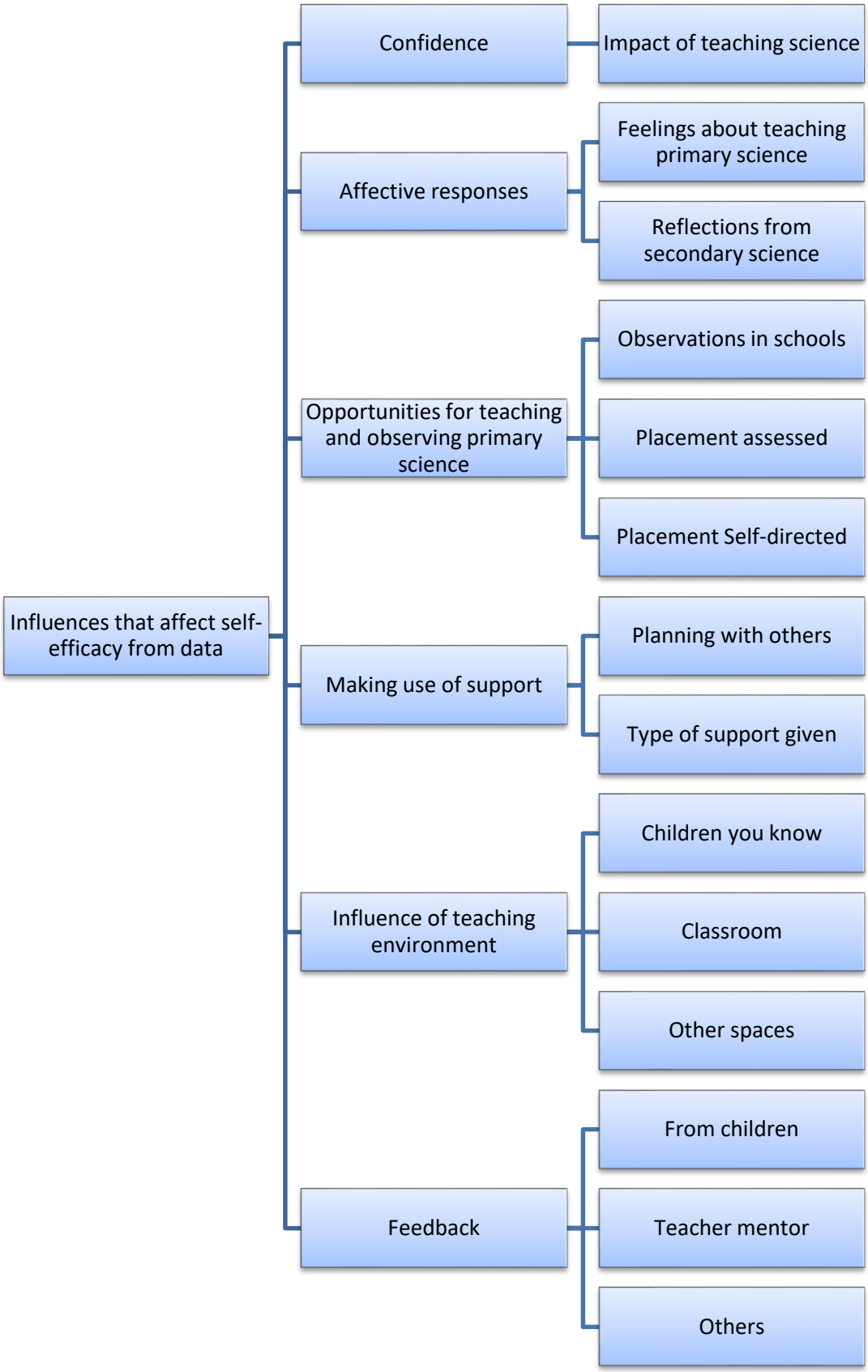


Figure 6.1: Illustrating the sub-themes and codes for Influences that affect self-efficacy

The literature review highlighted the need for development of approaches for assessing self-efficacy more holistically (Wheatley, 2005; Wyatt, 2016; Markova, 2021). The construction of an analytical framework was to bridge the gap between theory and practice, in order to begin to address criticisms raised about the

usefulness of literature on self-efficacy for practitioners, due to its theoretical nature and limited insight into practical applicability for practitioners (Wyatt, 2016). In order to construct the AF(TRC) I used the outcomes from the thematic analysis in conjunction with the TRC model of Bandura (1977; 1997) to provide the framework from which to reassess themes emerging from the data. The decision was taken to draw on insights from the data in my study to further develop Bandura's TRC model (Figure 6.2), a seminal aspect of Bandura's work (Bandura, 1997; Schunk et al., 2014), used in research today (Bergman *et al.,* 2019; Rowston *et al.,* 2021).

The TRC model links three determinants of human agency together. Bandura describes human agency as 'the power an individual has to take control for making something happen' (Bandura, 1997:3). The determinants that affect agency are labelled as personal, behavioural, and environmental which Bandura argues influence human agency through a dynamic bi-directional interaction (Bandura, 1997). Through the TRC model Bandura brings together different ideas about why people, despite having similar skills, respond differently in challenging situations. Figure 6.2 shows how these three determinants interact to affect behaviour providing insights into how people draw on their previous experiences and reflections of these experiences, as well as responding to the environmental and social context in which they are operating.

Source information for Diagram (Bandura, 1997:6) found in:

Bandura, A. (1997) *Self-efficacy: the exercise of control.* New York: W. H. Freeman.

Figure 6.2: Bi-directional relationships between the three determinants of the Triadic Reciprocal Causation Model (Bandura, 1997:6)

Each determinant is a holding base for complex constructs and in Figure 6.3 I have applied descriptors to each determinant in order to develop an analytical framework, AF(TRC) shown in Figure 6.4. Figure 6.3 illustrates my interpretation of the TRC model of Bandura (1997) drawing on descriptors developed from the analysis of the interview transcripts (column three). It also illustrates theoretical descriptors (column 2) influenced by the work of Bergman *et al.,* (2019) with their research on how the reciprocal interactions in Bandura's TRC model impacted on personal agency choices to do with sustainable mobility, and the work of Rowston *et al.,* (2021) illustrating their application of the TRC model to generate descriptors for each determinant within the context of technology and preservice teachers.

TRC Determinants (Bandura 1997)	**Descriptors from theory (Bergman *et al.,* 2019 Rowston *et al.,* 2021)**	**Descriptors from the interviews reflecting beliefs and degree of agency, linked with TRC determinants**
Personal Determinant	Cognitive processes which includes memories and perceptions of those memories, and physiological responses to those memories which contribute towards self-efficacy beliefs	Beliefs about primary science, Interpretation and perception of experiences, Affective responses to experiences and feedback such as a sense of enjoyment

TRC Determinants (Bandura 1997)	Descriptors from theory (Bergman *et al.,* 2019 Rowston *et al.,* 2021)	Descriptors from the interviews reflecting beliefs and degree of agency, linked with TRC determinants
Behavioural Determinant	Degree of empowerment demonstrated by proxy, individual or collective agency which guides the choices of behaviours used in teaching	**Proxy**-guided support/ Modelling/Observation of experienced others **e.g.** completing a worksheet with children/working directly from teachers' plans/being guided **Individual-** making decisions about class groups, type of assessment, choice of teaching approach to be used **Collective-**working with others to deliver the lesson, or parts of the lesson together.
Environmental Determinant	**Social environment**-all the different groups of people who may be involved **Physical environment-** resources, place and space in which the teaching occurs **Agency in each environment** Selected-individual Constructed- working with others to suit requirements Imposed-due to external constraints	**Selected**- chosen by individual as most appropriate **Constructed**-setting up a science fair **Imposed**- must use classroom as no other space available for teaching science

Figure 6.3: To show how I adapted the TRC model, for analysis of the interviews in order to explore the factors that contribute to the development of self-efficacy

Using Figure 6.3 I re-organised the determinants to develop the analytical framework shown in Figure 6.4, which I refer to as AF(TRC) throughout this chapter.

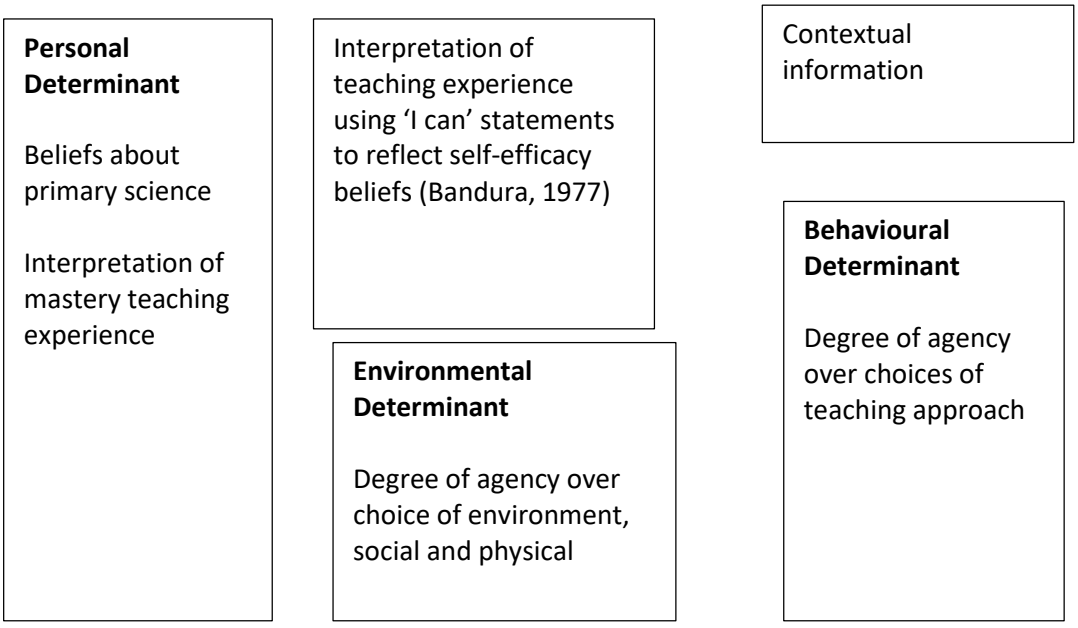


Figure 6.4: Blank AF(TRC) Analytical Framework developed from TRC model, AF(TRC), of Bandura (1977 and 1997) and work of Bergman et al., 2019 and Rowston et al., 2021

To complete the AF(TRC) (Figure 6.4) summary chart required a number of stages involving revisiting the data for each participant and creating an individual project map from elements that they had shared during the interview about their mastery experiences. I was then able to construct

vignettes to summarise their experiences shared in the interview, and use this information to complete AF(TRC), for each participant, specifically looking for personal, environmental and behavioural determinants that may influence self-efficacy beliefs. A second AF(TRC) was constructed after receiving the follow-up data from each participant. Subsequently for each individual participant I compared the AF(TRC) summaries created from data collected prior to a period of school experience (AF(TRC)1) with the second summary created from data collected post that school experience (AF(TRC) 2) to explore how mastery experiences may have influenced and altered self-efficacy beliefs. I did C11 first and then repeated the process with C4.

Stages undertaken to provide the AF(TRC) summaries

Figure 6.5 illustrates the stages taken to complete both AF(TRC) 1 and 2 and includes a brief description of what I did at each of the stages.

The order of the stages involved leading to completion of the AF(TRC) summary	**Description of each stages involved leading to completion of the AF(TRC) summary**
Creation of a project map from interview	Referred back to TA coding and created a project map on NVivo 12 pro
Creation of inductive vignette	Used project map to inform inductive vignettes, five and seven, for participants and provide a summary of experiences that might impact self-efficacy beliefs
Completion of AF(TRC) 1	Information from the project map and vignette were used to complete AF(TRC) 1 for each participant.
Interpretation of AF(TRC) 1 using a deductive vignette	AF(TRC) 1 was used to create deductive vignettes 6 and 8,
Completion of AF(TRC) 2 using follow-up interview and email	Stage 4 was repeated to construct AF(TRC) 2 summaries, based on mastery experiences. This information was provided by C4 and C11 based on their experiences from assessed placements which took place after the interviews
Comparison between AF(TRC) 1 and 2	Comparisons between AF(TRC) 1 and AF(TRC)2 were made to illustrate the influence mastery experiences might have potential self-efficacy beliefs

Figure 6.5: Illustrating the stages involved in the completion of the AF(TRC) tool

The next section shows how I applied the stages for completion of the AF(TRC) summary to C11, followed by C4, and constructed vignettes to reflect the insights gained from using the AF(TRC) framework.

6.1 Stages in the application of the analytical framework for C11

6.1.1 Creation of project map from interview for C11

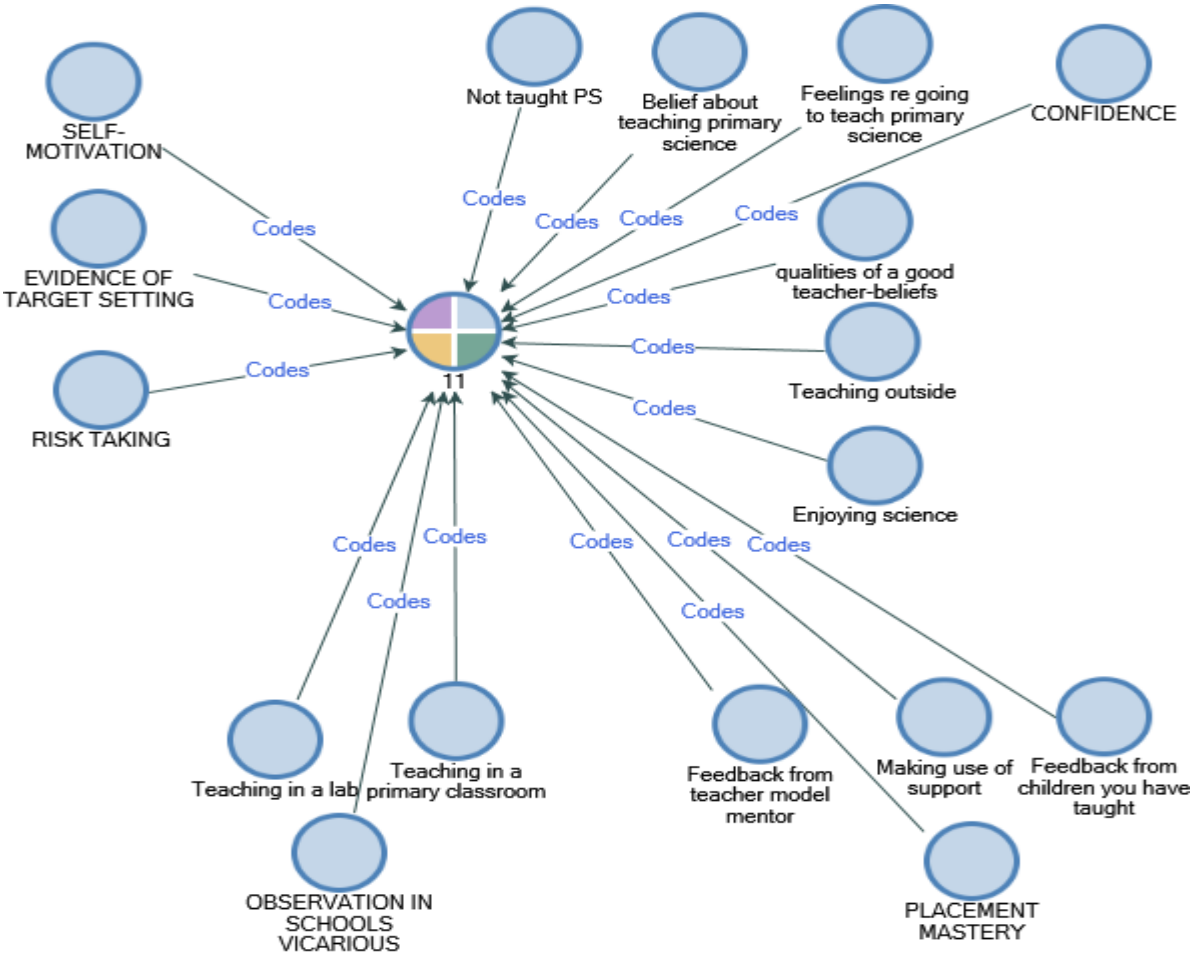


Figure 6.6: Project map developed from the thematic analysis of C11 interview using NVivo 12 pro

Figure 6.6 was generated in NVivo 12 pro to illustrate the influences, beliefs, feelings and experiences that C11 had about primary science, which might influence her self-efficacy beliefs for future experiences of teaching primary science.

6.1.2 Creation of inductive vignette five for C11

Information from the codes shown on the project map were used to construct the summary contextual background for participant 11 to inform inductive vignette 5.

Summary contextual background: C11	
Own assessment of science in terms of confidence	*'it's just a subject that I'm interested in, but I feel like I don't have the confidence in doing…* '*I think it's the subject knowledge which I'm a bit unsure about which I think makes me feel less confident with Science, like teaching Science.'* Has a lack of confidence with science as she feels *'really uncreative'* with science *'I think I'm more worried-- I'm confident teaching any other subject, but I think with science I'm just worried that I'm not doing it right, or I'm not teaching them the right things which I think that's what stresses me out the most.'*
Exploration of influences from vicarious experiences	Self-directed: visited a few middle schools, year five to year nine and private schools Liked this as lesson took place in a laboratory in specific science lessons with a science teacher. Has also observed lessons in a normal primary classroom and found this stressful as it appeared disorganised, working on a table, kids over excited, being silly. Her comments about this observation with KS2 children doing dissolving. *'It's just that I don't want to do a science lesson and then come out and not achieve what I wanted them to understand or come out with misconceptions.'*
Exploration of influences from mastery experiences	Said hadn't really taught science but on assessed placement two did take a group five –to six mixed ability children for electricity. The teacher was away and so the class was taken by a supply teacher. Her responses indicated that she: Didn't like the worksheet but did like doing practical work. Felt that she could not see herself doing this with a whole class. Did not know where to start so sought support from science specialist friends. Feedback from the children she worked with was good and they showed they had learnt something.
Additional comments about feelings towards primary science/science	*'I do enjoy Science. I do think it's a subject that I'd like to know better. When I was in school, I always remember doing Science, that kind of-- when I think it's a lot different, like thinking about Science as a subject and then teaching Science. I think-- I don't know, I feel like it's a lot more complicated and I haven't really had a chance to teach it yet as such.'* Her views of primary science are: *'I'd probably say boring.'* And teaching primary science: *'Stressful*

Figure 6.7: Summary contextual background for C11 including direct quotes in italics and some interpretive summaries

6.1.3 Inductive vignette five for C11

At the time of the interview C11 was a finalist ITT preservice teacher still to complete her final assessed placement. Figure 6.7 shows that C11 had had limited experiences of teaching science and that the only mastery experience that she discussed related to a second year placement experience of taking a group of children to teach them about electrical circuits as shown in Figure 6.7. From the interview responses and comparing this to the theoretical descriptors used to estimate levels of self-efficacy in research aim 1, C11 seemed to have a lower sense of self-efficacy towards teaching science, however it is also clear that C11 felt confident to teach other subject areas as reflected by her comment, '*I'm confident teaching any other subject, but I think with science I'm just worried that I'm not doing it right, or I'm not teaching them the right things, which I think that's what stresses me out the most'* C11. In her interview she provided further evidence of confidence for teaching art because she is an art specialist, and for teaching maths and English because she has been observed and received feedback teaching these subjects on her assessed SE2 placement. Additionally C11 felt confident in dealing with behaviour issues. Therefore, it can be interpreted

that her low sense of self-efficacy towards teaching science is to do with the subject itself, and not generic pedagogical issues.

Further evidence from the interview responses showed that the areas that seemed to cause most concern were: not knowing where to start for planning a science lesson, feeling that she needed a better subject knowledge, not feeling creative in teaching science in the same way as she might for teaching art, worrying about children not achieving what she had set out for them and coming up with misconceptions. It was also clear from her account of observing science in a primary classroom that the room itself was not a conducive environment for her to teach science in. In fact she said that she would probably prefer to teach science outside but then added, *'I don't know what I'd be doing'*. At the time of the interview she had quite negative views and described the idea of teaching primary science as stressful, however, C11 likes science itself as can be seen in her comment, *'I do enjoy Science. I do think it's a subject I'd like to know better.'* C11.

6.1.4 Completion of AF(TRC) 1 using the inductive vignette based on data collected prior to a school experience for C11

C11's experiences as outlined in vignette five were analysed using AT(TRC) one to produce a summary sheet highlighting the degree of agency that C11 shared during the interview. At the time of the interview C11 had been preparing to go into her final placement. She had had limited mastery experiences for teaching primary science (Wellcome, 2019) and this had contributed towards some of her concerns. Initially C11 did not appear to consider this experience as particularly relevant because it was with a small group of children, but during the interview she provided more detail. I have used this detail to highlight the constraints and facilitators that influenced her perception of the experience which is summarised using AF(TRC) 1. I then constructed a list of 'I can' statements (Williams and Rhodes, 2014) to show how the determinants of the TRC model could be used to interpret potential sources of self-efficacy beliefs, which might be interpreted in a different way by others.

<table>
<tr><td colspan="2">Teaching experience: Supporting a small group of Y5 children in learning about electricity</td></tr>
<tr><td>Personal Derminant

Beliefs about primary science

‘it's just a subject that I'm interested in, but I feel like I don't have the confidence in doing…

Her views of primary science are: ‘I'd probably say boring.’.

And teaching primary science: ‘Stressful ‘

‘I feel like if I start teaching science a lot more, I'll be a bit more confident, but yeah, I guess it's just the unknown of teaching science that I don't really know what to expect…’

Interpretation of experience

‘it was quite good coz the group I was with, they kind of didn't want to stop. They just found it really interesting …but I couldn't imagine doing it as a whole class.’</td><td>Outcome

Researcher interpreted construction of I Can statements potential contribution to self-efficacy beliefs

I can- work scientifically with a small group of children

I can- teach topics I am unsure of by seeking support from others.

I can- enjoy teaching science when I think I am helping the children to learn something and they are engaged

I can- plan and carry out suitable activities and this has given C11 ‘a little bit of confidence’.</td></tr>
<tr><td>Environmental Determinant

Contextual influences

Imposed: within a classroom

Social: Mainly worked with a group of 5-6, mixed ability children from a class of 20. Supply teacher took main responsibility for lesson.

Physical: Classroom. Involved practical work with resources for teaching electricity</td><td>Behavioural Determinant

Personal Agency Influences

Proxy: Topic largely planned by teacher who gave C11 a section on circuits to plan. Worksheets provided by teacher.

Individual: Some elements indicated since C11 ‘had a go at planning… circuits’. C11 ‘had no idea where to start’ and sought support from friends who were science specialists which contributed to enabling children to work practically with circuits and ‘in groups’.

C11 seems to suggest that it was her decision to work with a group rather than do the whole lesson: ‘My teacher tutor wasn't there so we had a supply teacher and because I hadn't done science before I was a bit nervous, so I ended up just taking a group’.</td></tr>
</table>

Figure 6.8 Summary AF(TRC) 1 for C11

Figure 6.8 shows how the AF(TRC)1 was applied. The personal determinant contains quotes linked to C11’s beliefs about primary science, and C11’s interpretation of the teaching experience, at the time of the interview. The behavioural determinant indicates to what level C11 controlled the activities or was guided by others, and the environmental determinant indicates the degree of agency C11 had over the environment in which the science took place.

6.1.5 Interpretation of AF(TRC) 1 through deductive vignette six for C11

Bidirectional reciprocal interactions between the determinants can dynamically raise and lower self-efficacy belief (Ponton and Carr, 2012). This example illustrates how each determinant in the TRC model can influence decisions in the other determinants.

The size of each determinant from Figure 6.8 reflected that the personal and behavioral determinants were the most influential in contributing towards C11’s perception of this experience. Evidence for self-efficacy was interpreted from C11’s response by referring back to Figure 6.8 on theoretical descriptors for high/low

self-efficacy. For instance evidence of a low sense of self-efficacy (Klassen and Durksen, 2014) was shown when she seemed to have had the opportunity to do her section on circuits with the class, but decided to take a group whilst the supply teacher took the whole class.

C11 also demonstrated aspects of high self-efficacy. For instance, she wanted to ensure a successful experience and sought support from her friends who were science specialists, demonstrating motivation and persistence to achieve her teaching goals (Bandura, 1997). In seeking support, however, she also demonstrated aspects of low self-efficacy because C11 seemed to perceive this as further evidence that she doesn't know what to do and sees others as being more knowledgeable about teaching science than she is (Glackin and Hohenstein, 2018). Analysed in terms of the TRC determinants (Bandura, 1997), C11 showed that her personal worries and lack of experience for teaching primary science in the personal determinant, led to her choices of agency in the behavioural section.

The environmental determinant reflected that the availability of resources for teaching electricity influenced C11's choices for using practical investigations as shown in the behavioural determninant. C11 reflected that the practical part of the lesson led to good feedback from the children because the children were engaged and she felt that they had learnt something through the activities. The session went well and in the end did contribute to building up her self-efficacy *'a little bit'* but she still said that 'I *feel like I'm a confident teacher and I feel like I can make lessons work but with science, I feel like I'll be a lot more nervous and-- yeah, just nervous'*. Therefore, her behavioral and environmental choices resulted in positive feedback and improved her perception of the teaching experience, but still did not build up her self-efficacy beliefs sufficiently when she considered whether she would be able to teach the same topic to a whole class.

Knowing the starting point for a lesson and being able to develop a plan for a really interesting lesson seemed to be important issues for C11 as she said*, 'Like taking them outside, kind of giving them all these materials for them to experiment themselves, and kind of give them a not boring experience. Because I feel like they could learn a lot better than kind of being talked to. I feel like that's boring.'* Her desire to be an effective science teacher acted in part as a constraint because she was more concerned about getting things right, further evidence of a low sense of self-efficacy towards teaching science (Brigido *et al.,* 2013).

When asked about her own estimate of self-efficacy for teaching primary science, towards the end of the interview, C11 indicated that it was probably *'somewhere in the middle'*. In determining her own self-efficacy beliefs for teaching science in the future she had assessed the mastery experience through the three levels of assessment associated with self-efficacy beliefs (Bandura, 1977):

- the level of difficulty of the task she experienced,
- the strength of confidence she had about carrying out the task and how this altered during the experience,
- her awareness of being able to transfer generic skills across subject boundaries in order to teach primary science.

In conclusion C11 identified that different areas of science may be more challenging for her to teach than other areas, that she can use some general pedagogy to support her in teaching primary science but the strength of her self-efficacy beliefs for teaching primary science were insecure at the point of the interview.

6.1.6 Completion of AF(TRC) 2 following teaching experience for C11

From the initial interview it appeared that C11 had a lower sense of self-efficacy towards teaching science than other primary curriculum subjects such as art, English and Mathematics. Her own judgement of self-efficacy for teaching science lay somewhere in the middle *'If I had a plan, knew what I was doing, I feel like I could teach a science lesson. But it's just getting the ideas and starting and knowing what to do first'.* Given her concerns C11 may have avoided choosing to teach science in situations which she might find challenging e.g. whole class teaching, classroom environment, teaching topics that she was unfamiliar with or had had little experience in, however this was not the case and she sent a follow-up email describing what, and how she was involved in teaching science to key stage one. AF(TRC) 2, in Figure 6.9, was created from C11's email description of teaching science on her final practice. Quotes are taken from the email. It can be seen that C11 took more responsibility for changes in the environmental and behavioural determinants and demonstrated a greater autonomy for her teaching which reflected a higher level of self-efficacy (Klassen and Durksen, 2014).

6.1.6.1 Application of AF(TRC) 2 to data collected following teaching experience for C11

Figure 6.9 was completed after C11 had taught science on an assessed placement and shared her thoughts via an email.

<table>
<tr><th colspan="2">Teaching experience: Teaching KS1 Animals including Humans</th></tr>
<tr><td>Personal Determinant
Beliefs prior to placement

'I feel like primary science is very boring. I don't want to say boring but that's-- because I know it can be exciting but I think my experience has been all… well it's all the same and it's not exciting.'
'I feel like I'm a confident teacher and I feel like I can make lessons work but with science, I feel like I'll be a lot more nervous and-- yeah, just nervous'

Interpretation of placement experience

'I have been able to teach quite a bit of science and I would say that it has been really successful so far!'
'The children loved it and I felt it was a really practical approach to their learning (which I was mainly worried about not achieving before)...'
'We have also done some really good outdoor learning…'
'Recently I have started introducing elicitation activities, such as concept mapping, that I do with the children… it also a really good form of assessment.'</td><td>Researcher Interpreted construction of I Can statements-potential contribution to self-efficacy beliefs

I can-teach science in a creative and interesting way to help children's engagement with science

I can- seek and use others' support successfully

I can- take science outside and use practical approaches successfully

I can- use my own ideas successfully to enable children to make progress in science

I can use a range of strategies for teaching and assessing science

Behavioural Determinant
Personal Agency Influences</td></tr>
</table>

Environmental Determinant Contextual Influences **Imposed:** classroom **Selected**: Using the outdoor space. Bringing in additional resources such as the hedgehog tunnel and children's books **Social:** Y1 and Y2 children **Physical:** Bringing in additional resources such as the hedgehog tunnel and children's books, using different teaching spaces	**Individual:** *'When I first started teaching science I didn't have much support from the teacher tutors in terms of how to teach it, but I have used a science specialist quite a lot for ideas!'* Choosing practical approaches such as observing what happened with the hedgehog tunnel Choosing to use elicitation activities such as concept mapping Choosing to use elicitation activities such as concept mapping

Figure 6.9: Summary AF(TRC) 2 for C11

6.1.7 Comparisons between AF(TRC) 1 and AF(TRC) 2 to illustrate the influence mastery experiences might have in altering potential self-efficacy beliefs for C11

In her placement experience C11 taught key stage one children and she was able to use the outdoor space to support some science teaching. This was an area of concern for her in the interview because she found the classroom to be a potential source of messiness causing additional issues for teaching science and lowering her self-efficacy (Bandura, 2006). C11 demonstrated motivation to bring in relevant resources to support the practical activities and to support her own aspirations of being creative and an effective teacher by making science 'not boring' and this reflects higher levels of self-efficacy (Mansfield and Woods-McConney, 2012). The feedback from the children suggested that she had been successful by providing activities which they enjoyed as well as promoting their science learning. C11 introduced elicitation activities (Harlen and Qualter, 2018), demonstrating a willingness to try new ideas and new pedagogical approaches (Glackin and Hohenstein, 2018), which in the interview was another cause of concern in case she did not have enough subject knowledge to work with the children's ideas. The suggested I can statements from AF(TRC) 1 and 2 are illustrated in Figure 6.10. They have been interpreted by me from C11's interview and email, and others may have developed a different set of statements.

AF(TRC) 1 Potential influences on self-efficacy-researcher interpreted	**AF(TRC) 2 Potential influences on self-efficacy-researcher interpreted**
I can- work scientifically with a small group of children I can- teach topics I am unsure of by seeking support from others. I can- enjoy teaching science when I think I am helping the children to learn something and they are engaged I can- plan and carry out suitable activities and this has given C11 *'a little bit of confidence'*.	I can-teach science in a creative and interesting way to help children's engagement with science. I can- seek and use others' support successfully. I can- take science outside and use practical approaches successfully. I can- use my own ideas successfully to enable children to make progress in science. I can- use a range of strategies for teaching and assessing science

Figure 6.10: Comparison between AF(TRC) 1 and AF(TRC) 2 summaries of C11's experiences

Linking these outcomes with Figure 2.1 on high/low self-efficacy (Klassen and Durksen, 2014), it can be seen that C11 showed evidence of behaviours linked to high self-efficacy such as willingness to try new ideas, enthusiasm and a sense of competency for teaching primary science (Bandura, 2006, Glackin and Hohenstein, 2018; Klassen and Durksen, 2014; Brigido *et al.,* 2013). Her increased involvement with the environmental and behavioural determinants have positively impacted her personal views of teaching science. Therefore, It can be seen that C11's experiences interpreted through AF(TRC) 2, reflected a higher sense of self-efficacy than was illustrated in AF(TRC) 1 (prior to her teaching experience), though it must be remembered that self-efficacy beliefs are dynamic and open to change in differing situations (Bandura, 1997). In an environment involving working with key stage one children C11 may have felt more secure with the topic area and her own subject knowledge.

6.1.8 Reflective thoughts

The process of reflection through the interview may have encouraged C11 to create opportunities to develop her experiences of teaching science, and to use pedagogical approaches from other areas such as art to support this. The interview appeared to provide a means for her to reflect on what she could do, and in the process take an active role as author of her own experiences. Through discussion from prior-to, and after-placement, C11 moved from being a passive responder to ideas that she did not seem to own, to becoming an active, involved teacher looking to help children make progress in science. The successes she experienced motivated her further to try different resources and identify constructivist strategies for teaching science (Dunne and Maklad, 2015). Therefore, AF(TRC) had been useful in identifying 'I can' statements from her experiences which may have contributed towards changes in C11's self-efficacy for teaching primary science. It still relies on being able to interpret the experiences that may influence the 'I can' section, but it provides a way of analysing influences on self-efficacy using the TRC perspective.

Themes that appear from comparisons of the two experiences indicate how greater mastery experiences impacted on potential self-efficacy judgments for teaching primary science such as:

- Greater autonomy in choosing her teaching environment and choosing resources to support that environment,
- Evidence of effective teaching through feedback from the children to demonstrate that they are learning, are enjoying what they are doing and that C11's teaching approaches are successful,
- Her own capacity to deal with new children in different key stages studying, different science topics,
- Her own capacity to make use of generic pedagogy and subject specific pedagogy,
- Evidence of influences on self-efficacy beliefs such as the three factor analysis of the teaching task, and goal-setting to continue to achieve successful experiences of teaching science.

The next section repeats the process with C4.

6.2 Stages in the application of the analytical framework AF(TRC)for C4

6.2.1 Creation of project map from interview for C4

Figure 6.11: Project map developed from the thematic analysis of C4 interview using NVivo 12 pro

Figure 6.11 was generated in NVivo 12 pro to illustrate the influences, beliefs, feelings and experiences that C4 had about primary science, which might influence her self-efficacy beliefs for future experiences of teaching primary science. Observations in schools and placement circles are not connected to C4 because she had yet to undertake her first assessed teaching placement at school.

6.2.2 Creation of inductive vignette seven for C4

Information from the codes shown on the project map were used to construct the summary contextual background for C4 as shown in Figure 6.12.

Summary contextual background for C4	
Own assessment of science in terms of confidence	*'my er GCSE times probably the last time I did science at school. It wasn't something I continued into A level. But I did go on to do Geography in A level and I did my undergraduate in Geography. So that's like a side a part of science isn't it.'* '*The main thing for me was to tell you about the fact that I wasn't in school in KS3…I feel like you wouldn't have known that... that's affected part of my big knowledge gap.'* '*I did the science confidence audits and things which I was pretty pleased with…I got 53 out of the 73 so that was.. that made me feel more confident'* Completed GCSE science and additional science
Exploration of influences from vicarious experiences	*'I found Physics and Chemistry most interesting and that might have been also down to the teachers because I feel like I had good teachers for those subjects as well…'* Her beliefs about a good teacher: '*Someone who is going to be willing to explain why things work and enquire more about those processes, um. Give different approaches, different experiments to engage with. Um, not just. Being given the opportunity to explore areas that interest you in a bit more detail than, just, what we're going to be learning today and then follow the lesson plan to..'* *'the encouragement that I've had from friends and family that have told me that I was good with working with children.'*
Exploration of influences from mastery experiences	*'In my pre-placement experience here some of it was in science lessons and I had the experience of supporting the teacher and to carry out a lesson to Year 4's on rocks and so they were supposed to have pictures of rocks and look at different rocks and explore the different features. But instead, me and the primary teacher got different actual physically different rocks and showed it to the children and it made them, in groups, discuss what the differences were; what they were like their weight and things like that so because they were physical objects they were able to explore them a little bit better and there was more questions coming out from that than there was than with the picture, I imagine*.' *'So, I was working in the class and like they were split up into four different groups so there would have been about 4-5 on a table.'*
Additional comments about feelings towards primary science/science	*'Yeah, I think though particularly because when I'm thinking of science I'm probably relating more to my secondary experience than my primary experience just because that's what I remember more'* *'…I've taken children out of class so many times when I've been working with children that….and I've had to carry out my own risk assessments for the different place to be visited'* *'Not at the moment. I think I need more experience of what I don't know…Once I start to carry out my own science lesson then I'll be able to reflect and evaluate that and go from there to be able to improve my own teaching, I think.'* '*I don't know. I guess if I had a science lesson, or any lesson that didn't go very well then that would knock my confidence. I know that's going to happen because I'm not going to go in there and be able to teach perfectly by next week. Um, I think one of my own threats about going to be a teacher is the fact that my own experience as a student is limited because I wasn't in a lot of my education myself. So I think just being…I'm not afraid to work with children. I'm just afraid of being in that environment to be able to teach. I'm happy with the kids outside so I think I work more with the kids outside of the school because that's not where my anxieties lie.'*

Figure 6.12: Summary contextual background for C4 including direct quotes in italics and some interpretive summaries

6.2.3 Inductive vignette seven for C4

At the time of the interview C4 was on a one year PGCE course with a background in Geography. C4 was shortly to do her first assessed placement in a primary school with Y6. She had not taught science before but her pre-course experience included an opportunity to actively support a lesson on rocks with Y4. In the interview C4 had considered teaching Geography in secondary school initially, but her experiences in the holiday club for children 4-11, plus feedback from friends and family persuaded her to change to primary education as can be seen here *'at home my job is to work at holiday clubs for primary school aged children 4-11 during all the school holidays and it was that work that I did with them and the encouragement that I've had from friends and family that have told me that I was good with working with children. Just all the experiences put together, really, made me want to go to primary'* C4.

From the interview responses and comparing this to the theoretical descriptors used to estimate levels of self-efficacy in research aim 1, C4 indicated that her self-efficacy for teaching some aspects of science were stronger than other aspects. For instance she indicated that she is not concerned about drawing up risk assessments or taking children outside because *'…I've taken children out of class so many times when I've been working with children that….and I've had to carry out my own risk assessments for the different place to be visited'* C4. C4 was not as confident when asked about teaching science because of her lack of experience. She was also realistic about her own expectations for her first placement '*I'm not going to go in there and be able to teach perfectly by next week'* C4. C4 indicated that she does have some self-efficacy doubts and these are linked to the fact that she '*wasn't in school in KS3'* due to personal reasons, which she felt has '*affected part of my big knowledge gap'* C4. However, C4 also showed that she was motivated to work at bridging her knowledge gap in order to be able to teach science, and was willing to draw on her own experiences and theory from her ITT course, to deal with general pedagogical issues such as behaviour management and approaches to working scientifically with children, as she indicates here*, 'I'm quite excited, in a way, to carry out different experiments with the children and enquire with the children. I suppose that's like where a lot of the Geography comes in about inquiry and exploration skills where they overlap there a little bit'* C4.

6.2.4 Completion of AF(TRC) 1 using the inductive vignette based on data collected prior to a school experience for C4

C4's experiences as outlined in vignette seven were analysed using AF(TRC) 1 to produce a summary interpreting her pre-course experience through personal, behavioural, and environmental determinants (Bandura, 1997). I have used the detail from her interview to highlight the constraints and facilitators that influenced her perception of the experience. I then constructed a list of 'I can' statements (Williams and Rhodes, 2014) to show how the determinants of AF(TRC) 1, Figure 6.13, could be used to interpret potential sources of self-efficacy beliefs, which might be interpreted in a different way by others.

AF(TRC) 1

C4 Teaching experience: Pre-placement supporting Y4 with rocks	
Personal Determinant **Beliefs about primary science** *'Lots of science experiments and going out into the field trying to not just use the classroom or things within the classroom things brought out of the science cupboard but going out and about as well.'* *'I'm quite excited, in a way, to carry out different experiments with the children and enquire with the children'* **Interpretation of pre-placement experience** *'what they were like their weight…because they were physical objects they were able to explore them a little bit better and there was more questions coming out from that… than with the picture, I imagine.'* *'…a bit too long than the teacher wanted to but she was happy to let it continue because the children were engaged with exploring these rocks'* the teacher said *'that she was just pleased with my engagement with the children…pleased with the questions that I was asking the children'*	**Outcome** **Researcher Interpreted construction of I Can statements-potential contribution to self-efficacy beliefs** **I can- use inquiry and exploratory skills from Geography within science** **I can- teach but it is not going to be perfect** **I can – do the science but there are gaps that worry me partly because of not doing KS3 at school and the lack of experience I feel that I have** **I can- work on these gaps to support teaching.** **I can- work with children** **I'm quite excited to use inquiry and exploration skills. I believe that classroom experiences will support my confidence**
Environmental Determinant Contextual influences **Imposed:** within a classroom **Social:** Mainly worked with groups of 4-5, Classroom teacher ran the lesson. **Physical:** Classroom. Involved practical work with physical resources of rocks for children to observe and explore.	**Behavioural Determinant** Personal Agency Influences **Proxy:** Lesson organised by teacher with C4 supporting **Individual:** Elements of individual input with groups*'I went round each group and I was able to engage with each group just as me and that group…'I would hold two different rocks and ask them "why are they different?'* **Collective:**'*…a lesson to Year 4's on rocks and so they were supposed to have pictures of rocks and look at different rocks and explore the different features. But instead, me and the primary teacher got different actual physically different rocks and showed it to the children and it made them, in groups, discuss what the differences were'*

Figure 6.13: Applying AF(TRC) for C4 supporting a teacher with Y4 on the topic of rocks

Figure 6.13 shows how the AF(TRC) tool was applied. The personal determinant contains quotes linked to C4's beliefs about primary science, and C4's interpretation of the teaching experience, at the time of the interview. The behavioural determinant indicates to what level C4 controlled the activities or was guided by others, and the environmental determinant indicates the degree of agency C4 had over the environment in

which the science took place. This was a limited but successful experience as highlighted by C4 when she said that it had supported her '*a little bit….. but I don't think it's made a big impact'* C4.

6.2.5 Interpretation of AF(TRC) 1 through deductive vignette eight for C4

Bidirectional reciprocal interactions between the determinants can dynamically raise and lower self-efficacy beliefs (Ponton and Carr, 2012).This example illustrates how each determinant in AF(TRC) 1 can influence decisions in the other determinants.

Both the personal and behavioural determinants in Figure 6.13 AF(TRC) 1, provided some indication of C4's perception of her pre-course experience. The personal determinant sector summarised some beliefs that C4 had for teaching science through an inquiry approach (Harlen and Qualter, 2018). This is reflected in both the environmental determinant which indicated the type of resources available, and the behavioural determinant where the teacher and C4 collectively decided on using rocks rather than pictures. The outcome enabled the children to work scientifically with real objects (Dunne and Peacock, 2015). The teacher provided a supportive environment for C4 to work within an area that she had some confidence in. C4 was able to use her skills and knowledge linked to her Geography background, to support an inquiry and exploration approach and the feedback she received from the teacher was positive. Therefore, C4 had a successful, though small mastery experience, focussing on helping children to learn about rocks. In the interview C4 was aware of aspects of the lesson she would not have known where to start with, such as at what level to pitch the lesson, or what the children already knew and what they might be doing in the future but C4 was already considering ways of addressing these for future teaching opportunities.

At the time of the interview therefore, C4 had had little experience about teaching primary science, however her responses placed her in the high self-efficacy column in Figure 2.1 because she demonstrated that she is excited about going to teach science, that she intends to address her subject knowledge issues as required, that she enjoys working with children, and is aware of her own limitations (Bandura, 1977; Glackin and Hohenstein, 2018; Klassen and Durksen, 2014; Brigido *et al.,* 2013). In C4's own judgement of self-efficacy for teaching primary science, going forward into placement, she thought that she appeared more confident than she felt because she said that '*I just don't think I've had enough experience to be able to teach'.* Later, however, she said that *'I think I will become more confident with experience. At first I don't think I'll be ever so confident but once I get used to teaching, not just in science, but teaching other areas then I can use that knowledge to build in to my primary science teaching'* C4. C4 perceives she has the capability to teach but judges that her lack of experience to draw on, prevents her from feeling secure in the context of teaching primary science prior to going out on her first placement.

6.2.6 Completion of AF(TRC) 2 following teaching experience for C4

C4 went on her first assessed placement and when she returned she came in and shared her teaching experiences in a second interview. In summary her main concerns about not having completed key stage three in secondary school and the impact this might have had on her subject knowledge affected her less than she had perceived. She was able to teach electrical circuits to year six, a topic that she was not so confident with but she worked with her teacher-tutor and felt more confident. The teacher modelled the first two lessons which C4 described as good. The teacher-tutor gave C4 the confidence to have a go at doing electrical circuits with the children. In the mastery template the behaviour section focussed more on individual responsibility though the teacher had done the planning. As a result C4 was able to focus on the teaching, and therefore, the teacher-tutor provided the scaffolding that C4 needed at this stage in order to build up experiences in teaching primary science without worrying about planning for an area that she was not familiar with. C4 was able to reflect on teaching strategies that she used such as questioning children's misunderstandings, the correct use of language, and how to respond to the children. C4 identified the importance of feedback from the teacher-tutor which also contributed to building up her confidence as well as the children enjoying the science lessons with her. This set of mastery and vicarious experiences successfully impacted on C4 and in the interview it could be seen that her self-efficacy going forward to her next placement, was more secure and that some of her concerns had been addressed.

The AF(TRC) 2 summary as in Figure 6.14, was created from C4's interview description of teaching science on her first assessed placement. It can be seen that changes in the environmental and behavioural determinants demonstrated that C4 took on greater autonomy for her teaching which reflected a higher level of self-efficacy (Klassen and Durksen, 2014). Despite showing some concern previously about subject knowledge, having missed out on KS3, C4 demonstrated a willingness to try new approaches such as modelling circuits to the children, and worked with children's ideas to attempt to address their misconceptions (Glackin and Hohenstein, 2018).

C4 Teaching experience: Teaching Y6 electrical circuits on first assessed placement of ITT course	
Personal Determinant **Beliefs prior to placement- from interview 2** C4 agreed that she has strengths in Geography and working with 4-11 years olds in a holiday club environment. C4 did not do KS3 at school and feels that this may contribute to subject knowledge gap and lack of experience. Feedback encouraged C4 to do Primary teaching **Interpretation of placement experience** C4 did not feel so confident with topic of electricity Having taught her first lesson the teacher-tutor thought that C4 was more confident than C4 thought. C4 said that having other people feel confident in her improved her own confidence for teaching Feedback was positive and regular which improved C4's confidence C4 modelled a circuit using electrical components to support children's learning. Children gained confidence from C4's confidence	**Outcome** **Researcher Interpreted construction of I Can statements-potential contribution to self-efficacy beliefs** **I can-adapt plans to suit children's progress** **I can – address subject knowledge to enable me to teach unfamiliar areas of science** **I can- work with my mentor to explore approaches to challenging children and assessment in science** **I can-model confidence to children to help children feel confident in their learning**
Environmental Determinant Contextual influences **Imposed:** within a classroom **Social:** Teacher in room whilst C4 led sessions with Y6 on electrical circuits, on most occasions **Physical:** Classroom. Involved practical work with electrical circuit equipment	**Behavioural Determinant** Personal Agency Influences **Proxy:** Lessons planned by teacher with teacher taking first two sessions and C4 taking remainder four. Modelling and planning by teacher proved helpful **Individual:** C4 adapted plans to reflect children's learning and feedback, and had the autonomy to direct the lesson. C4 did move groups about to support their learning

Figure 6.14: Applying AF(TRC)2 to C4's experience for teaching electrical circuits to Y6

6.2.7 Comparison between AF(TRC) 1 and AF(TRC) 2 to illustrate the influence mastery experiences might have in altering potential self-efficacy beliefs for C4

Using Figure 6.15 It can be seen that C4's experiences interpreted through AF(TRC) 2 using her follow-up interview, reflected a more secure sense of self-efficacy than seen at the initial interview and summarised in AF(TRC) 1. Linking these outcomes with Figure 2.1 on high/low self-efficacy it can be seen that C4 showed evidence of behaviours linked to high self-efficacy such as confidence with subject knowledge, enthusiasm and a sense of competency for teaching primary science (Bandura, 2006; Glackin and Hohenstein, 2018, Klassen and Durksen, 2014; Brigido *et al.,* 2013). Her increased involvement in the behavioural determinant increased her perception of knowing what is entailed in teaching primary science. Therefore, it can be seen that C4's experiences interpreted through the AF(TRC) 2 reflected that her self-efficacy for teaching primary science had developed over the assessed placement. The scaffolded support of the teacher-tutor provided C4 with successful experiences.

Both experiences for AF(TRC) 1 and AF(TRC) 2 demonstrated that C4 was motivated to develop her own way of teaching, was persistent in finding ways of challenging children either through questioning or additional

activities, was willing to risk untried/unfamiliar topics e.g. modelling a circuit to children, challenging their misconceptions and willing to be observed (Klassen and Durksen, 2014 and Glackin and Hohenstein, 2018).

AF(TRC) 1C4 Potential influences on self-efficacy- researcher interpreted	**AF(TRC) 2 C4 Potential influences on self-efficacy- researcher interpreted**
I can- use inquiry and exploratory skills from Geography within science I can- teach but it is not going to be perfect I can – do the science but there are gaps that worry me partly because of not doing KS3 at school and the lack of experience I feel that I have I can- work on these gaps to support teaching I can- work with children I'm quite excited to use inquiry and exploration skills. I believe that classroom experiences will support my confidence	I can-adapt plans to suit children's progress I can – address subject knowledge to enable me to teach unfamiliar areas of science I can- work with my mentor to explore approaches to challenging children and assessment in science I can-model confidence to children to help children feel confident in their learning

Figure 6.15: Comparison between AF(TRC)1 and AF(TRC) 2 summaries of experiences

6.2.8 Reflective thoughts

I have debated over how big should a mastery experience be? Given the limited opportunities in schools for science, I have made the decision that experiences that give participants opportunities to reflect on their capability for teaching science to children, contribute towards developing self-efficacy (Bandura, 1997). Therefore, C4's initial mastery experience, though small provided evidence of a successful teaching experience. Her second teaching experience was longer and developed over a period of time in a subject area that she was not so familiar with, and therefore, more demanding in terms of subject knowledge and subject specific pedagogy. C4 was persistent and motivated to encourage children's learning in electricity and sought ways of making this happen successfully, therefore, developing her self-efficacy within the high self-efficacy section (Bandura, 1997). This does not mean that C4 has high self-efficacy for all aspects of teaching primary science, but it provides her with some useful experiences to draw on for when she next contemplates her self-efficacy for teaching primary science.

Themes that were most likely to influence the development of self-efficacy beliefs of C4 included:

- The role of the mentor- in this case the mentor provided clear scaffolded support such as planning and modelling lessons which helped C4 in areas that she had concerns with- lack of experience, where to pitch lessons, and what level of knowledge she required to be able to address misconceptions that the children had,
- Aspects of teaching science that can cause preservice teachers concern- subject knowledge is mentioned but what comes across more is pedagogical subject knowledge (Schon,1986)- not generic pedagogy which can be assimilated from other areas of the curriculum, but organisation of the science lesson, where to pitch lessons, how to support progression in science, how to deal with

misconceptions, how to enable children to provide evidence of their work but still maintain a practical approach suitable for KS2,

- Feedback both explicit and implicit- this was important to C4 because it provided evidence of success, enabled her to see how to use the vocabulary required to teach this topic, and use models to illustrate circuits to support children's learning. Direct feedback from the teacher was also invaluable in building up her self-efficacy beliefs,
- Working with children over a period of time/lessons- this gave C4 the opportunity to assess her own input and adapt things as needed as she got to know the children and their abilities more fully,
- Autonomy to choose her own approach to teaching science in the classroom.

I think that AF(TRC) was useful because it signposted how C4's agency altered between experience one and experience two. It was useful to summarise the contexts in which the experiences took place and the role of the teacher within the contexts. Whilst the experience of teaching is important it is also important that the people who matter to the preservice teachers, such as their teacher mentors, provide the support that the preservice teachers need. In the case here if C4 had been asked to take the lessons straightaway she may still have done so successfully but her perceptions may not have been so positive afterwards, because the experience would have required greater initial effort in order for C4 to feel more secure about the topic area and her choice of suitable pedagogical choices appropriate for this class. I'm reminded that self-efficacy beliefs are dynamic, particularly so for preservice teachers in their early stages of development. Slight changes in the environmental and behavioural determinants can affect how C4 and C11 now perceive their self-efficacy beliefs for teaching primary science.

6.3 Introduction to the TRC Integrated Cyclical Model Development

In the final phase of this thesis I have explored approaches to inform understanding of the nature and development of self-efficacy through the use of cyclical models, a more recent development for self-efficacy research (Wyatt, 2016). As can be seen from the work of theorists such as Tschannen-Moran *et al.,* (1998), cyclical models have been used as a way to illustrate and visualise the influences and decisions that impact on the development and dynamic nature of self-efficacy theory. In the literature review I have identified the particular models that have been influential in this thesis and explored similarities and differences between how these models might contribute to developing understanding of self-efficacy. Drawing on the literature review it became apparent that these conceptual models were useful in demonstrating the number of factors in making self-efficacy judgments (Gist and Mitchell, 1992). There is, however, still a gap between the theoretical development of self-efficacy theory and the practical use of cyclical models for practitioners (Wyatt, 2016), particularly if they have little understanding of the construct. In this thesis I have developed my own cyclical model, TRC Integrated Cyclical Model, Figure 6.16. Chapter seven will be used to illustrate its use with practitioners.

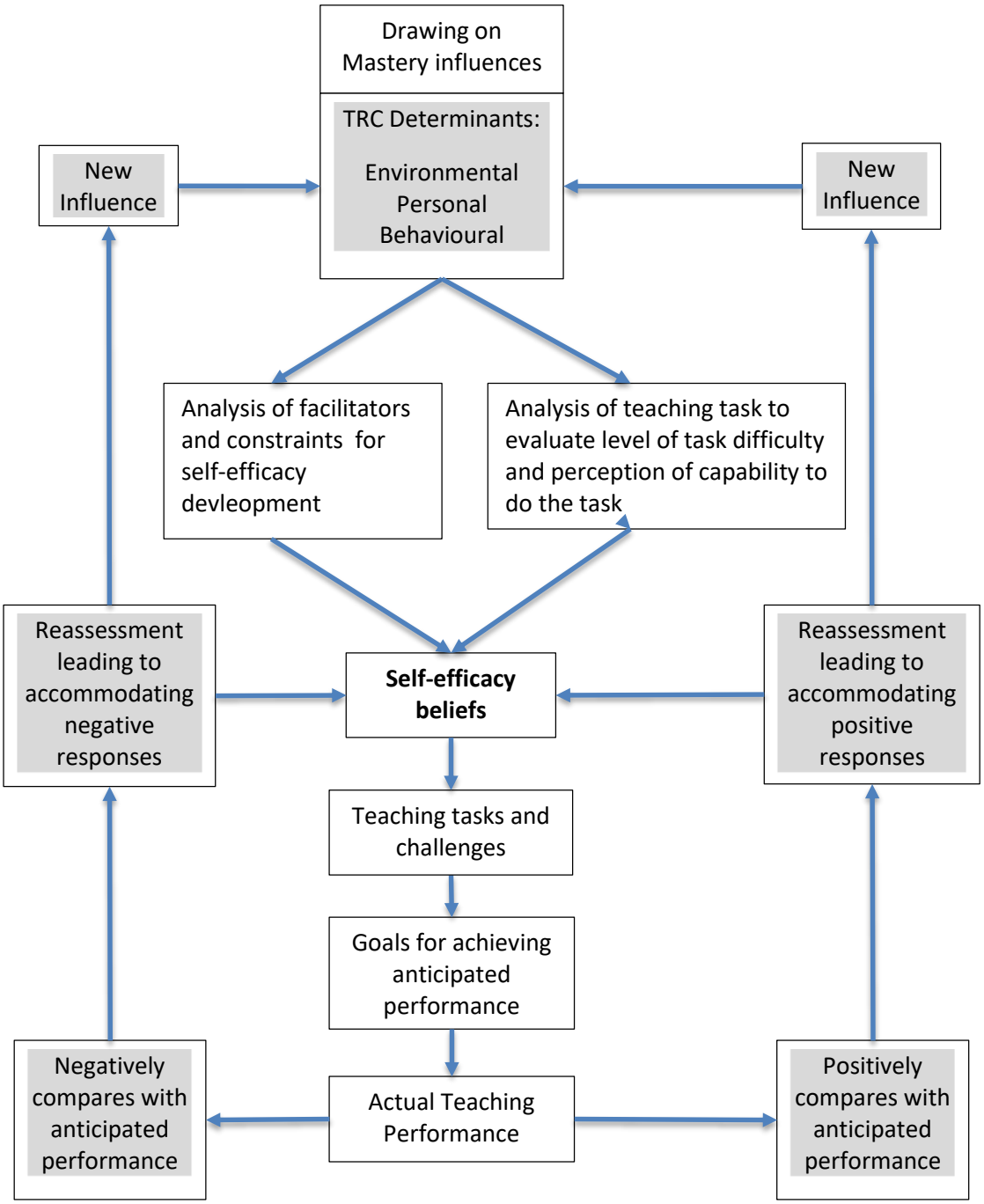


Figure 6.16: TRC integrated Cyclical Model

Recent progressions in self-efficacy research have focussed on the development of cyclical models to show the interrelationships between factors that may contribute towards self-efficacy beliefs. These cyclical models have been used to increase understanding of influences that impact on the dynamic and complex nature of self-efficacy and discussed in sections 2.6.9-2.6.12. Cyclical models continue to be interpreted in work such as that of Mansfield and Woods-McConney (2012) and Wyatt (2016). Drawing on the literature I have adapted theoretical cyclical models of Gist and Mitchell (1992) and Tschannen-Moran *et al.,* (1998) building on the foundation of the TRC model of Bandura (1997) and constructivist influences of von Glasersfeld (1995), to provide a visual framework of the processes involved that influence and potentially

change self-efficacy beliefs. The TRC Integrated Cyclical Model, has also been influenced by this research and has been designed to show:

- how self-efficacy beliefs influence anticipated performance,
- how self-efficacy beliefs are reassessed when these anticipated outcomes are evaluated and compared to actual outcomes, and
- how this reassessment feeds back into self-efficacy estimations through shorter 'in-the-moment' feedback loops, and longer term 'time to reflect and evaluate' feedback loop.

The central part of the TRC Integrated Cyclical Model, Figure 6.16, reflects Bandura's (1977; 1986; 2004) theoretical assumptions of how influences such as mastery experiences can impact on self-efficacy beliefs. Previous mastery influences can be assessed through the application of the AF(TRC) framework developed in section 6.4.5 of this research. Through the cognitive analysis of such mastery influences participants can reflect on the level of difficulty of previous teaching tasks, and the facilitators and constraints that impacted on participants' perception of their experiences. The perception of these experiences affect participants' self-efficacy beliefs which Bandura defined as 'beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments' (1997:3). The TRC Integrated Cyclical Model incorporates aspects of von Glasersfeld's interpretation of Piaget's Action scheme, in which cognitive beliefs contribute to behaviour which in turn reciprocally inform cognitive beliefs resulting in a feedback loop (von Glasersfeld, 1995). In constructivist terms assimilation and accommodation occur throughout the model, but in trying to keep the model succinct I have only focussed on points of accommodation to illustrate aspects affecting changes in self-efficacy beliefs.

The TRC Integrated Cyclical Model is further influenced by interpreting Gist and Mitchell's (1992) and Tschannen-Moran *et al's.* (1998) cyclical model to incorporate two feedback loops reflecting the evaluative interpretations that occur as a result of comparisons between anticipated performance and actual performance. The lower loop feeds into *'in the moment'* self-efficacy changes, when teachers have to respond to unexpected challenges that might occur during their lessons. The outer loop feeds into *'longer term'* changes when teachers have had a chance to evaluate the experience in terms of self-efficacy beliefs.

6.4 Summary

In this chapter I moved from operationalisation of self-efficacy through indicators (Chapter 5) to developing a more holistic approach using an analytical framework, AF(TRC), based on Bandura's TRC model (1997). The rationale behind my decision to develop AF(TRC) was influenced by Bandura who suggested that self-efficacy is better estimated through 'analysing how people select and integrate multidimensional efficacy information than by having them rate the relative weight they give to a few preselected factors (Bandura, 1997:84). I have provided a detailed discussion of the stages used to apply the AF(TRC) model in order to explore the factors that contribute to the development of self-efficacy with an emphasis on beliefs (Pajares,

1992) and the degree of agency given to preservice teachers during mastery experiences (Bandura, 1986). Two practitioners' experiences were used to exemplify the application of AF(TRC). In both cases I was able to use the framework twice because some months after the interviews, they both provided additional information about their experiences of teaching science on their assessed placements. As a result I was able to apply AF(TRC) twice and compare the results to illustrate how the factors that potentially contribute towards building self-efficacy beliefs had altered and progressed from their perceptions at the interview to their perceptions after the teaching experiences. In the final phase of this chapter I have introduced the TRC Integrated Cyclical Model in order to progress approaches to supporting practitioners use of self-efficacy dealt with in chapter seven.

CHAPTER 7 - Application of a cyclical model and analytical frameworks to inform self-efficacy development for school based practitioners

This chapter sets out to use contributions from this thesis in order to 1) illustrate the use of a models and frameworks for analysing the facilitators that influence the development of self-efficacy, and how these influences affect practitioners' teaching responses in the context of primary science, and 2) scaffolds understanding of self-efficacy to enable practitioners to operationalise the construct to support their professional development, in the context of primary science.

Research indicates that self-efficacy beliefs influence many aspects involved in teacher development, including their pedagogical choices (Wheatley, 2005; Wyatt, 2015). Furthermore Wheatley (2005) argues that self efficacy research should be able to offer ways in which to support teacher education. Therefore, I believe that if self-efficacy research is to become more accessible for teacher practitioners, it is necessary for self-efficacy to be defined in an attainable way for use within teachers' own practices, through indicators which operationalise the construct. In addition teacher practitioners need to be able to recognise and estimate their own self-efficacy, through a framework that enables them to identify the factors that potentially affect self-efficacy development (Wheatley, 2005; Palmer, 2011; Wyatt, 2015). In this research I have sought to explore ways in which to develop a more practical and usable construct for practitioners in the context of primary science, and to deepen practitioners' understanding of self-efficacy in general (Labone, 2004). The purpose of this chapter, then, is to bridge the gap between a highly theoretical and complex construct, and the practical approaches that practitioners may find more useful.

7.1 Using the TRC Integrated Cyclical Model to support understanding of the factors that influence self-efficacy

The approach I am taking here is to illustrate how the TRC Integrated Cyclical Model can be used from the perspective of a teacher educator. I would begin with introducing self-efficacy and its associations with many characteristics linked to effective teaching in the context of primary science. I would then introduce Bandura's definition of self-efficacy which is 'beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments' (1997:3), and encourage discussion around this. Following this I would introduce the TRC Integrated Cyclical Model, Figure 7.1, and talk about how we use self-efficacy beliefs to assess potential teaching tasks and inform our capability for carrying them out. Discussion might revolve around perception of the challenges involved in carrying out science investigations, and how this may influence the goals we set in order to ensure that we can carry out the tasks to achieve successful outcomes. Additionally it would be worth exploring how practitioners perceive what successful outcomes entail as this will affect how past experiences may impact on future self-efficacy beliefs (Bandura, 1997, Dunne and Peacock, 2015).

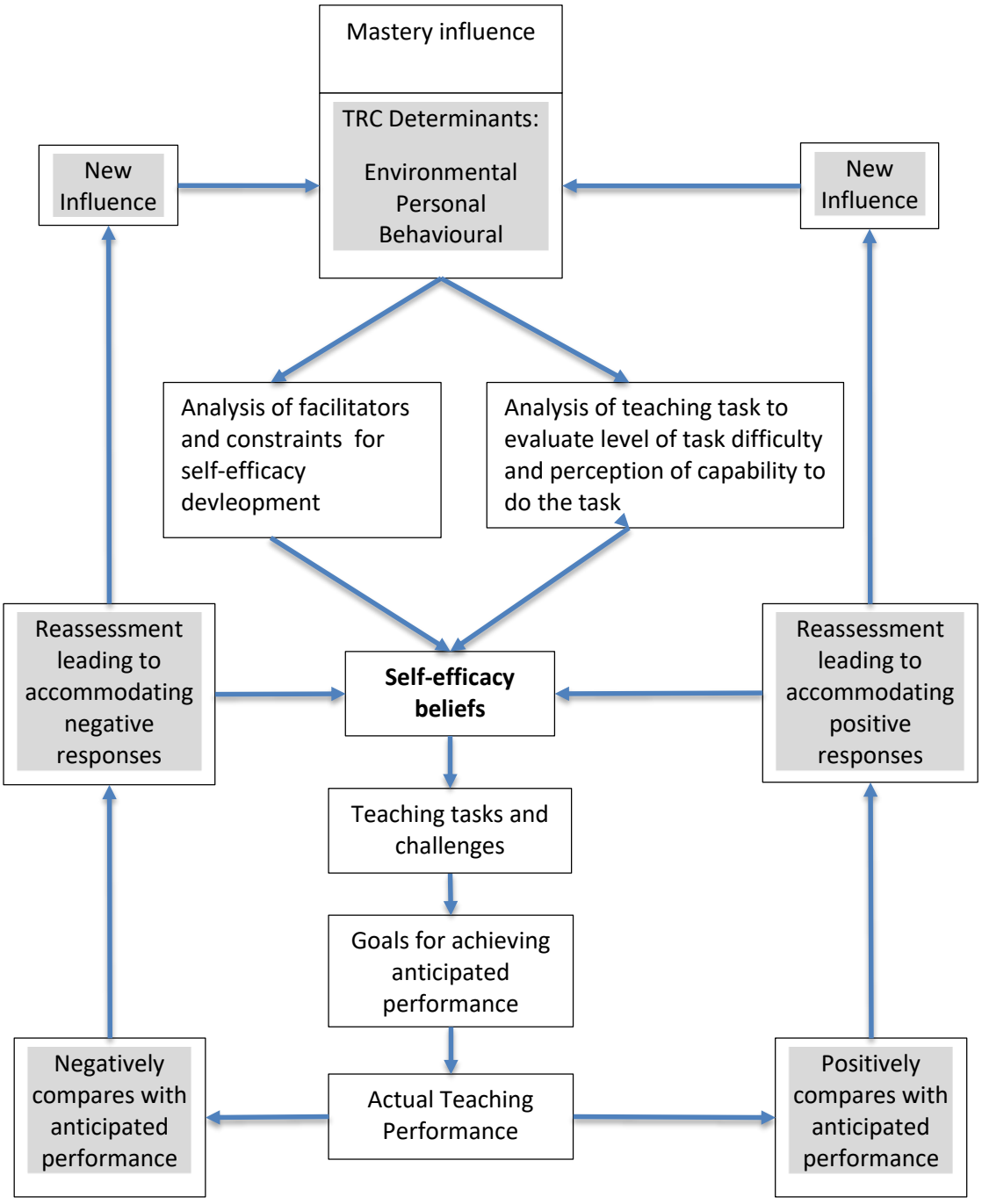


Figure 7.1: TRC Integrated Cyclical Model

Further discussion of the TRC Integrated Cyclical Model shows that comparisons are made between what we hoped to achieve and what we did achieve in terms of teaching. If the outcomes are comparable this leads towards the positive side of the model and continues to build up our self-efficacy in the short term. If we are teaching science through practical inquiry, we carry on. If the outcomes compare negatively with what was anticipated this may lead to reducing our self-efficacy and choosing to seek safer activities to do, such as moving away from child-led practical inquiries and using worksheets. The model simplifies the process of accommodation, associated with constructivist views of learning (von Glasersfeld, 1995), but does illustrate how experiences influence and alter self-efficacy beliefs.

The lower half of the model provides an 'in the moment' loop, reflecting how immediate responses to issues that arise in teaching, can also alter and influence self-efficacy beliefs reflecting the dynamic nature of self-efficacy. The whole larger 'longer term' loop illustrates that through reassessment of teaching experiences practitioners will reevalute their perceptions of their teaching experiences which will then reinforce or contribute new influences towards their self-efficacy beliefs.

Having introduced both a definition of self-efficacy and the TRC Integrated Cyclical Model in order to support the understanding of the nature of self-efficacy, I would then introduce the analytical framework shown in Figure 7.3, in readiness for a further session.

7.2 Application of the Analytical Framework based on AF(TRC)

In this session I would begin by asking practitioners to use Figure 7.2 as a discussion instrument for exploring their beliefs and influences which could potentially impact on their self-efficacy beliefs and their beliefs towards teaching science (Pajares, 1992; Mansfield Woods-McConney, 2012).

Exploration of beliefs and experiences	**Personal responses /or use examples**
Own assessment of confidence to teach science through practical inquiry	
Exploration of influences from watching others teach science through practical inquiry	
Exploration of influences from personal experiences of teaching science in general	
Own feelings towards using practical inquiry to support children's learning in science	

Figure 7.2: Table to reflect beliefs and experiences of participants

I would then introduce the analytical framework, Figure 7.3, and in discussion with participants provide examples of how to complete it using illustrative examples of mastery experiences taken from my own background.

<table>
<tr><td colspan="2">Context: including year group, science topic, teaching space, resources used</td></tr>
<tr><td>Personal Determinant

Things to consider: how confident do you feel about teaching science through practical inquiry. Explore possible reasons which may contribute towards this.</td><td>Intepretation of teaching experience using ‘I can’ statements to reflect self-efficacy beliefs (Bandura, 1997)

For instance

I can plan practical inquiry lessons for specific topics e.g.dissolving

I can help children to develop their own investigations</td></tr>
<tr><td>Environmental Determinant

Things to consider:

Social- who is involved such as other teachers, teaching assistants, children
Physical- resources available including the teaching space

For each social and physical aspect select from the following:

Selected-chosen by teachers as being most suitable for carrying out primary science lesson

Constructed-developed with others in order to suit requirements e.g. setting up a science fair

Imposed-due to external constraints e.g. must use classroom as going outside would be noisy and disruptive to other classes</td><td>Behavioural Determinant

Things to consider about your own approach

Select from the following

Proxy-will be working from other teachers’ plans or provided worksheets

Individual- will be making own decisions about the approach you intend to use for practical inquiry with the children

Collective- working with other teachers to deliver the lesson, or parts of the lesson together</td></tr>
</table>

Figure 7.3: Analytical Framework

Following on from discussion of an illustrative example of a completed analytical framework, I would discuss how the ‘I can’ statements may contribute towards determining self-efficacy beliefs for future teaching experiences (Bandura, 1997; Bergman *et al.,* 2019; Rowston *et al*., 2021). For a future experience teachers could complete the personal, environmental and behavioural aspects of Figure 7.3 during their planning phase. They could add to the framework afterwards to interpret the teaching experience through ‘I can’ statements to reflect potential implications for self-efficacy beliefs and reflect back on how personal, environmental and behavioural determinant had affected their choices for teaching science through practical inquiry.

Having completed the analytical framework the TRC Integrated Cyclical Model (Bandura, 1977; von Glasersfeld, 1995; Gist and Mitchell, 1992; Tschannen-Moran *et al.,* 1998) could then be referred back to show how changes in personal, environmental and behavioural elements impacted on ‘in the moment’

decisions, 'longer term' evaluations of teaching through practical inquiry, and their self-efficacy beliefs. Discussions could follow to explore the contextual, multi-layered and dynamic nature of self-efficacy beliefs (Bandura, 1997).

Through the use of the TRC Integrated Cyclical Model and the analytical framework, both developed from this thesis, I have illustrated an approach for informing the development of self-efficacy through contributing factors such as personal beliefs, environmental issues and behavioural choices.

In the following sections I use different analytical frameworks to illustrate how self-efficacy may be understood through the use of characteristic indicators to operationalise self-efficacy. It is important, however, to have an understanding of self-efficacy before attempting to operationalise self-efficacy through individual indicators, to stress the multi-dimensional nature of self-efficacy (Bandura, 1997).

7.2.1 Example of how practitioners may operationalise self-efficacy

I have included two approaches to illustrate how practitioners might develop greater understanding of the way in which self-efficacy can be operationalised through indicators, drawing on the outcomes from research aim 1. Through the use of thematic analysis motivation and resilience were identified as indicators of self-efficacy and have been identified in theory as well, for operationalizing self-efficacy (Gibbs, 2002; Bandura, 2006; Klassen and Durksen, 2014).

Approach one

Figure 7.4 was developed from research question one, to explore the operationalisation of self-efficacy through a thematic analysis approach. Figure 7.4 could be filled in with practitioners as an exercise or to provide illustrative examples to show how theory underpins the operationalisation of indicators associated with high/low self-efficacy.

1 **Theory behind specific indicator for self-efficacy e.g. resilience, motivation, optimism**	2 **Operationalisation of indicator from theory**	3 **Mastery experience/Vicarious detail**	4 **Extracts from mastery experience/Vicarious experience which match the operationalisation of the indicator**
Completed by teacher educator	Completed by teacher educator	Summary detail provided by vignettes chosen from mastery or vicarious experiences which can be provided by practitioners, of be from teacher videos of primary science lessons, or provided by teacher educator	After discussion of vignettes, select extracts from summary detail that illustrate the specific focus and estimate the degree of success illustrated in the example for the specific indicator. Repeat process for a different indicator

Figure 7.4: Analytical deductive framework for operationalizing self-efficacy

Teacher educators or others involved in training, could introduce practitioners to the indicator list showing indicators of high and low self-efficacy in Figure 7.5, introduced in the literature review, to illustrate outcomes from self-efficacy research (Bandura, 2006; Brigido *et al.,* 2013; Klassen and Durksen, 2014; Glackin and Hohenstein, 2018). It would be best to focus on one particular indicator, perhaps motivation and the teacher educator could complete columns one and two using theory to underpin and identify how motivation is defined and operationalised. Discussion could follow in order to explore intuitive understanding versus theoretical defining of motivation (Ryan and Deci, 2000). Practitioners could use their own notes from the chosen mastery experience or vicarious experience to match a theoretical underpinning of the indicator of self-efficacy, with their own experiences or observations. In this way participants could refer back to the indicator lists from Figure 7.5 and make judgments about the specific focus in terms of high/low self-efficacy. This would help them to identify how to make judgments about self-efficacy beliefs in terms of specific indicators associated with the operationalisation of self-efficacy. The process could be repeated for a different indicator such as resilience or any other indicator listed in the self-efficacy indicator list in Figure 7.5. This could provide rich data for discussion such as: whether self-efficacy for teaching science can be estimated from just one specific indicator, or do individual indicators reflect the dynamic and multi-layered nature of self-efficacy. Alternatively it could contribute to greater understanding of issues that might arise for having high self-efficacy in a specific area such as subject knowledge, but having low self-efficacy beliefs for delivering science through practical inquiry. It would be worth generating a range of cards with specific issues for discussion.

Author	High self-efficacy	Low self-efficacy
Bandura, 2006	Strategic thinker, optimistic, opt for challenges, committed to achieve goals, puts in the required effort to achieve goals, perseverant and resilient, challenges seen as obstacles to be overcome, stress –excitement, likely to succeed	Erratic thinker, pessimistic, opt out of things considered to be too challenging, less effort put into achieving goals, less perseverant or resilient, tendency to blame failures on personal weaknesses, challenges create stress and anxiety, may opt out rather than fail.
Glackin and Hohenstein, 2018	Good science subject knowledge, open-ended questions used, willingness to try new ideas and new pedagogical approaches, enthusiastic, focus on children's ideas and their learning,	Weak science subject knowledge, more use of closed questioning, avoidance of working with children's ideas, avoidance of new ideas and unfamiliar pedagogical approaches, lacking motivation to sort out problems for themselves, focus on doing it right rather than on working with children's ideas, sees others as more knowledgeable than they are.
Klassen and Durksen 2014	Positive rapport with children resulting in a willingness to go with children's ideas for inquiry, feeling autonomous when planning, feeling prepared and organised, recognising influential strategies, perseverant and resilient, seeking help as support, coping with stress, awareness of limitations but looking to challenge these and learn from experiences	Rapport with children more to do with control- so avoidance of challenges such as developing children's enquiries from their idea, using other's plans without adaptation for own approaches when planning, lack of preparedness and organisation, not seeking to adapt strategies even if what they are doing does not work, avoids difficulties if they arise, seeking help but seeing this as some sort of weakness, avoiding situations that may cause stress, awareness of limitations but using these to avoid challenges
Brigido *et al.,* 2013	Positive beliefs leading to a feeling of competency for teaching and supporting science learning, optimism,	Negative feelings about science, tendency to use transmissive approaches more, insecure about science teaching,

Figure 7.5: Summary chart showing some examples of theoretical indicators of self-efficacy

7.2.2 An alternative approach for practitioners

When practitioners are involved in teaching science they are often encouraged to evaluate their experiences (Bolton, 2010). Figure 7.7 shows how practitioners can incorporate self-efficacy into their evaluations, before and after a mastery experience to contribute to their own personal vignettes to provide summary accounts of their experiences (Miles *et al.,* 2020).

In this section I suggest a way of using the TRC Integrated Cyclical Model, Figure 7.1, would be for an experienced teacher/educator for teaching primary science, to guide initial discussion around what self-efficacy is, and how it contributes towards the decisions practitioners make towards their approaches to teaching primary science. Practitioners would then be provided with an indicator list underpinned by theory found in Figure 7.5, which illustrates how self-efficacy can be operationalised and estimated. Having estimated their self-efficacy for their next teaching experience across a range of indicators, practitioners

would then focus on one indicator such as resilience. Inductive and deductive descriptors for this indicator, developed from outcomes to research aim 1, are provided in Figure 7.6 and would be used for further discussion around this one indicator.

Approach to operationalisation	**Resilience indicator**
Inductive operationalisation from interviews	Extract provided examples of challenging situations which included preparation and delivering science lessons, working in unfamiliar settings, working with unfamiliar children Level of what counted as a challenge depended on participant Extract identified concerns, and how they were dealt with Extract shared what had been learnt Extract shared perceptions of the level of success in dealing with challenge
Deductive operationalisation from theory linked to construct	'Resilience includes the skills and abilities that, along with knowledge and experience, contribute to a person's ability to meet challenges, cope with those challenges, and overcome them.' (Rolbiecki *et al.,* 2017:90) 'Learning from past experiences increases available resources and thus improves one's resilience for dealing with future circumstances' (Bobek, 2002:202) Resilience is ' the capability of individuals to cope successfully in the face of change, adversity and risk' (Stajovic 2006:1211) 'Risk and protective factors have been shown to influence levels of resilience' (Arnup and Bowles, 2016:231)

Figure 7.6: Operationalisation of resilience

Following discussion practitioners could complete Figure 7.7 by recording what their personal challenging goals and concerns were prior to teaching science through practical inquiry, focussing on their chosen indicator, resilience in this example.

Practitioners would then complete the rest of Figure 7.7, after they had taught science and could review their self-efficacy indicator list, Figure 7.5, to see if their self-efficacy profile had altered, and in which direction. By making general estimations of their self-efficacy prior to, and after teaching, they can also see the impact of mastery experiences on developing self-efficacy. The same teaching experience could be used again but with a focus on a different indicator.

This example provides a way of illustrating how the resilience aspect of self-efficacy can be operationalised and evaluated through reflecting on using practical inquiry teaching approaches

<table>
<tr><td colspan="2">Context of teaching science through practical inquiry

Small group work or whole class teaching:
Focus of lesson: e.g. helping children develop their own investigations from their own questions/using a wow moment/</td></tr>
<tr><td colspan="2">How to operationalise self-efficacy indicator resilience

Key indicators:
• being able to deal with challenging situations which includes preparation and delivering science lessons, working in unfamiliar settings, working with unfamiliar children, first time teaching science
• Being able to identify concerns and dealing with them
• Sharing what has been learnt and evaluating the level of success achieved in dealing with challenges

Identified deductively through: being able to overcome challenges (Rolbiecki et al., 2017:90), cope successfully with new situations, risks and difficulties (Stajovik, 2006), and apply learning from past experiences as needed (Bobek, 2002)</td></tr>
<tr><td>Estimation of self-efficacy before teaching science through practical inquiry</td><td></td></tr>
<tr><td>Identification of anticipated challenges within the lesson</td><td></td></tr>
<tr><td>Identification of proactive strategies to deal with challenges arising during the lesson</td><td></td></tr>
<tr><td>Estimation of self-efficacy after teaching science through practical inquiry</td><td></td></tr>
</table>

Figure 7.7: Operationalizing self-efficacy

Summary

In this chapter I explored the application of the TRC Integrated Cyclical Model and analytical frameworks which I developed from addressing the research aims for this thesis. I have suggested potential teaching approaches to inform understanding of the nature of self-efficacy, its influences, and its operationalisation through the use of indicators. Therefore, self-efficacy could be the focus for supporting professional development in a practical way.

Reflective notes

> The question of its (self-efficacy) usability has bothered me throughout the whole process and the reason I found it so difficult to do this was I couldn't quite decide why I would use self-efficacy as the driver for my personal development instead of other theoretical approaches such as Shulman's pedagogical content knowledge (PCK) (1986).

PCK- brings together two areas that teachers show concern about- subject knowledge and pedagogy. This makes it an holistic approach which combines two aspects that cause teachers some concern for teaching primary science, but it does not address if you've got the wherewithal to use subject knowledge and science pedagogy effectively in the classroom. In fact one of the participants had this problem of not knowing what to do, despite completing a PCK. This is where self-efficacy definitely comes to the fore.

Self-efficacy judgments are more personally critical and integrate whether you have the teaching tools you need for teaching science, with your perception of what you can do with your subject knowledge and pedagogy.

You really need both! You can't focus on it in isolation. EB January 2022.

CHAPTER 8 - CONCLUSION

8.1 Introduction

This thesis set out to apply qualitative research approaches in order to explore the self-efficacy of preservice teachers, in the context of primary science. In particular I was seeking ways to understand how self-efficacy may be operationalised, as well as analysing how the accounts of primary science experiences, could be used to explore the factors that could lead to the development of self-efficacy beliefs.

My focus on qualitative research approaches was influenced by the literature, which highlighted the need to extend self-efficacy beyond quantitative methodologies into 'alternative paradigms' (Labone, 2004:342; Wheatley, 2005; Wyatt, 2014). Wyatt (2015) identified some of the issues as being associated with 'muddled definitions' (p.118) and studies that used 'omnibus-type questionnaire instruments' which removed 'context-specific judgments' (p.119), a key aspect of self-efficacy beliefs identified by Bandura (1997). Furthermore, Wheatley (2005) identified the lack of usability of self-efficacy research by practitioners. Consequently, I chose to focus on an in-depth qualitative analysis of interviews through a thematic analysis approach (Braun and Clarke, 2006), to inform the operationalisation of self-efficacy in the context of primary science teaching, and explore a qualitative approach for identifying factors that contribute towards the development of self-efficacy. There was no intention to provide generalisable outcomes from this research (Miles *et al.,* 2019). The research design aimed to ensure trustworthy processes (Lincoln *et al.,* 2018), through the application of a rigourous and accountable qualitative approach. It is hoped that the rigour of the research design enabled the findings to contribute towards models and analytical frameworks which practitioners could access to support their understanding and use of self-efficacy within their own settings.

Through the literature review I provided an account of the issues that preservice teachers encounter, such as the lack of opportunity for teaching science or to see science being taught whilst on their assessed placements. Since opportunities for mastery and vicarious experiences are limited, so too are opportunities for preservice teachers to practise and develop their understanding and use of practical inquiries, and consequently their self-efficacy for teaching science (Wellcome, 2017; Ofsted, 2021). I discussed the theoretical assumptions underpinning self-efficacy theory, based on the work of Bandura (1977; 1997), in order to illustrate the complexity and multi-dimensional nature of self-efficacy. With regard to the impact of self-efficacy on practice Bandura (1977) argues that self-efficacy beliefs influence behaviour, effort, and perseverance and resilience to cope with challenges. Additionally self-efficacy beliefs vary in magnitude, generality and strength depending on the type of task and context in which the behaviour occurs (Bandura, 1997). Furthermore, the many ways in which self-efficacy has been defined and measured has contributed towards some of the criticisms of quantitative research linked to self-efficacy (Wheatley, 2005; Wyatt, 2016).

In addition this research explored alternative ways of viewing self-efficacy and the factors influencing the development of self-efficacy, through the use of cyclical models (Gist and Mitchell, 1992; Tschannen-Moran

et al., 1998; Markova, 2021) which provide ways of seeing how the influences and behavioural responses associated with self-efficacy dynamically impact on each other. The development of the TRC Integrated Cyclical Model was influenced by previous models such as that of Tschannen-Moran et al. (1998) but additionally incorporates an 'in the moment' loop to reflect the dynamic nature of self-efficacy and a 'longer term' loop, as well to acknowledge that perceptions of events may be different when people reflect on what has been learnt from a teaching experience over a longer period of time. Additionally I incorporated Bandura's (1997) TRC model to use as an analytical tool for mastery experiences. I also explored self-efficacy within the context of Bandura's (1986) SCT including the use of his TRC model and its links with agency (Bandura, 2006). Agency is fundamental to the processes of ITT as preservice teachers move towards becoming fully qualified teachers. As self-efficacy beliefs are a key factor underpinning the development of agency (Bandura, 1997) I set out to develop methods and approaches to illustrate how self-efficacy could be used by practitioners to support their professional development.

8.2 Methodological reflections

The use of thematic analysis (Braun and Clarke, 2006; 2013; 2020) allowed me to explore and construct interpretations of interview contributions to explore the voices of the participants by deconstructing interview responses through a process of thematic coding. This process enabled the operationalisation of self-efficacy through the development of indicators associated with self-efficacy beliefs such as resilience. In addition thematic coding helping to clarify additional issues which impacted on participants' self-efficacy, such as the teaching environment. A cyclical inductive-deductive approach to coding enabled me to ensure that coding saturation was achieved so that I could organise the codes into themes. The purpose of this was to illustrate how thematic analysis, a bridge between quantitative and qualitative approaches (Braun and Clarke, 2006) could contribute to the development of analytical frameworks and models to develop rich descriptions seen as a strength of qualitative research approaches (Teddlie and Tashakkori, 2014). Thematic analysis required constant reviewing, refining and revising throughout the data analysis journey. This reflected the demands of working in a constructivist paradigm as indicated in this quote: 'Constructivist inquiry is problematic; it is the humanly devised way to entertain constructions about states of affairs that are subject to continuous refinement, revision and if necessary replacement' (Guba and Lincoln, 1989:104).

From a constructivist stance: 'Any observed action is the instantaneous resolution of a large number of mutual, simultaneuous shapers, each of which is constantly shaping, and being shaped by all other shapers' (Guba and Lincoln, 1989:106). This was reflected in the development of the TRC Integrated Cyclical Model placing self-efficacy in the centre of the model to illustrate how a range of influences are altering and shaping its development. Furthermore as Guba and Lincoln state 'The success of constructivist inquiry can be judged on whether it displays ever increasing understanding of its phenomena (the ultimate constructivist criterion for naturalistic inquiry)' (1989: 107). Additionally this study has contributed towards the application of using a qualitative research approach to inform understanding of the nature (operationalisation) of self-efficacy and the development of self-efficacy through contributing factors. These are summarised here:

Thematic analysis informed the development of indicators that operationalised self-efficacy, to ones identified in research. For this set of participants this included: affective (enjoyment and enthusiasm for science), motivation, making use of support, resilience, and target setting and confidence.

Thematic analysis helped to inform the identification of factors contributing to the development of preservice teachers' self-efficacy and these were categorised according to Bandura's (1997) TRC model. For this set of participants particular influences included: the teaching environment, explicit and implicit feedback from children and teacher mentors, being able to work with children they knew, and the type of support provided by mentors.

The development of the models and analytical frameworks provided the means to produce vignettes for developing rich descriptions (Teddlie, and Tashakkori, 2014).

8.2.1 Implications for Practice

In order to make self-efficacy useable and relevant to practitioners, a bridge is needed to enable understanding of how it is defined, the form its operationalisation takes in practice, and how self-efficacy development can be facilitated. Through this research I trialled analytical approaches for operationalizing self-efficacy from the participants' interviews which included the development and use of an analytical tool AF(TRC). The influence of Bandura's TRC model (1986) as well as the work of Bergman *et al.,* (2019) highlighted the links to agency, explored in the development of the vignettes. Using the outcomes from this research I then developed some practical approaches to support the development of practitioners' understanding and use of self-efficacy as a tool for professional development and research, with preservice teachers, teacher educators and teacher mentors, as discussed in Chapter 7. Finally influenced both by theory (Gist and Mitchell, 1992; Tschannen-Moran *et al.,* 1998; Markova, 2021), and the use of the analytical tool AF(TRC), I then developed my own version of a cyclical model to contribute towards the theoretical understanding of self-efficacy through the constructivist paradigm.

8.3 Limitations of the Study

The quality of qualitative research approaches may be assessed through trustworthiness criteria (Nowell *et al.,* 2017; Lincoln *et al.,* 2018) which include: credibility, transferability, dependability, confirmability and audit trails. In previous chapters, I have provided examples of how I have addressed each of these. For instance, I have shown how the vignettes were developed from the participants' interviews and captured their voices as accurately as I could. However, I am a new researcher, particularly with regard to qualitative approaches, and therefore, I found that each step of the data analysis process had to be researched, explored and interpreted in the initial application of thematic analysis. In particular I found that the interview data was so diverse that it was difficult to reduce the open coding into categories and themes that were relevant to this study. In addition, as I developed my knowledge and understanding of self-efficacy further that this impacted on how I viewed the coding process and which was continually informed by inductive and

deductive approaches (Braun and Clarke, 2013). However, a more experienced researcher may have come to different conclusions, as may two researchers working together highlighting the subjective nature of qualitative research (Fereday and Muir-Cochrane, 2006).

The analytical tool AF(TRC), whilst an important aspect of this research, has only been applied to the data collected in this study and has not been trialled with other contexts or participants. Therefore, I can only offer it as a potential solution to making self-efficacy more useable for practitioners and further trialling of the tool is necessary to explore the extent of its practical application. This study does not focus on verbal persuasion and affective responses as separate influences on self-efficacy (Bandura, 1997), but has integrated them within mastery and vicarious influences on self-efficacy (Mansfield and Woods-McConney, 2012).

8.3.1.1 Reflections on my role as the researcher

Through this research I propose that self-efficacy can be successfully explored through the constructivist paradigm. Previously my epistemological stance has leaned towards positivist approaches where the role of the researcher is external to the whole research process and attempts to reduce bias and research influence are reduced as far as is possible (Grix, 2010). By working within a constructivist paradigm (Crotty, 2013) I had to actively abandon the notion of prediction and hypothesis in order to fully embrace qualitative approaches. In doing so I recognised myself 'as an analytic resource' *(*Braun and Clarke, 2020:3) requiring my 'reflexive engagement with theory, data and interpretation' (Braun and Clarke, 2020:3). I found that my background enabled me to value being able to work through both inductive and deductive approaches for data analysis (Braun and Clarke, 2013). I kept a diary of my thoughts throughout the process to illustrate my reflexive engagement and integrated reflective sections throughout. I will end on looking back at my developing thoughts about self-efficacy through the reflection in Figure 8.1.

> Initially the assumptions that I came to this research were that: self-efficacy was clearly defined and that the measuring tools available to quantify self-efficacy were not in doubt. Why did I have such a fixed set of ideas? Several reasons: self-efficacy theory and research has been around for at least 40 years, its association with predictive behaviour led me to believe that the standards against which it was being measured were fixed and tested. I have found through this process that this was not the case, that the measurement tools provided a framework which every researcher adapted for their own purposes and which meant that the measurement of self-efficacy is based on using a variable selection of tools, underpinned by different theoretical input.
>
> That is why I found that it was more important to understand what self-efficacy meant, so I could develop a model to simplify this for practitioners. Qualitative approaches have enabled me to trial this. Notes: Liz Burgin January 2022

Figure 8.1: Reflections providing insight into early assumptions about self-efficacy

This has been a complex journey challenging my own self-efficacy but I feel that it is a valuable construct worth unravelling and using to greater effect informing the development of preservice teachers' understanding of the choices they make in teaching primary science.

References

Adams, P. (2006) Exploring social constructivism: theories and practicalities. *Educaiton 3-13,* 34**,** (3), 243-257.

Adey, P. and Shayer, M. (1993) An Exploration of Long-Term Far-Transfer Effects Following an Extended Intervention Program in the High School Science Curriculum. *Cognition and Instruction,* 11**,** (1), 1-29.

Adom, D., Yeboah, A. and Ankrah, A. (2016) Constructivism Philosophical Paradigm: Implication for Research, Teaching and Learning. *Global Journal of Arts Humanities and Social Sciences,* 4**,** (10), 1-9.

Appleton, K. and Kindt, I. (2002) Beginning Elementary Teachers' Development as Teachers of Science. *Journal of Science Teacher Education,* 13**,** (1), 43-61.

Arnup, J. and Bowles, T. (2016) Should I stay or should I go? Resilience as a protective factor for teachers' intention to leave the teaching profession. *Australian Journal of Education,* 60**,** (3), 229-224.

Atkinson, T. and Claxton, G. (eds.) (2001) *The Intuitive Practitioner.* Buckingham: Open University Press.

Aubrey, K. and Riley, A. (2019) *Understanding & using Educational Theories.* 2nd edn. London: SAGE.

Avraamidou, L. (2014) Tracing a Beginning Elementary Teacher's Development of Identity for Science Teaching. *Journal of Teacher Education,* 65**,** (3), 223-240.

Aydin, S. and Boz, Y. (2010) Pre-Service Elementary Science Teachers' Science Teaching Efficacy Beliefs and Their Sources. *Elementary Education Online*, 9**,** (2), 694-704. Available at: http://ilkogretim-online.org.tr [Accessed 8th July 2020].

Bailey, E. (2018) Constructivism and Future Self-Efficacy: Student Teachers' Confidence in Applying Learning Theories to Computer Technology. *Journal of Education & Social Policy,* 5**,** (4), 174-185.

Bandura, A. (1977) Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review,* 84**,** (2), 191-215.

Bandura, A. (1982) Self-efficacy Mechanism in Human Agency. *American Psychologist,* 37**,** (2), 122-147.

Bandura, A. (1986) *Social foundations of thought and action: a social cognitive theory.* Englewood Cliffs, N.J: Prentice-Hall.

Bandura, A. (1989) Human agency in social cognitive theory. *American Psychologist,* 44**,** (9), 1175-1184.

Bandura, A. (1994) Self-efficacy. In: Ramachaudran, V. (ed.) *Encyclopedia of Human Behavior.* New York: Academic Press, 71-81.

Bandura, A. (ed.) (1995a) *Self-efficacy in Changing Societies.* Cambridge: Cambridge University Press.

Bandura, A. (1995b) Comments on the crusade against the causal efficacy of human thought. *Journal of Behavior Therapy and Experimental Psychiatry,* 26**,** (3), 179-190.

Bandura, A. (1997) *Self-efficacy: the exercise of control.* New York: W. H. Freeman.

Bandura, A. (2001) Social Cognitive Theory of Mass Communication. *Media Psychology,* 3**,** 265-299.

Bandura, A. (2004) Health Promotion by Social Cognitive Means. *Health Education and Behavior*, 31, (2), 143-162.

Bandura, A. (2006) Toward a Psychology of Human Agency. *Perspectives on Psychological Science,* 1**,** (2), 164-180.

Bautista, N. (2011) Investigating the Use of Vicarious and Mastery Experiences in Influencing Early Childhood Education Majors' Self-Efficacy Beliefs. *Journal of Science Teacher Education*, 22**,** 333-349. Available at: https://doi.org/10.1007/s10972-011-9232-5 [Accessed 30th August 2021].

Bazeley, P. (2008) Software tool and the Development of Multiple and Mixed Methods Research *International Journal of Multiple Research Approaches,* 2**,** (1), 127-132.

Beauchamp, C. and Thomas, L. (2009) Understanding teacher identity: an overview of issues in the literature and implications for teacher education. *Cambridge Journal of Education,* 39**,** (2), 175-189.

Beauchamp, M., Crawford, K. and Jackson, B. (2019) Social cognitive theory and physical activity: Mechanisms of behavior change, critique, and legacy. *Psychology of Sport & Exercise,* 42**,** 110-117.

Bembenutty, H. (2016) Motivation and Self-Regulated Learning Among Preservice and In-Service Teachers Enrolled in Educational Psychology Courses. *Scholarship of Teaching and Learning in Psychology,* 2**,** (4), 231-244.

Bergman, Z., Bergman, M. and Thatcher, A. (2019) Agency and Bandura's Model of Triadic Reciprocal Causation: An Exploratory Mobility Study Among Metrorail Commuters in the Western Cape, South Africa. *Frontiers in Psychology*, 10**,** (411), 1-14. Available at: https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00411/full [Accessed 7 September 2020].

Best, S. (2012) *Understanding & Doing Successful Research.* Harlow: Pearson Education Limited.

Biesta, G. (2016) *The beautiful risk of education* London: Routledge.
Bjerke, A. and Solomon, Y. (2020) Developing Self-Efficacy in Teaching Mathematics: Pre-Service Teachers' Perceptions of the Role of Subject Knowledge. *Scandinavian Journal of Educational Research,* 64**,** (5), 692-705.
Blackmore, K., Howard, C. and Kington, A. (2018) Trainee teachers' experience of primary science teaching, and the perceived impact on their developing professional identity. *European Journal of Teacher Education,* 41**,** (4), 529-548.
Bleicher, R. (2006) Nurturing Confidence in Preservice Elementary Science Teachers. *Journal of Science Teacher Education,* 17**,** (2), 165-187.
Blonder, R., Benny, N. and Jones, G. (2014) Teaching Self-Efficacy of Science Teachers. In: Evans, R., Luft, J., Czerniak, C. & Pea, C. (eds.) *The Role of Science Teachers' Beliefs in International Classrooms.* Rotterdam: Sense Publishers, 3-16.
Bobek, B. (2002) Teacher Resiliency: A Key to Career Longevity. *The Clearing House,* 75**,** (4), 202-205.
Bold, C. (2012) *Using Narrative in Research.* London: SAGE.
Bolton, G. (2010) *Reflective Practice.* 3rd edn. London: SAGE.
Bong, M. and Clark, R. (1999) Comparison between self-concept and self-efficacy in academic motivation research. *1999,* 34**,** (3), 139-153.
Boyatzis, R. (1998) *Transforming qualitative information.* London: SAGE.
Braun, V. and Clarke, V. (2006) Using Thematic Analysis in Psychology. *Qualitative Research in Psychology,* 3**,** (2), 77-101.
Braun, V. and Clarke, V. (2013) *Successful qualitative research: A practical guide for beginners.* London: SAGE.
Braun, V. and Clarke, V. (2019) Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11**,** (4), 589-597. Available at: https://doi.org/10.1080/2159676X.2019.1628806 [Accessed 26 January 2021].
Braun, V. and Clarke, V. (2020) One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology***,** 1-25. Available at: https://doi.org/10.1080/14780887.2020.1769238 [Accessed 6 January 2022].
Brigido, M., Borrachero, A., Bermejo, M. and Mellado, V. (2013) Prospective Primary Teachers' Self-efficacy and Emotions in Science Teaching. *European Journal of Teacher Education,* 36**,** (2), 200-217.
Brinkmann, S. (2012) Qualitative research between craftsmanship and McDonaldization. A keynote address from the 17th Qualitative Health Research Conference. *Qualitative Studies,* 3**,** (1), 56-68.
Brinkmann, S. (2018) The Interview. In: Denzin, N. & Lincoln, S. (eds.) *The Sage handbook of qualitative research.* 5th Edn. London: SAGE, 576-600.
Brinkmann, S. and Kvale, S. (2018) *Doing Interviews.* 2nd edn. Los Angeles: SAGE.
Buchanan, R. (2015) Teacher identity and agency in an era of accountability. *Teachers and Teaching theory and practice,* 21**,** (6), 700-719.
Cambridge Dictionary. Available at: https://dictionary.cambridge.org/dictionary/english/judgment [Accessed 15 February 2022].
Cantrell, P., Young, S. and Moore, A. (2003) Factors Affecting Science Teaching Efficacy of Preservice Elementary Teachers. *Journal of Science Teacher Education*, 14**,** (3), 177-192. Available at: https://doi.org/10.1023/A:1025974417256 [Accessed 5th February 2021].
Cantrell, S. and Callaway, P. (2008) High and low implementers of content literacy instruction: Portraits of Teacher Efficacy. *Teaching and Teacher Education,* 24**,** 1739-1750.
Chamorro_Premuzic, T. and Lusk, D. (2017) The Dark side of Resilience. Available at: https://hbr.org/2017/08/the-dark-side-of-resilience [Accessed 10th February 2022].
Charmaz, K. (2006) *Constructing Grounded Theory.* London: SAGE.
Cheu-Jey, G. (2012) Reconsidering Constructivism in Qualitative Research. *Educational Philosophy and Theory*, 44**,** (4), 403-412. Available at: https://doi.org/10.1111/j.1469-5812.2010.00720.x [Accessed 19 June 2020].
Chichekian, T. and Shore, B. (2016) Preservice and practicing teachers' self-efficacy for inquiry-based instruction. *Cogent Education,* 3**,** 1236872.
Clandinin, D. and Connelly, F. (2000) *Narrative Inquiry.* San Francisco: Jossey-Bass.
Clandinin, D. and Connelly, F. (2000) *Narrative Inquiry: Experience and Story in Qualitative Research.* San Francisco: Jossey-Bass.
Clark, S. and Newberry, M. (2019) Are we building preservice Teacher self-efficacy? A large-scale study

examining Teacher education experiences. *Asia-Pacific Journal,* 47**,** (1), 32-47.
Cohen, L., Manion, L. and Morrison, K. (2007) *Research Methods in Education* 6th edn. London: Routledge.
Costlow, K. and Bornstein, M. (2018) Social Cognitive Theory. In: Frey, B. (ed.) *The SAGE Encyclopedia of Eductional Research, Measurement, and Evaluation.* Thousand Oaks: SAGE, 1533-1535.
Cramer, R., Neal, T. and Brodsky, S. (2009) Self-efficacy and confidence: Theoretical distinctions and Implicaitons for Trial Consultation. *Consulting Psychology Journal: Practice and Research,* 61**,** (4), 319-334.
Creswell, J. and Plano Clark, V. (2011) *Designing and Conducting Mixed Methods Research.* 2nd edn. London: SAGE.
Crotty, M. (2013) *The Foundations of Social Research.* London: SAGE.
Deehan, J. (2017) *The Science Teaching Efficacy Belief Instrument (STEBI A and B).* Springer Briefs in Education.
Denscombe, M. (2014) *The Good Research Guide.* Maidenhead: Open University Press.
Denzin, N. and Lincoln, Y. (1998) *The Landscape of Qualitative Research.* London: SAGE.
Denzin, N. and Lincoln, Y. (2003) *The Landscape of Qualitative Research.* London: SAGE.
Denzin, N. and Lincoln, Y. (eds.) (2018) *The SAGE Handbook of Qualitative Research.* 5th. London: SAGE.
DES (1989) *Science in the National Curriculum.* London: DfE. Available at: https://www.stem.org.uk/elibrary/resource/27657 [Accessed 19th February 2022].
DES (1991) *Science in the National Curriculum.* London: HMSO. Available at: https://www.stem.org.uk/resources/elibrary/resource/27761/science-national-curriculum-1991 [Accessed 19th February 2022].
DfE (2012) *Teachers' Standards.* Available at: https://www.gov.uk/government/publications/teachers-standards [Accessed 18th February 2022].
DfE (2013) *National Curriculum in England: science programmes of study DFE-00182-2013.* Available at: https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study [Accessed 19th February 2022].
DfE (2021) *Initial Teacher Training (ITT): Criteria and supporting advice.* Available at: https://www.gov.uk/government/publications/initial-teacher-training-criteria [Accessed 22nd February 2022].
DfE (2021) *Initial Teacher Training (ITT): criteria and supporting advice.* Available at: https://www.gov.uk/government/publications/initial-teacher-training-criteria/initial-teacher-training-itt-criteria-and-supporting-advice#training-criteria [Accessed 18th February 2022].
DfE (2021) *Teachers' Standards.* Available at: https://www.gov.uk/government/publications/teachers-standards#full-publication-update-history [Accessed 19th February 2022].
Dillon, J. and Manning, A. (2010) Science Teachers, Science Teaching: Issues and Challenges. In: Osborne, J. & Dillon, J. (eds.) *Good Practice in Science Teaching: What Research Has To Say.* 2nd Edn. Maidenhead: Open University Press, 6-19.
Dimenichi, B. and Richmond, L. (2015) Reflecting on past failures leads to increased perseverance and sustained attention. *Journal of Cognitive Psychology,* 27**,** (2), 180-193.
Doolittle, P. (2003) Constructivism as a Theoretical Foundation for the Use of Technology in Social Studies. *Theory and Research in Social Education,* 31**,** (1), 72-104.
Dunne, M. and Maklad, R. (2015) Doing Science. In: Dunne, M. & Peacock, A. (eds.) *Primary Science: A Guide to Teaching Practice.* 2nd Edn. London: SAGE, 47-68.
Dunne, M. and Peacock, A. (eds.) (2015) *Primary Science: A Guide To Teaching Practice.* 2nd. London: SAGE.
Enochs, L. and Riggs, I. (1990) Further Development of an Elementary Science Teaching Efficacy Belief Instrument: A Preservice Elementary Scale. *Conference paper for the National Association of Research in Science Teaching*, Atlanta. Available at: https://files.eric.ed.gov/fulltext/ED319601.pdf [Accessed 7th June 2018].
Enochs, L. and Riggs, I. (2002) Science Teaching Efficacy Belief Instrument-Form B. Available at: http://web.mnstate.edu/trn/TRNweb/stebi.pdf [Accessed 20th September 2018].
Erickson, F. (1985) *Qualitative Methods in Research on Teaching.* Michigan: Michigan State University
Fereday, J. and Muir-Cochrane, E. (2006) Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods,* 5**,** (1), 80-90.
Gibbs, C. (2007) *Analysing Qualitative Data.* London: SAGE.

Gibson, S. and Dembo, M. (1984) Teacher Efficcy: A Construct Validation. *Journal of Educational Psychology,* 76**,** (4), 569-582.
Gioia, D., Corley, K. and Hamilton, A. (2012) Seeking Qualitative Rigor in Inductive Research: Notes on Methodology. *Organisational Research Methods,* 16**,** (1), 15-31.
Gist, M. and Mitchell, T. (1992) Self-efficacy: A Theoretical Analysis of its Determinants and Malleability. *The Academy of Management review,* 17**,** (2), 183-211.
Glackin, M. (2016) 'Risky fun' or 'Authentic science'? How teachers' beliefs influence their practice during a professional devleopment programme on outdoor learning. *Internation Journal of Science Education* 38**,** (3), 409-433.
Glackin, M. and Hohenstein, J. (2018) Teacher's self-efficacy: progressing qualitative analysis. *International Journal of Research and Method in Education*, 41**,** (3), 271-290. Available at: https://doi.org/10.1080/1743727X.2017.1295940 [Accessed 24 April 2020].
Gorard, S. (2004) *Quantitative Methods in Social Science.* London: Continuum.
Grix, J. (2010) *The Foundations of Research.* Basingstoke:: Palgrave Macmillan.
Guba, E. and Lincoln, Y. (1989) *Fourth Generation Evaluation.* California: SAGE.
Guba, E. and Lincoln, Y. (1998) Competing Paradigms in Qualitative Research. In: Denzin, N. & Lincoln, S. (eds.) *The Landscape of Qualitative Research.* London: SAGE.
Hammersley, M. and Traianou, A. (2012) *Ethics in Qualitative Research.* London: SAGE.
Harlen, W. and Qualter, A. (2018) *The Teaching of Science in Primary Schools.* Abingdon: Routledge.
Hawkman, A., Chval, K. and Kingsley, L. (2018) 'I feel like I can do it now': preservice teacher efficacy in a co-teaching community of practice. *Teaching Education*, 30**,** (1), 86-104. Available at: https://doi.org/10.1080/10476210.2018.1446516 [Accessed 6th February 2022].
Hills, R. (2016) *The Authority Guide to Emotional Resilience in Business: Strategies to manage stress and weather storms in the workplace.* authorityguides.co.uk: The Authority Guides.
Hohenstein, J. and Manning, A. (2010) Thinking about Learning: Learning in Science. In: Osborne, J. & Dillon, J. (eds.) *Good Practice in Science Teaching: What research has to say.* 2nd Edn. Maidenhead: Open University Press, 68-81.
Holstein, J. and J, G. (2011) *Inside Interviewing: New Lenses, New Concerns.* Thousand Oaks: SAGE.
Howard, S. (2018) How children learn and teachers teach. In: Serret, N. & Earle, S. (eds.) *ASE Guide to Primary Science Education.* Hatfield: The Association for Science Education
Kazempour, M. and Sadler, T. (2015) Pre-service teachers' science beliefs, attitudes, and self-efficacy: a multi-case study. *Teaching Education*, 26**,** (3), 247-271. Available at: https://doi.org/10.1080/10476210.2014.996743 [Accessed 3rd September 2021].
Kim, D., Cho, Y. and Park, K. (2018) Comparative analysis of affective and physiological responses to emotional movies. *Human-centric computin and Information Sciences*, 8**,** (15). Available at: https://doi.org/10.1186/s13673-018-0138-5 [Accessed 1st January 2021].
King, N., Horrocks, C. and Brooks, J. (2019) *Interviews in Qualitative Research.* 2nd edn. London: SAGE.
Klassen, R. and Durksen, T. (2014) Weekly self-efficacy and work stress during the teaching practicum: A mixed methods study. *Learning and Instruction,* 33**,** 158-169.
Klassen, R., Tze, V., Betts, S. and Gordon, K. (2011) Teacher Efficacy Research 1998-2009: Signs of Progress or Unfulfilled Promise? *Educational Psychology Review*, 23**,** 21-43. Available at: [Accessed 17 March 2018].
Korthagen, F. (2010) Situated learning theory and the pedagogy of teacher education: Towards an integrative view of teacher behavior and teacher learning. *Teaching and Teacher Education,* 26**,** (1), 98-106.
Labone, E. (2004) Teacher efficacy: maturing the construct through research in alternative paradigms. *Teaching and Teacher Education,* 20**,** (4), 341-359.
Lauckner, H. (2012) Using Constructivist Case Study Methodology to Understand jCommunity Development Processes: Proposed Methodological Questions to Guide the Research Process. *The Qualitative Report,* 17**,** (25), 1-22.
Ligurgo, V., Philippette, T., Fastrez, P., Collard, A. and Jacques, J. (2018) A Method Combining Deductive and Inductive Principles to Define Work-Related Digital Media Literacy Competences. In: Kurbanoglu, S., Boustany, J., Spiranec, S., Grassian, E., Mizrachi, D. & Roy, L. (eds.) *Information Literacy in the Workplace.* New York: Springer Nature.
Lincoln, Y. and Guba, E. (2013) *The Constructivist Credo.* Walnut Creek: Left Coast Press.
Lincoln, Y., Lynham, S. and Guba, E. (2018) Paradigmatic Controversies, Contradictions, and Emerging

Confluences, Revisited. In: Denzin, N. & Lincoln, Y. (eds.) *The SAGE Handbook of Qualitative Research.* 5th Edn. London: SAGE, 108-150.
Loxley, P., Dawes, L., Nicholls, L. and Dore, B. (2014) *Teaching Primary Science: Promoting Enjoyment and Developing Understandng.* 2nd edn. Abingdon: Routledge.
Maguire, M. and Delahunt, B. (2017) Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Teachng and Learning in Higher Education*, 9**,** (3), 3351-33514. Available at: https://ojs.aishe.org/index.php/aishe-j/article/view/335/553 [Accessed 1st February 2022].
Mansfield, C. and Woods-McConney (2012) "I didn't always perceive myself as a Science Person": Examining Efficacy for Primary Science Teaching. *Australian Journal of Teacher Education,* 37**,** (10), 37-52.
Markova, Z. (2021) Towards a comprehensive conceptualisation of teachers' self-efficacy beliefs. *Cambridge Journal of Education,* 51**,** (5), 653-671.
Miles, M., Huberman, A. and Saldana, J. (2020) *Qualitative Data Analysis.* 4th edn. London: SAGE.
Millar, R. (2010) Practical Work. In: Osbourne, J. & Dillon, J. (eds.) *Good Practice in Science Teaching: What Research has to say.* Maidenhead: Open University Press.
Mitchell, M. (2013) Teacher Enthusiasm: Seeking Student Learning and Avoiding Apathy. *Journal of Physical Education, Recreating & Dance,* 84**,** (6), 19-24.
Morris, D., Usher, E. and Chen, J. (2017) Reconceptualizing the Sources of Teaching Self-Efficacy: a Critical Review of Emerging Literature. *Educational Psychology,* 29**,** (4), 795-833.
Morris, J., Lummis, G., Mckinnon, D. and Heyworth, J. (2017a) Measuring preservice teacher self-efficacy in music and visual arts: Validation of an amended science teacher efficacy belief instrument. *Teaching and Teacher Education,* 64**,** 1-11.
Muijs, D. and Reynolds, D. (2002) Teachers' Beliefs and Behaviors: What Really Matters? *The Journal of Classroom Interaction,* 37**,** (2), 3-15.
Mullholland, J. and Wallace, J. (2001) Teacher induction and elementary science teaching: enhancing self-efficacy. 17**,** (2), 243-261.
Nilsen, H. (2009) Influence on Student Academic Behaviour through Motivation, Self-Efficacy and Value-Expectation: An Action Research Project to Improve Learning. *Issues in Informing Science and Information Technology,* 6**,** 545-556.
Norris, C., Morris, J. and Lummis, G. (2018) Preservice teachers' self-efficacy to teach primary science based on 'science learner' typology. *International Journal of Science Education*, 40**,** (18), 2292-2308. Available at: https://doi.org/10.1080/09500693.2018.1528645 [Accessed 13th December 2021].
Nowell, L., Norris, J., White, D. and Moules, N. (2017) Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods,* 16**,** (1), 1-13.
Ofsted (2021) *Research review series: Science.* London: Ofsted. Available at: https://www.gov.uk/government/publications/research-review-series-science/research-review-series-science#contents [Accessed 18th February 2022].
Oppenheim, A. (1992) *Questionnaire Design, and Attitude Measurement.* New York Continuum.
Opperman, E., Brunner, M. and Anders, Y. (2019) The interplay between preschool teachers' science self-efficacy beliefs, their teaching practices, and girls' and boys' early science motivation. *Learning and Individual Differences*, 70**,** 86-99. Available at: https://www.sciencedirect.com/science/article/pii/S1041608019300123 [Accessed 17th September 2020].
Osborne, J. and Dillon, J. (eds.) (2010) *Good Practice in Science Teaching: What research has to say.* 2nd Maidenhead: Open University Press.
Pajares, F. (1992) Teachers' Beliefs and Educational Research: Cleaning up a Messy Construct. *Review of Educational Research*, 62**,** (3), 307-332. Available at: http://www.jstor.com/stable/1170741 [Accessed 21st June 2020].
Pajares, F. (1997) Current Directions in Self-efficacy Research. In: Maehr, M. & Pintrich, P. (eds.) *Advances in motivation and achievement.* Greenwich, CT: JAI Press. Available at https://www.uky.edu/~eushe2/Pajares/effchapter.html [Accessed 15 February 2022].
Pajares, F. (2003) Self-efficacy beliefs, Motivation, and achievement in Writing: A review of the literature. *Reading &Writing Quarterly,* 19**,** (2), 139-158.
Pajares, F. and Schunk, D. (2001) Self-Beliefs and School Success: Self-Efficacy, Self-Concept, and School Achievement. *International Perspectives on Individual Differences: Self-Perception*, 2**,** 239-265.

Available at: https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1810967 [Accessed 17th May 2020].
Pajares, F. and Schunk, D. (2001) Self-beliefs and school success: self-efficacy, self-concept, and school achievement. In: Riding, R. & Rayner, S. (eds.) *Self Perception.* Westport, USA: Ablex Publishing, 239-266.
Palmer, D. (2011) Sources of efficacy information in an inservice program for elementary teachers. 95**,** (4), 577-600. Available at: https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=e617665c-ef4e-46ee-8a62-1ca1bebdbe1d%40redis [Accessed 27th May 2021].
Palmer, D. H. (2006) Sources of Self-efficacy in a Science Methods Course for Primary Teacher Education Students. *Research in Science Education*, 36**,** (4), 337-353. Available at: https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=fceb1759-37f9-45c4-84cc-37da53327a43%40redis [Accessed 6th August 2018].
Pandee, M., Tepsuriwong, S. and Darasawang, P. (2020) The dynamic state of pre-service teachers' self-efficacy: A critical incident study in Thailand. *Issues in Educational Research*, 30**,** (4), 1442-1462. Available at: http://www.iier.org.au/iier30/pandee.pdf [Accessed 11 October 2021].
Peacock, A. and Dunne, M. (2015) Why is Science Hard to Teach? In: Dunne, M. & Peacock, A. (eds.) *Primary Science: A Guide to Teaching Practice.* 2nd Edn. London: SAGE, 47-68.
Ponton, M. and Carr, P. (2012) Autonomous Learning and Triadic Reciprocal Causation: A Theoretical Discussion. *International Journal of Self-Directed Learning*, 9**,** (1), 1-10. Available at: https://www.sdlglobal.com/journals [Accessed 1/2/2022].
Pritchard, A. (2018) *Ways of Learning: Learning Theories for the Classroom.* 4th edn. Abingdon: Routledge.
Riggs, I. and Enochs, G. (1989) Toward the Development of an Elementary Teacher's Science Teaching Efficcy Belief Instrument. *Paper presented at the Annual Meeting of the National Association for Research in Science Teaching*, San Franciso.
Riggs, I. and Enochs, L. (1989) Toward the Development of an Elementary Teacher's Science Teaching Efficacy Belief Instrument. *National Association for Research in Science Teaching*, San Francisco.
Ritchie, L. (2016) *Fostering Self-Efficacy in Higher Education Students.* London: Palgrave.
Rolbiecki, A., Subramanian, R., Crenshaw, B., Albright, D., Perreault, M. and Mehr, D. (2017) A Qualitative Exploration of Resilience Among Patients Living With Chronic Pain. *Traumatology,* 23**,** (1), 89-94.
Rotter, J. (1954) *Social Learning and Clinical Psychology.* Englewood Cliffs, NJ: Prentice Hall.
Rotter, J. (1966) Generalised expectancies for internal versus external control of reinforcement. *Psychological Monographs: General and Applied,* , 80**,** (1). Available at: https://www.proquest.com/docview/916300178?pq-origsite=primo [Accessed 1 August 2021].
Ryan, R. and Deci, E. (2000) Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology,* 25**,** 54-67.
Sagone, E. and De Caroli, M. (2013) Relationships between Resilience, Self-Efficacy, and Thinking Styles in Italian Middle Adolescents. *Procedia - Social and Behavioral Sciences,* 92**,** 838-845.
Savin-Baden, M. and Howell Major, C. (2012) *Qualitative research: the essential guide to theory and practice.* London: Routledge.
Schon, D. (1983) *The Reflective Practitioner: How Professional Think in Action.* New York: Basic Books.
Schunk, D. (2003) Self-Efficacy for Reading and Writing: Influence of modeling, Goal setting, and self-evaluation. *Reading & Writing Quarterly,* 19**,** (2), 159-172.
Schunk, D. (2012) Social Cognitive Theory. In: Harris, K., Graham, S. & Urdan, T. (eds.) *APA Educational Psychology Handbook.* 101-123.
Schunk, D. and Usher, E. (2012) Social Cognitive Theory and Motivation. In: Ryan, R. (ed.) *The Oxford Handbook of Human Motivation.* New York: Oxford University Press, 13-28.
Schunk, D., Meece, J. and Pintrich, P. (2014) *Motivation in education: theory, research, and applications.* 4th edn edn. Harlow: Pearson.
Schwandt, T. (1998) Constructivist Interpretivist Approaches to Human Inquiry. In: Denzin, N. & Lincoln, Y. (eds.) *The Landscape of Qualitative Research.* London: SAGE, 221-259.
Scott, P., Dyson, T. and Gater, S. (1987) *A Constructivist View of Learning and Teaching in Science.* Leeds: CLISP Booklets.
Scott, P. H., Mortimer, E. F., and Aguiar, O. G. (2006) The Tension between Authoritative and Dialogic

Discourse: A fundamental characteristic of meaning making interactions in high school science lessons. *Science Education,* 90, (4), 605-631.
Serret, N. and Earle, S. (2018) Introduction: Why is Learning Science important in Primary School today? In: Serret, N. & Earle, S. (eds.) *ASE Guide to Primary Science Education.* Hatfield: The Association for Science Education.
Shulman, L. (1986) Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher,* 15**,** (2), 4-14.
Skaalvik, E. and Skaalvik, S. (2014) Teacher Self-efficacy and Perceived Autonomy: Relations with Teacher Engagement, Job Satisfaction, and Emotional Exhaustion. *Psychological Reports: Employment Psychology & Marketing,* 114**,** 68-77.
Skamp, K. and Mueller, A. (2001) Student teachers' conceptions about effective primary science teaching: a longitudinal study. 23**,** (4), 331-351.
Skinner, E. (1996) A Guide to Constructs of Control. *Journal of Personality and Social Psychology,* 71**,** (3), 549-570.
Stajkovic, A. (2006) Development of a Core Confidence–Higher Order Construct. *Journal of Applied Psychology,* 91**,** (6), 1208-1224.
Stewart, D. (2010) Researcher as Instrument: Understanding "Shifting" Findings in Constructivist Research. *Higher Education and Student Affairs Faculty Publications,* 47**,** (3), 291-306.
Stingu, M. (2012) Reflexive practice in teacher education: facts and trends. *Procedia - Social and Behavioral Sciences,* 33**,** 617-621.
Taylor, D. and Hamdy, H. (2013) Adult learning theories: Implications for learning and teaching in medical education: AMEE Guide, No. 83. *Medical Teacher*, 35**,** (11), 1561-1572. Available at: https://doi.org/10.3109/0142159X.2013.828153 [Accessed 6th July 2020].
Teddlie, C. and Tashakkori, A. (2009) *Foundations of MIxed Method Research.* London: SAGE.
Traianou, A. (2007) *Understanding Teacher Expertise in Primary Science.* Rotterdam Sense Publishers.
Tschannen-Moran, M. and Woolfolk Hoy, A. (2001) Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education,* 17**,** (7), 783-805.
Tschannen-Moran, M. and Woolfolk Hoy, A. (2005) The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education,* 23**,** 944-956.
Tschannen-Moran, M. and Woolfolk Hoy, A. (2007) The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education*, 23**,** (6), 944-956. Available at: https://www.sciencedirect.com/science/article/pii/S0742051X06000953 [Accessed 31st May 2018].
Tschannen-Moran, M., Woolfolk Hoy, A. and Hoy, W. (1998) Teacher Efficacy: Its Meaning and Measure. *Review of Educational Research*, 68**,** (2), 202-248. Available at: https://journals.sagepub.com/doi/abs/10.3102/00346543068002202 [Accessed 18 May 2020].
Turford, B. and Turner, J. (2018) Professional Development and Learning. In: Serret, N. & Earle, S. (eds.) *ASE Guide to Primary Science Education.* Hatfield: The Association for Science Education
Vanbreda, A. (2001) Resilience Theory: A Literature Review. Available at: https://www.academia.edu/19596069/Van_Breda_A_D_2001_Resilience_theory_A_literature_review_Pretoria_South_Africa_South_African_Military_Health_Service [Accessed 14th January 2021].
Velthuis, C., Fisser, P. and Pieters, J. (2014) Teacher Training and Pre-service Primary Teachers' Self-Efficacy for Science Teaching. *Journal of Science Teacher Education,* 25**,** (4), 445-464.
Von Glasersfeld, E. (1995) *Radical Constructivism: a way of knowing and learning.* London: Falmers Press.
Walsh, P., Owen, P., Mustafa, N. and Beech, R. (2020) Learning and teaching approaches promoting resilience in student nurses: An integrated review of the literature. *Nurse Education in Practice*, 45**,** (102748), 1-9. Available at: https://pubmed.ncbi.nlm.nih.gov/32302957/ [Accessed 20th January 2021].
Wellcome (2017) *'State of the nation' report of UK Primary Science Education*. Available at: https://wellcome.org/reports/state-nation-report-uk-primary-science-education [Accessed 18th February 2022].
Wellcome (2019) *Understanding the 'State of the Nation' report of UK Primary Science Education*. Available at: https://wellcome.org/sites/default/files/understanding-state-of-the-nation-report-of-uk-primary-science-education.pdf [Accessed 18th February 2022].
Wheatley, K. (2005) The case for reconceptualising teacher efficacy research. *Teaching and Teacher Education,* 21**,** (7), 747-766.

Williams, D. and Rhodes, R. (2016) The confounded self-efficacy construct: conceptual analysis and recommendations for future research. *Health Psychology Review*, 10**,** (2), 113-128. Available at: https://www.tandfonline.com/doi/full/10.1080/17437199.2014.941998 [Accessed November 2021].

Willig, C. (2013) *Introducing Qualitative Research in Psychology.* 3rd edn. Maidenhead: Open University Press.

Wyatt, M. (2013) Overcoming low self-efficacy beliefs in teaching English to young learners. *International Journal of Qualitative Studies in Education,* 26**,** (2), 238-255.

Wyatt, M. (2014) Towards a re-conceptualization of teachers' self-efficacy beliefs: tackling enduring problems with the quantitative research and moving on. *International Journal of Research and Method in Education,* 37**,** (2), 166-189.

Wyatt, M. (2015) Using Qualitative Research Methods to Assess the Degree of Fit between Teachers' Reported Self-efficacy Beliefs and their Practical Knowledge during Teacher Education. *Australian Journal of Teacher Education,* 40**,** (1), 117-150.

Wyatt, M. (2016) Are they becoming more reflective and/or efficacious? A conceptual model mapping how teachers' self-efficacy beliefs might grow. *Educational Review,* 68**,** (1), 114-137.

Wyatt, M. (2018) Language Teachers' Self-efficacy Beliefs: A Review of the Literature (2005-2016). *Australian Journal of Teacher Education,* 43**,** (4), 92-120.

Yilmaz, K. (2011) The Cognitive Perspective on Learning: Its Theoretical Underpinning and Implication for Classroom Practices. *The Clearing House,* 84**,** (5), 204-212.

Zee, M. and Koomen, H. (2016) Teacher Self-Efficacy and Its Effects on Classroom Processes, Student Academic Adjustment, and Teacher Well-Being: A Synthesis of 40 Years of Research. *Review of Educational Research,* 86**,** (4), 981-1015.

Zwozdiak-Myers, P. (2012) *The Teacher's Reflective Practice Handbook.* Abingdon: Routledge.

Appendices

Appendix 1: Ethics forms

APPENDIX 2

RKE ETHICS PROFORMA – FULL REVIEW APPLICATIONS

Staff and Students

GUIDELINES

Before completing this proforma, please refer to the University Research and Knowledge Exchange Ethics Policy which provides further information and also clarifies the terms used.

Please note that it is your responsibility to follow the University's Policy on the ethical conduct of research and knowledge exchange and any relevant academic or professional codes of practice and guidelines pertaining to your study. This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the storage and use of data. The checklists will identify whether ethics approval is required and at what level.

This Ethics Proforma should be completed for each research, study or knowledge exchange project involving human participants or data derived from directly identifiable individuals. This should be done before any potential participant is approached to take part in the research/study.

The questions in this proforma are intended to guide your reflection on the ethical implication of your research. Explanatory notes can be found at the end of this proforma. Additional notes can be seen by hovering over the asterisks (*).

If any aspect of the project changes during the course of the research, you must notify the Faculty RKE Committee or the University RKE Ethics Committee, whichever is relevant, by completing Section 6 of this proforma.

SECTION 1: DETERMINING WHETHER YOU REQUIRE ETHICAL APPROVAL

Hover the mouse over the asterisks (*) for guidance on how to proceed with this triage questionnaire.

1. **Is the proposed activity classified as Research or Audit/Service Evaluation?**
   √Research * ☐ Audit/Service Evaluation *

   If the proposed activity is considered research, continue with question 2. If it is an Audit or a Service Evaluation, you do not need to seek ethical approval.

2. **Does the research involve living human participants, samples or data derived from identifiable individuals?**

   √ Yes * ☐ No *

3. **Does your research require external ethics approval (e.g. NHS or another institution)?** *(See note 1)*
   ☐ Yes * **√** No *

4. **Does the research involve the use of animals?**
   ☐ Yes * **√** No *

5. **Does the research involve the use of documentary material not in the public domain?**
   ☐ Yes * **√** No *

6. **Does the research involve environmental interventions?**
   ☐ Yes * **√** No *

SECTION 2: DETERMINING THE LEVEL OF ETHICAL SCRUTINY

Please mark with an "X" as appropriate	**YES**	**NO**
Does the research involve individuals who are vulnerable or unable to give informed consent? (e.g. vulnerable children, over-researched groups, people with learning difficulties, people with mental health problems, young offenders, people in care facilities, including prisons)	☐	**x**
Does the research involve individuals in unequal relationships e.g. your own students? (students recruited via SONA are not considered your own students)	**x**	☐
Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in public places, deception)? (see note 2)	☐	**x**
Will the study involve discussion of sensitive topics? For example (but not limited to): sexual activity, illegal behaviour, experience of violence or abuse, drug use, etc.). (Please refer to the Research Ethics Policy).	☐	**x**
Is there a risk that the highly sensitive nature of the research topic might lead to disclosures from the participant concerning their own involvement in illegal activities or other activities that represent a threat to themselves or others (e.g. sexual activity, drug use, or professional misconduct)?	☐	**x**
Will research involve the sharing of data or confidential information beyond the initial consent given?	☐	**x**

Will the anonymity of the participant be compromised at any time during or after the study?	☐	x
Is the study likely to induce severe physical harm or psychological distress?	☐	x
Does your research involve tissue samples covered by the Human Tissue Act?	☐	x
Is there a possibility that the safety of the researcher may be in question (e.g. research in high risk locations or among high risk groups)?	☐	x
Does the research involve creating, downloading, storing or transmitting material that may be considered to be unlawful, indecent, offensive, defamatory, threatening, discriminatory or extremist?	☐	x

If you have answered "yes" to any of these questions, CONTINUE WITH THIS FORM. and submit it to the University RKE Ethics Committee (staff) or to the Departmental Ethics Committee (students).

If you have answered "yes" to the last question, in addition to ethical approval by the relevant ethics committee, you must also contact the Director of IT Services, who must provide approval for the use of such data.

If you have answered no to all of these questions THIS FORM IS NOT FOR YOU. Please complete the Low Risk Application Form and submit it to the Faculty Head of RKE (staff) or to your supervisor (students)

SECTION 3: YOUR PERSONAL DETAILS

1.1. Your name: **Liz Burgin**

1.2. Your Department: FHSE Education

1.3. Your status:

☐ Undergraduate Student

☐ Taught Master

xResearch Degree student

x Staff (Academic)

☐ Staff (Professional Services)

☐ Other (please specify):

1.4. Your Email address: Elizabeth.Burgin@winchester.ac.uk

1.5. Your Telephone number: 07595 980386

For students only:

1.6. Your degree programme: Doctorate in Education

1.7. Your supervisor's name: Dr. Eira Patterson, Dr. Victoria Randall, Dr. Janice deSousa

1.8. Your supervisor's department: FHSE Education now Institute of Education

SECTION 4: YOUR RESEARCH

2.1. Project title: Thesis for EdD

Primary science teachers' self-efficacy: a critical evaluation through a constructivist approach.

2.2. Expected start date: May 2019

2.3. Expected completion date: June 30th 2021

2.4. Expected location: Winchester UK

2.6. If outside the UK, state country: No

2.7. Has ethical approval been obtained at the host country? * ☐ Yes ☐ No

2.8. If not, why not?

2.9 If the research is taking place outside the UK, is it covered by the University's insurance, or has the researcher obtained an appropriate insurance (e.g. travel insurance)? ☐ Yes ☐ No

2.10. Does the research include risks or other factors that might cause it to be excluded from coverage by the University insurers? (see note 5) ☐ Yes No

2.11 Has funding been sought for this research? ☐ Yes No

2.12. If so, where have you applied for funding?

2.13. Has the funding been granted? ☐ Yes ☐ No ☐ Pending

2.14. Other collaborators *

None

SECTION 5- QUESTIONNAIRE

If you have answered YES TO ANY OF THE QUESTIONS IN SECTION 3 or have been referred by the Faculty Head of RKE (or Head of Department in the case of students) you should complete this questionnaire, where you can describe more fully how you plan to deal with the ethical issues raised by your research.

1- RESEARCH AIMS AND SIGNIFICANCE

Aim: To critically evaluate how preservice primary teachers draw on their self-efficacy to teach primary science.

Objectives:

To explore preservice primary teachers' perception of self-efficacy and its relevance for teaching primary science.

To explore what factors influence the development of student teachers' self-efficacy within the teaching of primary science.

To contribute new insights into the development of self-efficacy through qualitative research.

I have been passionate about teaching science all my professional career and am now involved in Initial Teacher Training (ITE) programmes both at postgraduate and undergraduate level, particularly in primary science. Drawing on previous modules from the EdD programme, in particular Reflecting on and Evaluating Practice, it is clear that my professional development has been influenced by constructivism which Zwozdiak-Myers (2012:96) argues, within the context of ITE, is 'an active, creative, interpretive process, in which the telling and retelling of stories provide a framework for the construction of professional knowledge in teaching'. These shared experiences can contribute to developing 'high teacher self-efficacy' (Glackin and Hohenstein, 2018:272), which is linked with 'pedagogical choices and teacher resilience' (Deehan, 2016:7). Albert Bandura, who is most associated with this construct, defines self-efficacy as 'beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments' (Bandura, 1997:3). Research into self-efficacy in teaching, identifies it as an important influence on teacher motivation, attitudes and approaches towards classroom practice (Mansfield and Woods-McConney, 2012).

These ideas have shaped the direction of my research project. From a professional basis I want to explore how preservice primary teachers develop their self-efficacy towards teaching primary science, given the variable status of the subject in schools and the potential lack of opportunity to teach science on school placements (Leonardi et al., 2019). Glackin and Hohenstein (2018) argue that one of the criticisms of research into self-efficacy lies in its close connection with quantitative approaches, which are seen as narrow and with limited applicability for classroom practice. Furthermore they highlight the need for more in-depth qualitative research in order to address this issue. Therefore through this research I intend to contribute new knowledge to the construct of self-efficacy through a qualitative approach, within the context of science teaching, and to gain insights into the factors influencing the development of teachers' self-efficacy.

2- RESEARCH PARTICIPANTS

Mark with an X as appropriate		**YES**	**NO**	**Not certain**
a	How will participants be identified and approached? I intend to use a convenience sample using participants who are willing to take part in the study. I will contact potential participants, who are on ITE Primary Teaching courses, through approved channels of communication at the university, such as Year group Canvas announcements and Year group seminars with the approval of the Year Lead and Programme Leaders for the courses. Since the participants will be volunteers from ITE Primary Teaching courses the demographic diversity is likely to be small. In any case care will be taken to ensure that anonymity of all participants will be maintained throughout the transcription process, analysis and final write up. I will share the project information sheet and ask participants to contact me via the university email if they are interested in taking part. As I am using the university site for communication, access to these emails is password protected Each volunteer will be given a number and I will interview in numerical order of contact with me. Should there be more volunteers than expected I will place additional volunteers on a reserve list and contact them to let them know if they will/will not be required. I will then ensure that all volunteers have read the project information sheet and letters of consent in order to inform participants of the purpose of the study, how it will be conducted, and ensure that confidentiality will be maintained throughout. Participants are free to choose to participate in the			

	interviews. Once the initial interview is completed participants will be asked if they would be happy for me to observe them teaching science and/or be interviewed further, the purpose of which would be to develop the initial interview discussion more fully and explore their commentary further. Participants will be asked to indicate on their consent form should they wish to be involved at this point and reminded that they are free to withdraw at any time without issue. Once their participation has taken place I will delete their emails and store their letters of consent, using code identifiers only, in a locked cabinet. These will be destroyed once the doctorate has been completed. Participants will also be made aware that the outcomes will be used for the substantive thesis of the EdD. This is in accordance with Ethical Guidelines for Research (BERA, 2018) and the Research and Knowledge Exchange Ethics Policy and Procedure as outlined by the University of Winchester (2015).			
b	Do you intend to recruit children under the age of 16?	☐	**NO**	☐
c	Do you intend to recruit participant who may be deemed vulnerable in any way?	☐	**NO**	☐
If you have answered YES to the above, please justify why their participation in the research is necessary and provide further details on how you intend to protect these participants.				
d	Is it possible that a current or past relationship with potential participants could give rise to a perceived pressure to participate because are you in a position of authority or influence over them (e.g. they are your students, colleagues, family, etc.)?	YES	☐	☐
If so, what steps will you take to mitigate this issue? Best (2012:20) points out that 'all research practice requires an awareness of ethical issues' and that issues can arise from conducting research with students who are studying courses that I contribute to. There may be a perceived pressure to participate because I am a lecturer for some, but not all, of these participants. I have decided to do a general announcement via email or if invited, via a Year group				

seminar, to let all students know about the research project, its purpose and their potential involvement. I will reiterate that participation is completely voluntary and if they do participate, they can withdraw without any adverse consequences and their contribution will be removed from any interview material including observation notes. I am using a broad approach towards accessing volunteers, in order to avoid any individual feeling pressurised to take place because they know me. If after the initial interview participants have indicated that they would be happy to be observed teaching science it will be made clear that this would contribute towards extending points that have been raised in the initial interview discussion and will have no impact on their placement assessment.

Participants will be encouraged to take part whether they like/dislike science, like/dislike teaching science. As the research is about self-efficacy this is an important aspect of the research and may lead to unexpected outcomes that can contribute to developing ways in which ITE can better support students who find science a challenge to teach. Therefore this will have not impact on the researcher's judgement of the participant's performance with respect to the course they are studying, but will in fact be a potentially valuable source of information about how to provide better support.

I will be guided by the Data Protection Act (1988) and I am in the process of upgrading my knowledge of the General Data Protection Regulation (2018). The research will be carried out in accordance with BERA Ethical Guidelines for Ethical Research (BERA, 2018) and the University of Winchester Research and Knowledge Exchange Ethics Policy and Procedures (UoW, 2015).

e	Do you intend to collect tissue samples (blood, saliva, hair, or any other body part, including human skeletal remains?	☐	NO	☐

Please indicate the procedures in place for safeguarding the sensitive materials, including storage and whether further use beyond this research is envisaged. If so, has adequate consent been obtained?

NA

Human tissues/ remains: If the work involves obtaining a licence under the provisions of the Human Tissue Act (2008), please indicate who the **named holder** of the relevant licence is.

The named holder of the licence is **Licence number**

3- INFORMED CONSENT

Mark with an X as appropriate		**YES**	**NO**	**Not Certain**
a	Will potential participants be asked to give informed consent in writing and will they be asked to confirm that they have received and read the information about the study? *Please attach a draft information sheet and/or consent form, if this is necessary.*	**YES**	☐	☐
If not or not certain, please provide more information				
b	Has information (written or oral) about the study been prepared in an appropriate form and language for potential participants?	YES	☐	☐
If not or not certain, please justify. At what point in the study will information about the research be offered?				

c	How do you intend to discuss the study with potential participants or those who may represent their views? My aim is to ensure that trust and confidentiality are maintained throughout (Best, 2012:89) and that participants' views are reflected through the following ways: • Any participant will be provided with an information sheet outlining what the research is for, and their right to view the outcomes from the interviews. Participants will be identified by code identifiers and no names will be used during the interviews or with the transcriptions or within the thesis. • Participants will be encouraged to respond as fully, openly and professionally as they are comfortable with and it is the responsibility of the researcher to ensure that a good rapport is established with participants. As this will be a professional discussion participants will be reminded not to use names of establishments, children or other adults during the discussion. If names do occur they will not be used in the transcript, data analysis or any aspect of the final thesis. • Participants will be reminded that the purpose of the interview is to explore self-efficacy and thus some critical comments may arise which may be valuable to the outcomes of the research. Any such commentary will be addressed sensitively by the researcher, however there is no intention in the transcript, analysis or final write up, to link these comments to specific establishments or people. • Should participants disclose anything that gave cause for concern about their own welfare during the interview, the researcher will suggest they contact student services for support and advice. If the scenario warrented it the researcher would use her judgement to stop the interview and seek the permission of the participant to share the issues with relevant staff who can provide the appropriate support. • Should participants disclose anything that indicated risk to a child they will be reminded of the safeguarding advice given prior to placement and be asked to report to the partnership office to share their concerns. • Transcriptions will be made from the interviews so that no participants can be identified. In the initial part of the research I will do the transcriptions but it may be necessary to use a recommended transcriber if there are a lot of interviews to cover or time is an issue. I will make this clear to all participants and ensure that the transcriber follows the code of confidentiality by establishing that no names of participants are used in the transcript. The copy of the sound file must be returned to me with the transcript and no other copies kept by the transcriber. I will make the transcriptions available for viewing on specific dates and times, in a room in which I will be present at all times. Where individual interviews are used I will send these via the university email system. Participants are free to view the transcript and confirm that they are happy for me to proceed and use the transcription for data analysis linked to the research project. Following the viewing of the transcript participants will be given one further week to decide if they wish to withdraw from the research, after which the analysis process will begin. • All data will be stored securely on a password encrypted storage device and deleted after the completion of the EdD. Whilst anonymity and confidentiality will be a priority I will ask participants to include their name and contact details only if they wish to participate further in the research process and take part in the observation/further interview section. •

	This is in accordance with BERA (2018:16) which states that 'Researchers should aim to be open and honest with participants'.			
d	Will potential participants be informed of any adverse consequences of a decision not to participate? Or of a decision to withdraw during the course of the study?	☐	NO ☐	Not certain
Please provide any further information that may be relevant. For the pilot study I do not anticipate any adverse consequences for non-participation or withdrawal from the study. For the substantive thesis I do not anticipate any adverse consequences for non-participation or withdrawal from any aspect of the study. Participants will be reminded that participation is voluntary and that they can withdraw at any time. This will be made clear on the consent form.				
e	Will participants be told that they can withdraw at any time, ask for their interview tape to be destroyed and/or their data removed from the project until it is no longer practical to do so (e.g. when you have written up your report).	YES	☐	☐
Please provide further information if necessary. • Participants will be told that they can withdraw from the interview at any time. Individual participants can request for their interview tape to be destroyed at this point if they do not wish the interview to be transcribed. Interviews that are transcribed will be made available for participants to view and give consent for its use in the data analysis aspect of the research. Participants may redact any of their own commentary at this viewing and/or add additional comments. This same process will occur if the participant takes part in the follow-up observation/interview section. • Following the viewing of the transcript participants will be given one further week to decide if they wish to withdraw from the research, after which the analysis process will begin.				
What provision has been made to respond to queries and problems raised by participants during the course of the study? Throughout the research process I will ensure that participants can approach me if they need to. The intention is to deal with issues as they arise ensuring that participants know exactly how the research will be used and that they are happy to continue to participate.				

	4- RESEARCH METHODOLOGY
a	Where relevant, how does the research methodology justify the use of deception? Can the information be obtained by other means? NA
b	How will data be collected and analysed during the project? Data will be collected via audio recordings and the researcher's reflective journal entries. The audio recordings will be stored on a password encrypted storage device and the reflected journal will be stored in a locked cabinet. The audio recordings will be deleted at the completion of the EdD. Analysis will make use of computer assisted software and manual approaches. Files will be kept on password protected storage devices which will be deleted at the completion of the EdD. Any written materials will be kept securely and only accessible by the researcher. In the case of a transcriber being used I will ensure that confidentiality is maintained at all times and that the transcriber will not keep any copies of the audio tape or transcript once the process has been completed.
	How have the ethical and legal dimensions of the process of collecting, analysing and storing the data been addressed? I will be guided by the Data Protection Act (1998) and I am in the process of upgrading my knowledge of the General Data Protection Regulation (2018). The research will be carried out in accordance with BERA Ethical Guidelines for Ethical Research (BERA, 2018) and the University of Winchester Ethics Policy and Procedures (UoW, 2015). The study aims to collect relevant but not excessive data which will be kept securely for the duration of the substantive Thesis. Participants have the right to withdraw at any time during the study and have any personal responses/information deleted. Code identifiers will be used for all participants.
	5- PRIVACY
a	What arrangements have been made to preserve confidentiality for the participants or those potentially affected, and compliance with data protection law? I will take responsibility for ensuring confidentiality throughout the processes of data collection, data analysis and reporting. Real names for participants will not be used in order to protect their

	anonymity, and all data will be saved onto a password encrypted storage device or stored securely so that only the researcher has access to this material. This is in line with point 50 in BERA (2018:25) '*Researchers should ensure that data are kept securely, and that the form of any publication (including those published online) does not directly or indirectly lead to a breach of agreed confidentiality and anonymity'*.
b	Will the research data be used for any other purpose? If you intend to re-use this data then please state this clearly on the Information Sheet & Consent Form, and state below what potential uses you may envisage. I have indicated on the project information sheets that the outcomes may be used for research and publication beyond the completion of the EdD, but all data will be anonymised.
	6- FINANCIAL INCENTIVES
a	Please specify any incentives being offered to participants and a justification for their use. NA
	Please specify any payments to researcher or participants and state whether they may have an impact on the objectivity of the research NA
	7- RISKS
a	What are the specific risks to research participants or third parties? None

b	If the research involves pain, stress, physical or emotional risk, please detail the steps taken to minimize such effects. NA
c	Are there any potential risks to the researcher/s? None

SECTION 6: ADDITIONAL INFORMATION

UNIVERSITY OF WINCHESTER

Tel: 01962 841515
Fax: 01962 842280
www.winchester.ac.uk

Winchester
Hampshire
SO22 4NR

Project Information Sheet Group Interview

Invitation:

My name is Liz Burgin and I am currently working as a Senior Lecturer in Education and the Route Manager for the PGCE part-time course, at the University of Winchester. I teach on the BA and PGCE courses, in particular preparing trainees for teaching primary science. I am presently completing the thesis for a Doctorate in Education and wish to draw on my many years of classroom practice to carry out research into how teachers develop their self-efficacy and confidence towards teaching science, and the implications this may have on their approach in the classroom. I invite you to take part in this research the outcomes of which will contribute to the thesis stage of the Doctorate in Education, and may also be used for publication purposes.

What is the purpose of the research?

Aim: To critically evaluate how preservice primary teachers draw on their self-efficacy to teach primary science.

Objectives:

To explore preservice primary teachers' perception of self-efficacy and its relevance for teaching primary science.

To explore what factors influence the development of preservice primary teachers' self-efficacy within the teaching of primary science.

To contribute new insights into the development of self-efficacy through qualitative research.

Why get involved?

- Because you have some good ideas to contribute towards a professional enquiry into the teaching of primary science.
- Because you will gain an insight into the research approaches used in exploring how teachers develop their self-efficacy and confidence towards teaching science, and the implications this may have on their approach in the classroom.
-

Before you decide to participate, it is important you understand what the project involves and what you will have to do. So, please take time to read the following information. Ask if anything is unclear.

Participation: Your participation in the study is entirely voluntary and you are free to withdraw from the interview process at any time without giving reason and without penalty. You are asked to participate in a group discussion into how teachers develop their self-efficacy and confidence towards teaching science. Participants involved in the group interview will be asked to read and understand this Project Information Sheet and sign a consent form. The conduct of the research will be according to the British Educational Research Association (BERA, 2018) and the accepted ethical principles of confidentiality, anonymity, and data protection.

- **Procedure**: If you are happy to take part, the group interview will be conducted in the university at a convenient time for you. The purpose of the group interview is to provide the opportunity for a professional discussion during which I will be taking notes. I will also audio record the conversation in order to provide a reliable transcription of the discussion for the purposes of analysis. Due to time limitations a transcriber will be used but I will be checking the transcript so that it reflects the interview accurately and confidentiality is maintained throughout. You do not need to use your names and no names will be recorded in the transcript. Recordings and transcripts will be stored securely only by myself and destroyed once the Thesis stage is completed. The transcript will be made available for you to view and give consent for its use in the data analysis aspect of the research. You may redact any of your own commentary at this viewing and/or add additional comments. Following the viewing of the transcript you will be given one further week to decide if you wish to withdraw from the research, after which the analysis process will begin. You can also view how I have used the outcomes from the group interview in the Thesis.
- At the end of the initial interview you will be asked if you would be willing to be observed teaching a science lesson or part of a science lesson, with the purpose of raising discussion points and developing your initial interview further. This is entirely optional and you are free to decline this without any adverse consequences.

A consent slip is attached to this information form. This asks you to confirm that you understand the nature of the project, any possible risks involved, and the safeguards to your privacy and those participating in the group interview. Please tick the appropriate box to indicate if you wish to participate further with the observation/further interview section.

Confidentiality: Results from the study will be confidential and you will not be able to be identified should the work be published. I will be delighted to share the outcomes from the group discussion should you wish to see them at any time.

Who has approved the study? The study has been approved through the procedures outlined by the University Research & Knowledge Exchange Ethics Committee and approved by the Faculty of Education at the University of Winchester.

Contact for Further Information: You can contact Liz Burgin about the research or The University RKE Ethics Committee or Programme Leader for the Doctorate in Education

Liz Burgin

Senior Lecturer

EHSC

University of Winchester

SO22 4NR

Elizabeth.Burgin@winchester.ac.uk

References for sample questionnaire.

Enochs, L. G. and Riggs, I. M. (1990) Further development of an elementary science teaching efficacy belief instrument: A presevice elementary scale. School Science and Mathematics, 90 , (8) 694-706.

Available at: https://files.eric.ed.gov/fulltext/ED319601.pdf [Accessed 6 June 2018].

- **Project title:** An exploration into how teachers develop their self-efficacy and confidence towards teaching science, and the implications this may have on their approach in the classroom.

Investigator: Liz Burgin

Participant consent form

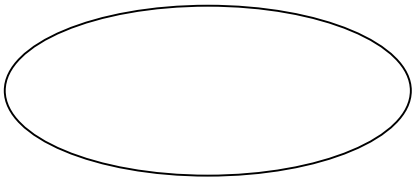
I have read and understood the project information sheet laying out the project aims, ethical guidelines, outcomes and methods. I agree to take part in the research under the conditions described. I agree material from the group discussion may be used for the purpose of research or publication. I understand that no individuals will be identified in any publication or public presentation drawing on my interview material. I am aware participation is voluntary and I have the right to withdraw at any stage without prejudice.

Signed: ..... Date: .....

Printed Name: .....

If you are willing to be observed teaching a science lesson or part of a science lesson with the purpose of raising discussion points and developing your initial interview further, please tick this box.

If you do not wish to be observed but would be interested in doing a further interview following your placement please tick this box.



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Project Information Sheet Individual Interviews

Invitation:

My name is Liz Burgin and I am currently working as a Senior Lecturer in Education and the Route Manager for the PGCE part-time course, at the University of Winchester. I teach on the BA and PGCE courses, in particular preparing trainees for teaching primary science. I am presently completing the thesis for a Doctorate in Education and wish to draw on my many years of classroom practice to carry out research into how teachers develop their self-efficacy and confidence towards teaching science, and the implications this may have on their approach in the classroom. I invite you to take part in this research the outcomes of which will contribute to the thesis stage of the Doctorate in Education, and may also be used for publication purposes.

What is the purpose of the research?

Aim: To critically evaluate how preservice primary teachers draw on their self-efficacy to teach primary science.

Objectives:

To explore preservice primary teachers' perception of self-efficacy and its relevance for teaching primary science.

To explore what factors influence the development of preservice primary teachers' self-efficacy within the teaching of primary science.

To contribute new insights into the development of self-efficacy through qualitative research.

Why get involved?

- Because you have some good ideas to contribute towards a professional enquiry into the teaching of primary science.
- Because you will gain an insight into the research approaches used in exploring how teachers develop their self-efficacy and confidence towards teaching science, and the implications this may have on their approach in the classroom.

•

Before you decide to participate, it is important you understand what the project involves and what you will have to do. So, please take time to read the following information. Ask if anything is unclear.

Participation: Your participation in the study is entirely voluntary and you are free to withdraw from the interview process at any time without giving reason and without penalty. You are asked to participate in a series of individual interviews into how teachers develop their self-efficacy and confidence towards teaching science. Participants involved in the individual interviews will be asked to read and understand this Project Information Sheet and sign a consent form. The conduct of the research will be according to the British Educational Research Association (BERA, 2018) and the accepted ethical principles of confidentiality, anonymity, and data protection.

- **Procedure**: If you are happy to take part, the interviews will be conducted in the university at a convenient time for you. The purpose of the interviews is to provide the opportunity for a professional discussion during which I will be taking notes. I will also audio record the conversation in order to provide a reliable transcription of the discussion for the purposes of analysis. Due to time limitations a transcriber will be used but I will be checking the transcript so that it reflects the interview accurately and confidentiality is maintained throughout. You do not need to use your name and no names will be recorded in the transcript. Recordings and transcripts will be stored securely and destroyed once the Thesis stage is completed. You are free to look at the transcript. You may redact any of your own commentary at this viewing and/or add additional comments. Following the viewing of the transcript you will be given one further week to decide if you wish to withdraw from the research, after which the analysis process will begin. You can also view how I have used the outcomes from the interviews in the Thesis.
- At the end of the initial interview you will be asked if you would be willing to be observed teaching a science lesson or part of a science lesson, with the purpose of raising discussion points and developing your initial interview further. This is entirely optional and you are free to decline this without any adverse consequences

A consent slip is attached to this information form. This asks you to confirm that you understand the nature of the project, any possible risks involved, and the safeguards to your privacy.

Confidentiality: Results from the study will be confidential and you will not be able to be identified should the work be published. I will be delighted to share the outcomes from the group discussion should you wish to see them at any time.

Who has approved the study? The study has been approved through the procedures outlined by the University Research &

Knowledge Exchange Ethics Committee and approved by the Faculty of Education at the University of Winchester.

Contact for Further Information: You can contact Liz Burgin about the research or The University RKE Ethics Committee or Programme Leader for the Doctorate in Education

Liz Burgin

Senior Lecturer

EHSC

University of Winchester

SO22 4NR

Elizabeth.Burgin@winchester.ac.uk

References for sample questionnaire.

Enochs, L. G. and Riggs, I. M. (1990) Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. School Science and Mathematics, 90 , (8) 694-706.

Available at: https://files.eric.ed.gov/fulltext/ED319601.pdf [Accessed 6 June 2018].

-
- **Project title:** An exploration into how teachers develop their self-efficacy and confidence towards teaching science, and the implications this may have on their approach in the classroom.

Investigator: Liz Burgin

Participant consent form

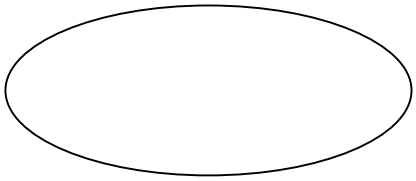
I have read and understood the project information sheet laying out the project aims, ethical guidelines, outcomes and methods. I agree to take part in the research under the conditions described. I agree material from the interviews may be used for the purpose of research or publication. I understand that no individuals will be identified in any publication or public presentation drawing on my interview material. I am aware participation is voluntary and I have the right to withdraw at any stage without prejudice.

Signed: ..... Date: .....

Printed Name: .....

If you are willing to be observed teaching a science lesson or part of a science lesson with the purpose of raising discussion points and developing your initial interview further, please tick this box.

If you do not wish to be observed but would be interested in doing a further interview following your placement please tick this box.



Many thanks.

Ethics Declaration

X I confirm that if a Risk Assessment is required I will complete it and have it co-signed by my Supervisor or Head of Department before data collection takes place.

X I confirm that, if DBS clearance is required for my project, then I will seek it before commencement of my project.

X I confirm that my research does not include risks that might cause it be excluded from coverage by the University's insurers or

☐ I confirm that I have appropriate insurance for this research - I do not require additional insurance for this research beyond the Employers' liability certificate.

I have read and understood the University of Winchester Research and Knowledge Exchange Ethics Policy and confirm that adequate safeguards in relation to the ethical issues raised by this research can and will be put in place. I am aware of and understand University procedures on ethics in Research and Knowledge Exchange and Health and Safety. I understand that the ethical propriety of this project may be monitored by the RKE Ethics Committee.

Researcher's signature: Liz Burgin DATE: April 25th, 2019

Approved May 2019, Updated August 2019

References

Bandura, A. (1997) *Self-Efficacy: The exercise of control.* New York: W.H.Freeman and Company.

BERA (2018*) Ethical Guidelines for Educational Research.* 4th edn. London: BERA. Available at: https://www.bera.ac.uk/wp-content/uploads/2018/06/BERA-Ethical-Guidelines-for-Educational-Research_4thEdn_2018.pdf?noredirect=1 [Accessed August 12th 2019].

Deehan, J. (2016) The Science Teaching Efficacy Belief Instruments. Switzerland: SpringerNature.

Glackin, M. and Hohenstein, J. (2018) Teachers' self-efficacy: progressing qualitative analysis, *International Journal of Research and Method in Education*, 41, (3), 271-290.

Leonardi, S., Lamb, H., Harisson, J., Stutz, A., Steer, R., Howe, P. and Corley, A. (2019) *Understanding the 'state of the nation' report of UK primary science education.* London: Wellcome Trust.

Mansfield, C. and Woods-McConney, A. (2012) "I Didn't Always Perceive Myself as a Science Person": Examining Efficacy for Primary Science Teaching, A*ustralian Journal of Teacher Education*. 37, (10), Article 3.

Available at: http://ro.ecu.edu.au/ajte/vol37/iss10/3 [Accessed July 12th 2018].

UoW, (2015) Research and Knowledge Exchange Ethics Policy and Procedures. Available at: https://intranet.winchester.ac.uk/information-bank/research-and-knowledge-exchange/Documents/Ethics%20Policy%20and%20Procedures%20_Final%20Sep2015.pdf [Accessed 6 June 2018].

Zwozdiak-Myers, P. (2012) *The Teacher's Reflective Practice Handbook.* Abingdon: Routledge.

Appendix 2: Interview Schedule

Aim: To critically evaluate how student teachers draw on their self-efficacy to teach primary science.

Objectives:

To explore student teachers' perception of self-efficacy and its relevance for teaching primary science.

To explore what factors influence the development of student teachers' self-efficacy within the teaching of primary science.

To contribute new insights into the development of self-efficacy through qualitative research.

Introduction

Check Consent given and participant understands the right to withdraw including the opportunity to read the transcript- one week grace before I begin to analyse things.

Background: A short intro about yourself in terms of what science you have previously studied (no grades required just up to what level), your views about science, whether you have taught any science- what years and what topics.

Starter section

What's the first thing that comes to mind when I say:

- Primary science
- Teaching primary science

Section 1 To explore what factors influence the development of preservice primary teachers' self-efficacy within the teaching of primary science.

Over the last few years what opportunities have you had to **observe science**-draw on any experiences you wish to refer to- course/self-directed/placement/other e.g. scout group/video/youtube-transmission/enquiry based etc

Over the last few years what opportunities have you had to **teach** science- draw on any experiences you wish to share-

Course

Placement

Self-directed

Other

Was it a whole class or group experience/ working from own plans or teachers

Did you receive any feedback (pupil?teacher/own eval) and do you think this will affect how you next teach science?

What do you feel about teaching PRIMARY SCIENCE/aspects of primary science?

What do you think has contributed to your approach to using an enquiry based approach to teaching primary science?

What do you think has limited your approach to using an enquiry based approach to teaching primary science?

Section 2: To explore preservice primary teachers' perception of self-efficacy and its relevance for teaching primary science.

Taking these examples (previous) a little further- How would you describe your confidence to teach primary science. Can you think of a lesson when you felt really confident at some point- before during after- and did your confidence change during the lesson? What affected this- feedback/chn responses/reflection

To what extent do you feel that you helped the chn to learn effectively or facilitated their learning in science?

Can you think of a lesson where you felt less confident –and as above. What contributed to this?

Reflecting on these responses How do you think your confidence contributes to how you will teach primary science? Do in Year order- how did things change/or not change over the period of your course?

How do you think your own experiences of being taught science may affect your approach to teaching PS?

Do you think primary science and secondary science are the same- explore response

How do you think primary science should be taught- if not already covered.

What aspirations do you have for your teaching of primary science? What would your priorities be?

What has influenced you in deciding on these priorities?

How ready do you feel to teach primary science in your NQT year- How will you approach this?

What do you think we could do on the course to prepare you to become an effective teacher of primary science?

What do you think the term self-efficacy means? Exploration of term only

Finish: Do you have any other thoughts or views that you would like to add to the interview/Has this been a useful experience for you- explore further and take suggestions.

Appendix 3: Examples of transcriptions

Removed from open access version.