A PHENOMENOLOGICAL STUDY OF PRE-SERVICE TEACHERS' SUBJECT KNOWLEDGE IN SECONDARY DESIGN AND TECHNOLOGY

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Abstract

This study explored the development of subject knowledge by pre-service teachers of Design and Technology (D&T) in secondary schools in England. In doing so it aimed to throw light on their lived experience of developing subject knowledge whilst on placement in schools. It was anticipated that this would help to identify the factors that shape what is learned and the ways in which pre-service teachers may be better prepared and supported for placement in the future.

The study made use of phenomenology as a methodological approach in order to capture the lived experience of developing knowledge through the eyes of pre-service teachers. This was framed against an exploration of subject knowledge in Design and Technology and the extensive experience of the researcher in the field. Empirical data was gathered through a process of interviewing 11 participants three times during the course of one academic year. Processes of data reduction and explication were undertaken to explore individual experiences and aspects that they had in common.

Findings from the study highlight the inadequacy of the term *subject knowledge* in describing the processes that take place. They demonstrate that pre-service teachers drawn on cognitive, psychomotor and affective domains in developing their understanding of materials and processes in preparation for teaching. The findings also highlight the complex, and interrelated nature of factors that affect the development of subject knowledge and the significant influence that the placement school arena, and teachers, have on shaping the nature of what can be learned. They also indicate that learning new knowledge is a central part of the experience and that developing ‘skills of knowing’ is essential.

Key recommendations from the study include the preparation of pre-service teachers for their placement experiences by enabling them to understand how they learn completely new things. It is also recommended that the responsibility for the development of subject knowledge should be more in the hands of placement schools. Further work is also needed in exploring alternative ways of representing the processes that take place when knowledge is acquired by individuals as they become the teachers of the future.

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1 Introduction

This research study looked at the experiences of pre-service teachers as they developed their subject knowledge in Design and Technology during a postgraduate course of teacher education at secondary level in England. To introduce the study, this chapter provides some background information on the significance of subject knowledge as a part of teacher education and the key document that prompted the study. This is followed by an overview of the context in which the study took place, a brief account of the experience of the researcher and an explanation of the rationale for the study as a whole. This chapter concludes by discussing the general research questions that were identified before undertaking the literature review along with an overview of the thesis as a whole.

1.1 Background

Developing appropriate subject knowledge is recognised by many authors including McNamara (1991) and Ellis (2010) as an essential part of becoming a teacher. Given the short period of time that most pre-service teachers have to develop their understanding of subject knowledge, how exactly they develop their knowledge is of critical importance. Teacher educators running courses of initial teacher education in England are expected to audit beginning teachers' subject knowledge and track this throughout their training. An assessment of such tracking has formed part of the inspection regime (Ofsted, 2008) for some time, making it a priority for teacher educators in an age of considerable accountability. Such was the continuing interest in subject knowledge as a part of teacher education in 2007 that the Training and Development Agency for Schools produced a booklet entitled *Developing trainees' subject knowledge for teaching* (TDA, 2007) and held national subject seminars to discuss it.

The key text that provoked this research study in the first place, and that relates to design and technology in particular, was *The Minimum Competences for Students to Teach Design and Technology in Secondary Schools* (DATA, 1995). Although described as a research paper in the title, there is no mention of any empirical research inside the document and it reads more as a synthesis

of the collective views of the authors. It sets out a common core of knowledge and also specific areas of specialism namely: control and systems, resistant materials, food, and textiles.

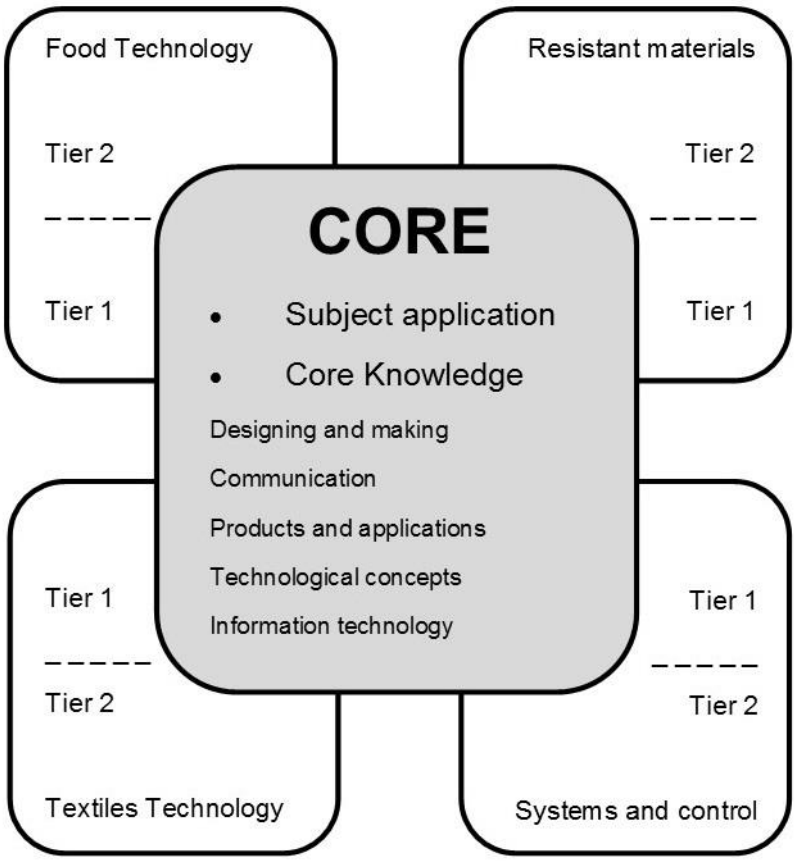

Figure 1: Fields of D&T

Within the Core, and each specialist area, a list of competences was provided which pre-service teachers were expected to attain through their training. The document was produced at a time of significant change in teacher education with the development of Standards, provided by the government (DES, 1992), that pre-service teachers needed to meet. The introduction of these, as Burchell and Westmoreland (1999) comment, had a major impact on teacher education in England. The definition of a set of subject competences, to run alongside the generic ones for all teachers, helped to secure the status of Design and Technology as a subject to be taken seriously as a part of the National Curriculum (DES, 1990).

The job of supporting those wishing to teach Design and Technology has been a challenging one given the difference between the background that many pre-service teachers have (Lewis, 1996) and the open-ended nature of the subject. During this time of change the training of pre-service teachers of Design and Technology was undertaken within universities, each with their own unique course and distinctive features. The Minimum Competences was the first document that identified an agreed set of skills and knowledge that might be audited and monitored. Their inclusion in the work of the Office for Standards in Education (Ofsted) helped to establish them as a national standard to which all pre-service teachers of design and technology could be expected to meet wherever they were training in the country. Consequently they defined what teacher education courses should be delivering in terms of subject knowledge for Design and Technology. With the increasing accountability of teacher education courses and the introduction of increasingly specific standards for students (DfEE, 1998), the use of the Minimum Competences took on greater significance. Those being trained on teacher education courses were required to audit their existing knowledge against the competences and seek to fill gaps in their knowledge through subject knowledge sessions at university or whilst on placement. Such was their significance that, at one time on the PGCE course at Liverpool John Moores University (LJMU), mentors in school were required to sign that they felt that an individual was competent for each of the statements. Even today such checking against this codified body of knowledge still takes place within teacher education as pre-service teachers are ‘signed off’ to say they are competent.

Whilst at first they seemed fit for purpose, over time it started to become clear that the Minimum Competences were not appropriate or effectively doing their job. As Martin (2008) reported, there were some ambiguous and overlapping statements, pre-service teachers did not consider them to be helpful and they appeared to be out of step with what future employers wanted. In addition teachers in school seemed prepared to sign off documents, whether competences were met or not, in order to help pre-service teachers pass the course.

At the Design and Technology subject association conference held at Loughborough University in 2002 there was a discussion of the Minimum Competences and clear dissatisfaction, amongst those present, of the ways in which they were written and structured. Despite the very nature of the competences being questioned at that time, the Design and Technology Association simply revised them (DATA, 2003) with much the same structure and format. Such was the discomfort with the document, and it's historically located, and gender oriented structure, that a paper was written by the author (Martin, 2008) that put competences in the spotlight.

The continuing retention of a fixed set of competences implied that Design and Technology had a fixed body of knowledge and the acquisition of knowledge outside of this defined domain was of little value. This, however, did not reflect the practice in schools with a continually expanding range of materials and processes being used in creative ways (Martin, 2013). Outside of the subject there were questions raised over the nature of subject knowledge with Edwards, Gilroy, and Hartley (2002) posing the question 'what is teacher knowledge'. They suggested that a limited response to such a question can end up with a list of competences which can then be formally assessed to measure training. This suggests that not enough thought had been given to the Minimum Competences and that it was perhaps easier just to amend them than consider an alternative.

1.2 Context

For those involved in the design and delivery of courses of initial teacher education, developing pre-service teachers' subject knowledge was a central part of their responsibility in developing effective practitioners. It was anticipated that the results of this doctoral investigation would inform future practice in the ways in which pre-service teachers' subject knowledge development is supported. At a time of change to the curriculum (DfE, 2014) and the changing nature of the environment of initial teacher education (DfE, 2016b) such a study was timely and has provided insights into an important aspect of the work of teacher educators in the future.

At the time of data collection in the 2012/2013 academic year, the majority of courses were university based. There was, however, increasing interest by the government in developing more school-focused courses. Currently there are many different routes into teaching such as Schools Direct (DfE, 2016b). The introduction of such courses, with an increased focus on the experience that pre-service teachers had in schools, raised questions about their subject knowledge development and made the study of particular interest to those involved in teacher education, both in and out of higher education institutions. In addition there was also a decrease in the number of undergraduate courses being offered with the main route for those entering the teaching profession being through one-year postgraduate courses. The relatively short time to develop the skills and knowledge necessary to teach a subject further increased the demand on pre-service teachers to develop their subject knowledge.

In order to discuss how knowledge is conceived within design and technological activity it was necessary to explore how the subject domain is defined. Unusually, for a school subject, the domain is defined by the school curriculum and subject qualifications. This is as a result of the discipline of Design and Technology not having an equivalent, beyond school curricula, in universities and in professional life. Designing products and making them from appropriate materials can be found in many professions and industries such as catering and mechanical engineering etc. Whilst it is possible to undertake higher education courses focused on these areas, the subject of Design and Technology only appears as an undergraduate course in a handful of universities. For other subjects in school, such as Geography, it is possible to study at a higher level. There will always be a mismatch between what is learned in university and the curriculum content in school, there is nowhere near the gap that exists between areas such as catering and the curriculum content of Design and Technology.

The National Curriculum in England was the first national curriculum in the world to include the subject of Design and Technology as an entitlement for all pupils age 5 to 16 (DES, 1990). Its aim then, and now (DfE, 2014), was to enable pupils to design and make two and three dimensional objects in a variety

of materials as an expression of their own thinking and decision making. From its creation as a subject in the curriculum at the end of the 1980's, Design and Technology has held a sometimes controversial position as part of children's general education and has been fought over by a number of different interest groups at different times. This was highlighted by Layton who described a number of different stakeholder groups that played a part in the socio-political shaping the subject. These were identified as: economic functionalists; professional technologists; liberal educators; sustainable educators; women Layton (1992, p. 3).

In terms of focus and content the subject has undergone a number of iterations to reach the current structure (DfE, 2014) and still continues to develop today. It's relatively short history is filled with changes to content (Martin, 2013), as well as structure, reflecting to some extent the way in which our world of industry and technological products has changed. The subject has its roots in the practical subjects available in schools through the 1970s and 1980s this area of learning was dominated by practical skills and the acquisition of knowledge associate with them (Penfold, 1988).Through the 1990s there was an increasing focus on pupils' ability to design what they would be making and the skills and knowledge required changed. Currently designing and making are set out as equally important parts of the Design and Technology curriculum (DfE, 2014). It is within this conceptual understanding of the subject that the study was undertaken.

As a result of the history of Design and Technology, the content knowledge of the subject was split into four material areas: Control and Systems; Food Technology; Resistant Materials and Textiles. Despite the fact that many products incorporated a range of materials across these categories, they still exist within the subject as we know it today and often shape the structure of departments in schools. Dividing the content knowledge into categories of materials can give the impression that such content is fixed. However, this is far from the truth as content has changed over time in response to the changing manufacturing world in which we live. This can be seen through the changing emphasis of the National Curriculum documentation. For example, in 1990

there was almost no mention of Computer Aided Design (CAD) (DES, 1990). However, in the most recent version of the curriculum (DfE, 2014) there is considerable mention of CAD. Indeed, it is hard to imagine a secondary school department of Design and Technology without at least one computer running CAD software linked to a laser cutter. This constant change in our material world filters through to the subject in school, making the very idea of a fixed body of content knowledge both an impossible and inappropriate idea.

Outside of England there are subjects similar to Design and Technology that involve designing and making with materials to produce three-dimensional outcomes. In Scotland, for example, such activity falls under the area of Technologies (Education Scotland, 2014) where pupils have opportunities to work with food and textiles as well as craft and engineering. The area of Technologies also includes business as well as ICT and is consequently structured in a completely different way than the curriculum in England. Further afield, design and technological activity is also part of the curriculum in a number of countries but, again, takes on different forms. In New Zealand, Technology is quite similar to the way in which the curriculum was defined in England some years ago with an emphasis on working with materials but is organised differently through three areas namely: technological practice, technological knowledge and the nature of technology (Ministry of Education NZ, 2014). In the USA, the Standards of Technological Literacy (ITEEA, 2007) placed a strong emphasis on manufacturing and the subject makes a significant contribution to their Science Technology Engineering and Math (STEM) education .This study is particularly focused on the curriculum in England. Whilst making use of the literature available internationally about the subject domain, the study is bounded by what has taken place in England and is firmly located within that socio-political landscape.

1.3 Researcher

After completing University in 1983 with a degree in Mechanical Engineering, I spent three years working with Voluntary Service Overseas (VSO) teaching first at a secondary school and then at a vocational centre in Ghana, West Africa.

This was an important time in developing attitudes and values in relation to technology and technology education. I saw both the positive effect that technology education can have on a community and the negative effect of poorly managed technology transfer. From this experience I could see the importance of a critical attitude towards technology and technology education along with the importance of developing high level skills and knowledge when handling tools and materials.

On completion of my experience abroad I returned to England and trained as a teacher of Craft, Design and Technology (CDT) at a time when the subject of Design and Technology was being developed as part of the National Curriculum. As a result of this timing, my professional life has always been highly intertwined with the subject. In terms of my own experience of subject knowledge development, I have learned a great deal during my professional life whilst teaching and as a teacher educator. Despite having a degree in mechanical engineering, which appeared to be appropriate for the subject, my knowledge of materials and processes had significant gaps. In particular, when it came to working with wood as a material I had much to learn. This was also a time when plastics gradually became used for designing and making in school workshops.

For more than 20 years I have been involved in the education of pre-service teachers across a number of universities and across primary and secondary phases. The nature of teacher education has changed in that time and it has been necessary to adapt to the changing circumstances. One of the most significant issues for those involved in teacher education has been the development of teaching Standards (DfEE, 1998) and an increasing focus on subject knowledge as a key component for all those entering the teaching profession (TDA, 2007).

1.4 Thesis overview

This thesis explores the experience of pre-service teachers as they develop their subject knowledge whilst on placement in schools. It aimed to provide insights into what actually happens and how future pre-service teachers may be

better prepared for working in school environments. In focusing on the area under study, a number of key questions emerged from the researcher's professional experience of working with pre-service teachers over a 20-year period. These are:

- How useful is a fixed set of knowledge competences?
- How important is the placement environment in shaping knowledge?
- Who has an impact on the development of pre-service teachers' knowledge?
- Is constructivism helpful in understanding what goes on?
- What opportunities do pre-service teachers have to learn new knowledge when on placement?

These questions arose from a desire to fully understand the experience that pre-service teachers actually have and were influenced by what has been written by others. This thesis provides a summary of what was undertaken and has been organised as a series of connected chapters.

Chapter 2 – Literature review

This provides an overview of the literature related to the subject of Design and Technology, teacher education in general and ways in which knowledge has been conceptualised. In particular, the review focuses on what has been written about subject knowledge within Design and Technology and suggests that there are significant gaps in what is known about the experience of pre-service teachers when on placement. A number of theoretical frameworks are explored and the chapter concludes with a refinement of the above key research questions.

Chapter 3 – Methodology

The methodology discusses the nature of qualitative research and the problems associated with the use of different terminology. The chapter outlines the theoretical perspective that was selected for the study that reflects the philosophical position of the researcher. There is a discussion of the approach that was selected to frame the study and a rationale for choosing it. It also details the data collection methods used and how quality and ethical issues have been incorporated into the research design and considered throughout.

Chapter 4 – Data analysis

Selecting an appropriate form of data analysis with a phenomenological approach is difficult as there are a variety of forms of analysis that can be applied. This chapter provides details of the ways in which such forms of analysis were explored to determine what was the most appropriate one for the study and that could be used to explicate meanings from the data. Phenomenological considerations are discussed and a rational for the chosen method of explication is given.

Chapter 5 – Findings

The findings from the data are provided in this chapter. It begins by focusing on the perspective of individuals through an account of their experiences across the placements. This is then followed by an exploration of a number of aspects that participants had in common to provide a different perspective on the development of subject knowledge. Finally the aspects of their experience are looked at over time and those that change are identified.

Chapter 6 – Discussion

This chapter discusses the emerging findings in relation to the literature in the field. Significant aspects of the findings are dealt with in detail and linked back to the literature where appropriate. Given the experience of working with phenomenology, and the considerable time spent exploring different ways in which it can be used as a research approach, there is also critical reflection of the methodology used and how it could be refined in future work.

Chapter 7 – Conclusions

The thesis ends with a chapter that summarises the research study and draws a number of conclusions related to knowledge and placement. Implications for practice are also included in this chapter.

1.5 Summary

This chapter has provided an introduction to the study beginning with the background that led to the research focusing on this area. A description of the context was given along with the personal background of the researcher. It was concluded with an overview of the thesis and content of the chapters. Overall, this study is significant because it provides primary research about a 'traditional' route into secondary teaching based in a higher education institution at a time of considerable change with greater choice in the options available for those learning to teach (DfE, 2016b). The next chapter provides a review of the relevant literature related to the area being studied.

2 Literature review

2.1 Introduction

This chapter focuses on the literature related to the study and takes account of the research questions identified in the previous chapter to help guide the selection of appropriate sources. It begins with an explanation of how the literature review was structured to logically present what can be complex issues. This is followed by a review of the literature associated with three areas, namely: knowledge; the subject of Design and Technology; teacher education. These are then combined towards the ends of the chapter. Given that the study is related to a specific curriculum subject that has only existed since 1989, it was decided that the review should, in the main, reflect the literature since that time. With the limited number of academics writing about the subject it was possible to consider every article in the subject specific journals that exist, thus ensuring that a comprehensive review was undertaken.

The focus of the study was on subject knowledge. More specifically, it was about the experience of pre-service teachers of secondary Design and Technology whilst on placement as part of a course of teacher education in England. In undertaking the review of literature it was important to consider what is meant by experience. This study has adopted the perspective of Crotty (1996) in considering experience to be the ordinary everyday understandings of events, interactions and processes that contribute to the participants' development of knowledge. The area of interest is not limited to what actually happened as chronological facts, but also in what was of significance for the individual. Consideration of how it felt, what it meant, and the impact it had, provide insights that go beyond describing the appearance of an experience to defining its essence. In his literature review of phenomenological nursing research, Crotty suggested that the pivotal notions of experience were:

> *feelings, attitudes and meanings (or perspectives)*
>
> (Crotty, 1998, p. 14)

As will be discussed later, developing a clear understanding of experience is an important consideration when using a phenomenological approach.

Given the focus it was felt necessary to look at three overlapping areas of literature, namely: *Design and Technology* as a subject, *teacher education* as a context, and theories of *knowledge* that could provide an appropriate frame of reference. The following diagram illustrates the different areas with the overlap of all three being the focus of the study.

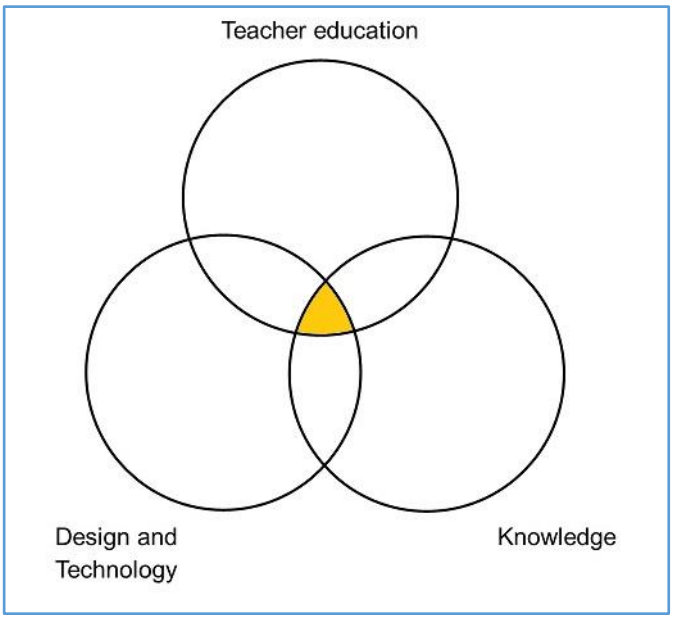

Figure 2: Focus of the study

Representing the study in such a way was felt to be useful in introducing the literature review. It was recognised, however, that such a diagram has limitations in representing the complex and dynamic nature of experience involving human interactions. In developing the literature review, it was decided to explore the overlaps between pairs of circles prior to exploring the central focus of the study. In addition, constructivist theories of learning were also explored as it was felt necessary to consider how knowledge can be acquired.

The review therefore covered:

- Literature that explores subject knowledge within Design and Technology
- Literature that discusses subject knowledge in relation to teacher education
- Literature about teacher education for Design and Technology
- Literature about constructivist views of learning.

- Literature about subject knowledge development of pre-service teachers of secondary Design and Technology

In covering this literature, the review aimed to explore what has already been written about subject knowledge, identify gaps in the literature and highlight issues that needed to be considered when undertaking the study. Whilst reference was made to some literature written before the existence of the National Curriculum, the review mainly focused on the literature from the 25 year period 1990-2015 in which the subject has existed as a statutory requirement for pupils in mainstream schools in England. The literature review concludes by drawing out all of the aspects and issues together and identifying key questions that became the focus of the research.

With the focus of the study on the development of subject knowledge, it would seem appropriate to have defined the term at the very beginning. This is, however, not a straightforward, nor necessarily helpful process. As Ellis (2007b) suggests, the term subject knowledge is very much open to interpretation and varies in meaning according to the context in which it is applied. It was the very nature of subject knowledge that was being explored in this study and disquiet with an existing means of defining subject knowledge that triggered the research in the first place. Therefore, it is not helpful to use a definition but to accept that there will be differences in understanding and that the captured experiences of individuals will reveal what they have understood by it.

2.2 Subject knowledge in Design and Technology

For this study, it was important to explore the literature surrounding subject knowledge in relation to design and technological activity. Given that the study was focused on subject knowledge development of pre-service teachers it was felt to be important to explore the issues surrounding knowledge within the subject as a whole. There has been a limited amount written about knowledge per-se within Design and Technology but some consideration of the types of knowledge and their associated terminology was a necessary part of the review. Knowledge in relation to teacher education for Design and Technology will be considered separately in a later section.

The idea of distinct *forms of knowledge* was highlighted by Hirst who made distinctions between such areas as scientific knowledge and musical knowledge Hirst (1974, p. 46). Whilst he did not explicitly link his forms of knowledge to subjects, it is clear that such a view supported their existence. This represented a highly objectivist view of the world in which knowledge was to be acquired, or perhaps transferred, from exploring the world and guided by others 'in the know'. Implicit within this view was the promotion of curriculum subjects that can be defined by content. This is, to some extent, still the case today when looking at the very structure of the current National Curriculum (DfE, 2014) which is written down subject by subject with deliberate highlighting of essential facts and concepts. Within Design and Technology, however, understanding subject knowledge is more complex as will become clear in the following sections.

The exploration of theoretical views on knowledge, and knowing, for the subject started with the Interim Report of the National Curriculum Design and Technology Working Group (DES, 1988). The following extract summarises their definition of the contribution of the subject at that time and illustrates the importance of exploring the meaning attributed to subject knowledge within the subject. It is provided in full so that none of its meaning is lost.

> *The nature of design and technological activity*
>
> *1.9 We address now what is at the heart of design and technology, namely the special characteristics which are the ultimate warrant for its inclusion as a foundation subject in the National Curriculum. What is it that pupils learn from design and technological activities which can be learnt in no other way?*
>
> *1.10 In its most general form, the answer to this question is in terms of capability to operate effectively and creatively in the made world. The goal is increased 'competence in the indeterminate zones of practice'. Distinctions are sometimes drawn between*
>
> *'knowing that' and 'knowing how'*

> *'propositional knowledge' and 'action knowledge'*
>
> *'homo sapiens' and 'homo faber'*
>
> *(man the understander) (man the maker)*
>
> *Whilst it would be misleading to imply that the components in these polarities are mutually independent, it is the second in each pair which is indicative of what is distinctive about an education in design and technology.*
>
> (DES, 1990, pp. 3-4)

In putting forward the above, the Working Group (DES, 1988) set the agenda for a long running debate within the subject about the relative importance of content (knowing that) over process (knowing how). Such a dualistic view was a vast oversimplification of the dynamics taking place within the subject area with regards to knowledge, but for those teaching the subject, this division into different types of knowledge was helpful. Classroom and workshop activities could be given a different emphasis depending on the type of knowledge to be developed from the theoretical to the practical. Even more contemporary views of the subject use this division as a means of outlining the different activities that can take place. For example, in proposing a new way of looking at activities within the subject, Barlex has suggested that there could be four different types of teaching strategy namely: making without designing; designing without making; designing and making; exploring the technology and society relationship (Barlex, 2011, p. 12).

McCormick (1997) discussed the use of the term conceptual knowledge which he saw as more relevant than propositional knowledge as it has more to do with understanding the relationships between items of knowledge, rather than just learning facts in isolation from each other. The active formation of conceptual understanding he saw as important within design and technology so that it can be applied to new and challenging situations. The task for those involved in the subject was deciding what conceptual (or propositional) knowledge was to be acquired given the breadth of topics that could be covered.

As a practical subject, the understanding of subject knowledge takes on even more complexity, as the acquisition of skills and developing those skills to a level of *mastery*, involves more than the simple accumulation of definable and codified knowledge. Pupils are required to have knowledge of tools and materials as well as design strategies to develop products that fit the needs of people within specific contexts (DfE, 2014). Linked to this, and a not insignificant area for exploration of knowledge in practical subjects, is that of tacit knowledge (Polanyi, 1967). This is the hard to define, intangible knowledge that is held by individuals well practiced in their field. Consider riding a bicycle and try to explain how it is done - this is difficult. Within the subject of design and technology, examples could include the feel of using a correctly sharpened plane to the sound of perfectly baked bread when tapped. Such tacit knowledge can, as (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004) say, be passed on through individuals as a result of social interaction during practice. Those who are very capable of designing and making demonstrate effective use of such tacit knowledge which defies classification. The development of such expert tacit knowledge takes time and was considered by Eraut (2007) to be developed through work with expert practitioners as well as a result of repeated and routine action.

Another contribution that McCormick (1997) made to the discussion of knowledge within education was with his work on highlighting *strategic knowledge*. As he pointed out, cognitive psychologists use the term to describe this as knowing when procedural and conceptual knowledge should be applied. The acquisition of such knowledge is of great significance for Design and Technology as it is the development of this that enables pupils to make better decisions. One of the key aims of the design and technology curriculum was, and is, to develop capability in the processes of design and making with materials. In order to become better, or more capable, it is essential to be able to make better decisions about the application of tools and processes involved in designing and making. In some ways, strategic knowledge is more like a skill where it's possible to get better at making strategic decisions.

From all of the aspects considered so far, a model of subject knowledge within design and technology can be created that involves a blend of conceptual, procedural, tacit and strategic knowledge held by the individual. Differences between individual teachers may account for the differences found between practice in schools and variations of projects undertaken by pupils. What emerges is a picture of the subject with overarching categories of knowledge within which there can be variations in delivery as long as key concepts are maintained. The ecological model of knowledge proposed by Davis and Sumara (2000) is useful in helping to understand how this can work. They suggested that knowledge can be seen at different levels rather like fractals. For example, designing and making simple automata in one school and designing and making moving pictures in another school are both reflective of a higher level of understanding with regard to mechanisms. Such an understanding of mechanisms in turn reflects a further higher level of understanding about systems as a whole. Practice on the ground can be seen to be following the prescribed curriculum as long as the higher level concepts are developed at the same time as the particular skills and knowledge needed for that specific product. Quite how this variation is manifested in school environments remains unknown.

The subject of Design and Technology has no single professional equivalent outside of school. Rather, it relates to a number of different professional activities within the design and manufacturing sectors. One of the consequences of this is that the precise content of the curriculum has been hotly contested with different stakeholders privileging different aspects (Layton, 1992). In the early 1990s the interaction of these stakeholders resulted in a number of different iterations of the subject before an embargo on change was issued (Dearing, 1994).The subject has also changed in emphasis from being very focused on the design process at its inception to its current form where there is a greater balance between designing and making. This can be exemplified by considering the original four attainment targets used when the subject became part of the National Curriculum (DES, 1990) to the current

situation where there is a single attainment target of *Designing and Making* (DfE, 2013).

The general changes in emphasis over the subject's lifetime is further documented by Martin (2013) who describes the relative change in the emphasis of the subject knowledge and skills since the subject was developed less than thirty years ago. One area of continuous debate within the subject domain has been the tension between factual knowledge and practical making skills. As Martin and Owen-Jackson (2013) outline, this is something that has changed over time. Exactly how this rapid development was interpreted by school departments, and indeed individual teachers, has yet to be researched.

In summary, this section has highlighted some of the different forms of knowledge, and associated terminology, that can be identified within the subject. Questions remain about the extent to which these different forms of knowledge are significant for pre-service teachers whilst on placement and it was anticipated that the research study would help identify any significant issues in this regard.

2.3 Subject knowledge and teacher education

The exploration of knowledge now turns to teacher education as the context within which the pre-service teachers acquire their experience. Developing appropriate subject knowledge in order to teach the subject is clearly an essential part of becoming a teacher. In addition, it is also necessary to have the pedagogical skills necessary to support learners during lessons. Given the short period of time that most pre-service teachers have to develop their understanding of subject knowledge, the ways in which they develop their knowledge is of critical importance. McNamara (1991) discusses the extent to which the pedagogical knowledge of 'how to teach' is of more, or less, importance than the subject knowledge about 'what to teach' has always been an area for debate.

Within teacher education, subject knowledge is usually viewed as an important part of courses both within higher education institutions and schools. The introduction of Circular 4/98 (DfEE, 1998) saw the codification of teaching into nationally defined statements of what pre-service teachers should be able to do by the end of their course of training. In the current context, subject knowledge still continues to be of significance as it remains one of the eight main Standards for Qualified Teacher Status (QTS) that need to be evidenced before an individual can be recommended for QTS (DfE, 2016a)

There is an expectation that those running courses of initial teacher education will audit pre-service teachers' subject knowledge and track this throughout their training. An assessment of such tracking has formed part of the inspection regime (Ofsted, 2008) for some time, making it a priority for teacher educators in an age of increasing accountability. In addition, the government's white paper on education (DfE, 2016a) suggests that subject knowledge is an essential component. Ellis (2007b) has made the case for an increased focus on what pre-service teachers know about their specialist area and suggested that it is important to 'problematise' subject knowledge and not take it for granted. For him, focusing teacher education's work on stimulating, supporting and, indeed, researching subject knowledge development in school settings enables us to take subject knowledge much more seriously than getting beginning teachers to tick lists and identify 'gaps'.

The relationship between pedagogical knowledge and subject knowledge has been discussed by a number of authors. Mantyla and Nousiainen (2014) suggest that subject knowledge is often considered a pre-requisite to developing pedagogical approaches. For McKewan and Bull (1991), however, all content knowledge has a pedagogical dimension and the two elements cannot be separated. Other authors such as Burn, Childs, and McNicholl (2007) along with Herold and Waring (2011) explore the experience of pre-service teachers and their interpretation of subject knowledge. There are also those that have sought to find ways of assessing and improving subject knowledge such as Lannin et al. (2013) and Mantyla and Nousiainen (2014). In this literature there was discussion of teaching as a profession and the knowledge that

teachers require being defined as professional knowledge. Some authors have attempted to show the relationships between areas of knowledge that pre-service teachers need to acquire for successful teaching. Within teacher education one of the most significant of these models was a model of professional knowledge proposed by Banks, Leach, and Moon (1999). The later version of this for Design and Technology (Banks & Barlex, 2001, p. 19) is shown below:

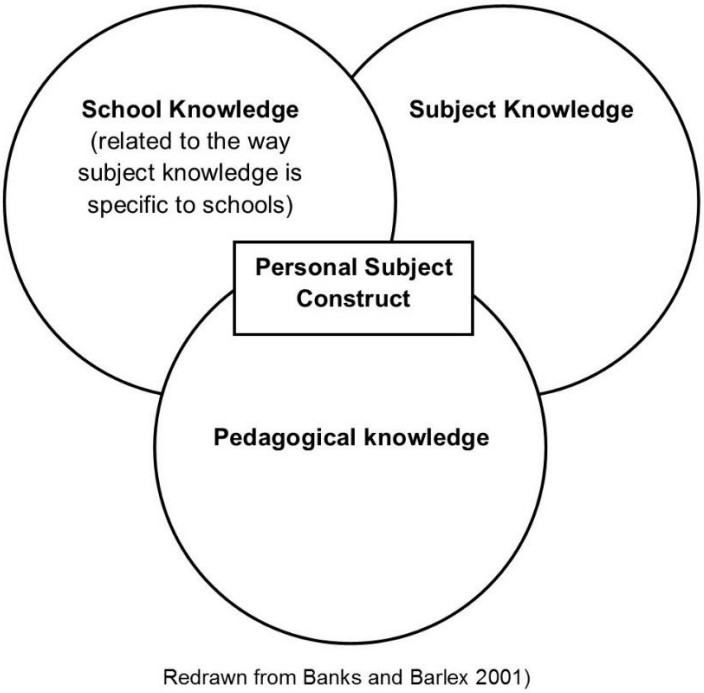

Figure 3: A model of professional knowledge

In this model, the central focus is on what they refer to as the *personal subject construct* which represents pre-service teachers' knowledge about schools, subject and pedagogy. This representation highlights the importance of considering the context in which the pupils are learning, along with teaching strategies, as elements of the subject.

The Developing Professional Thinking (DEPTH) tool emerged from the work done at the Open University by the Centre for Research and Development in Teacher education (CReTE). It involved the use of the graphical tool (Figure 3) to help pre-service teachers reflect on their personal subject construct,

considering what was referred to as their school knowledge, subject knowledge and pedagogical knowledge. The DEPTH tool, as it was referred to, was used over a number of years and across a number of countries (Banks et al., 2004) proving a useful way of helping pre-service teachers frame their experience. In relation to subject knowledge, a number of issues emerged from this research including. Whilst this model was useful in framing beginning teachers' subject knowledge as part of their overall development it is, given the nature of knowledge, a simplification on a complex process.

The writing about the DEPTH graphical tool, and case studies of its use, has been significant within the subject domain and have clearly been effective in enabling pre-service teachers to reflect on their emerging role as subject teachers. The focus is on pre-service teachers experiences as a whole in comparison with the study being undertaken here which directly focuses on subject knowledge development and the influences that shape it. When looking at the research undertaken using the DEPTH tool, the pre-service teachers' comments related to the amount of subject knowledge they had and the gaps that they needed to fill. How the subject knowledge developed whilst on placement, and the factors affecting the acquisition of knowledge, were not covered in detail and this remains an area that is yet to be explored within the subject.

A later document by the TDA (2007) proposed a particular view of subject knowledge with a number of key elements. This is reproduced in Figure 4.

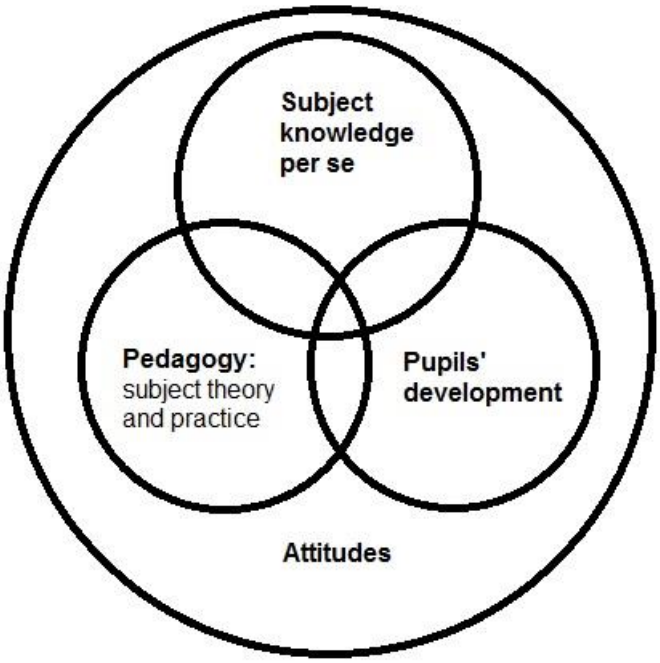

Figure 4: Redrawn TDA model of subject knowledge

Here we can see subject knowledge as involving a mixture of content, subject specific pedagogy and a more general understanding of how pupils learn. The origins of the conceptual framework presented in the document, and the rationale for such division of subject knowledge, into parts, was not made explicit as there are no references to any literature. Research undertaken by Evans, Hawksley, Holland, and Caillau (2008) suggested that pre-service teachers acquire subject knowledge in a variety of highly individualistic ways and consider that this TDA model only partially explained what is happening.

Those researching the nature of subject knowledge in schools will not get far without meeting the concept of *pedagogical content knowledge* (PCK). The term has been attributed to L. Shulman (1986) who discussed different types of knowledge used by teachers and their relationship with each other. Given the level of influence of his work on research into teacher education, some further explanation is required here. Shulman began his theoretical work with a look at teacher development and the changing emphasis of what was required when

training. He pointed to the historical emphasis on content and the significant change of emphasis towards pedagogical methods at the time of his writing. Shulman questioned the research linking pupil performance to teachers' understanding of pedagogy by highlighting the de-contextualised or highly focused nature of academic research. He aimed to reconcile the seemingly opposing views promoting content knowledge on one side and promoting pedagogy on the other, by what he called the 'missing paradigm' with a focus on subject knowledge.

Central to Shulman's argument was the view that there are three categories of content knowledge: *subject matter* content knowledge; *pedagogical* content knowledge; *curricular* content knowledge. Subject matter content knowledge he described as the amount and organisation of knowledge per-se. This also included the ability to justify a particular position when knowledge structure is contested. Pedagogical content knowledge he described as content knowledge but that germane to its teachability. For example, the most useful forms of representation and alternatives. PCK also includes an understanding of preconceptions and misconceptions. Curricular content knowledge he described as knowledge of curriculum materials including knowledge of what's happening in other subjects. Of these categories, it is pedagogical content knowledge that he explored further and also has the greatest relevance for the study.

Shulman (1987) raised important questions about the source of teacher knowledge and their selection of that knowledge for instruction. He failed, however, to deal with the question of how teachers deal with new material they are given to teach when they go beyond the limits of their existing subject knowledge. For the study undertaken this was an important consideration as there is always new knowledge to be gained within Design and Technology. Despite this, and other criticisms explored below, pedagogical content knowledge has been very influential in framing research about subject knowledge in teacher education, especially in Science as Loughran, Friedrichsen, and Berry (2015) point out.

Deng (2007) explored the ideas behind the concept of PCK by looking at the intellectual work that underpinned it. Deng made the case that the transformation of content knowledge from teacher to pupil was more linked to the curriculum than knowledge directly from a particular discipline. School subjects are unique (D&T perhaps more so than others) and contain content that has been codified by those involved in shaping the curriculum. The content that pupils have access to is therefore constrained by the boundaries of the subject and the pedagogical strategies that are shaped by it. For Design and Technology, little is known about this and it is relevant for the study. Key in the work of Deng (2007) was the message that many advocates of PCK focus on the content knowledge direct from a discipline and do not take account of the curriculum and other constraints that exist in schools and classrooms. For some highly structured elements of subjects such as Mathematics it may be possible to see how highly codified subject content can lead to similarly codified PCK (Lannin et al., 2013). With subjects such as Design and Technology, however, content knowledge is variable and such a positivist view of the world, with the adoption of simplistic representations of knowledge 'transfer', is not appropriate.

Other critics of pedagogical content knowledge, such as Ellis (2007a) suggest that the separation of knowledge into different types does not fit well with current views of the socio-cultural nature of learning and teaching such as that held by Glasersfeld (1984) which is discussed later under constructivist views of learning. In his analysis, Ellis identified three significant issues: dualism, objectivism and individualism.

He suggested that subject knowledge has been seen as a given and unproblematic. It was:

> *context-free content: stable, prior and universally agreed*
>
> (Ellis, 2007b, p. 450).

The problem for teachers is how to put the ‘given’ knowledge over with suitable pedagogical strategies, something he saw as a problem of dualism. This was compounded by objectivism as with PCK the conceptualization of knowledge is one having physical presence and volume. The contrasting view of this is what

Edwards et al. (2002) have called contextualist epistemology that emphasises the significance of context in shaping knowledge. The final issue identified by Ellis is that of individualism - This is the problem of seeing knowledge as developing inside the head – suggesting that learning is essentially an individual act. The alternative here is to see a learner as both a user and producer of knowledge.

Ellis also suggests that the notion of pedagogical content knowledge (PCK) has become so embedded in the discourse of teacher education that alternatives are not even considered. Subject knowledge is consequently taken as fixed and individual. Looking at the experiences of pre-service teachers should help to throw light on this issue and reveal the extent to which the development of subject knowledge is really in the hands of the individual. The pervasiveness of the work of Lee Shulman appearing in research and thinking about subject knowledge cannot be underestimated. Despite critique of his ideas, even by himself (L. S. Shulman & Shulman, 2004), there is still research undertaken about subject knowledge underpinned by his original thinking such as that by Adadan and Oner (2014).

One of the criticisms of the work of L. Shulman (1986) has been that of the objective nature of PCK in which the active role of the individual is not really considered. Looking at subject knowledge from a constructivist point of view, Cochran, DeRuiter, and King (1993) consider the term knowledge unhelpful and make the case for the adoption of *pedagogical content knowing* as a more dynamic concept that views the individual teacher as active. In detail, they see pedagogical content knowing as involving four components: pedagogy, subject matter content, students' characteristics and the environmental context of learning. These components work together in actively creating new knowledge specifically for that setting.

The extent to which subject knowledge is dependent on the context in which it is developed is also an area that is discussed in the literature. Medwell (1998) for example, discussed the context dependent nature of subject knowledge where there is a process of validation by the community of practice. This perspective

was added to by Herold and Waring (2011) who, from their empirical research, found that progress of participant subject knowledge remained reliant on the models and practices provided by schools. As Green (2006) pointed out, such variation makes the transition from a university to a school context problematic in nature. To overcome the difficulties, he suggests that a pragmatic approach is required from the pre-service teacher and a degree of compromise necessary to ensure a successful transition to a placement environment.

Writing more recently, Brown, Rowley, and Smith (2016) suggest that subject knowledge has become a commodity that can be delivered and received on demand. This suggests a more passive role for the individual and that subject knowledge can be considered context-independent and something that can be quantified and measured. Referring to Schools Direct they go further to suggest that subject knowledge is being gradually marginalised as a significant concern for those on courses of teacher education. The emerging view is that of pre-service teachers, from the very beginning of placement, needing to be brought into alignment with the content and pedagogy existing in schools.

One area of potential confusion for those interested in Design and Technology education is the use of the alternative term *technology education* which is open to interpretation. For much of the time this potential confusion in terminology is easily dealt with. However, in the area of subject knowledge, a degree of caution is required as there is a good deal of research emerging about Technological Pedagogical Content Knowledge – often referred to as TPACK (Koehler, Mishra, & Cain, 2013). The work in this area is focused on computing or information and communication technology (ICT) and is not about design and technological activity. Not only does TPACK suffer from the same issues as the more generic pedagogical content knowledge, mentioned above, but the view of technology adopted is one of seeing ‘technology as things’. Viewing technology as ‘things’ rather than having organizational and cultural aspects is what Pacey (1986) identified as a limited view of technology. Such a limited view of the nature of technology is of concern given the prevalence of information and communications technology (ICT) and the effect it has on peoples and cultures throughout the world. It is, however, outside the scope of

this study to engage with this area of research and it is suffice to say that the research on TPACK has little to offer.

Overall, the literature suggests that subject knowledge can be seen as being formed by teachers themselves and uniquely interpreted by them as a result of their own values and beliefs. Not only does the background of pre-service teachers affect the amount of existing knowledge that they bring with them but, as McKewan and Bull (1991) suggest, individuals also bring as set of values associated with that knowledge. The subject knowledge that is then developed for teaching becomes 'value laden' (Gudmundsdottir, 1990) and is effectively personalised by the teacher. Common to nearly all of the literature, about subject knowledge in teacher education, is the subject-focused nature, making any findings similarly subject oriented. Whilst they are helpful in demonstrating the extent of research, they are of limited use in framing a study focused on the subject of Design and Technology.

2.4 Teacher education for Design and Technology

Whilst there has been a good deal of research in teacher education more generally, the amount directly focused on pre-service teachers of Design and Technology is quite limited. The literature that has been written since the development of the subject is quite varied but, as a whole, acknowledges that subject knowledge is an essential element for all courses of teacher education for Design and Technology (Rutland, 1996). The specific areas that authors have focused on are outlined below.

Design and Technology is a broad subject, covering a considerable range of materials and processes. (Banks, 1996) writes that, as a result of this, a common knowledge base can difficult to define. Not surprisingly teachers have therefore interpreted the curriculum in their own way which Banks and Barlex (1999), and more recently Martin (2013), suggest may have an effect on the subject knowledge developed by pre-service teachers when on placement. Findings from the empirical research undertaken by Owen-Jackson (2008) indicate that pre-service teachers develop subject knowledge on a 'need to know' basis. This echoes research undertaken by Lewis (2003) that looked at

the subject knowledge developed by pupils when involved in designing and making activities.

One of the ways in which subject knowledge has been codified as an expectation for pre-service teachers, is in the Minimum Competences document (DATA, 2003). The work of Owen-Jackson (2008) suggested that subject knowledge is interpreted by pre-service teachers as the 'four fields' built into the Minimum Competences model of the subject with a complete focus on knowledge for making and not knowledge for designing. The research of Martin (2008) in exploring job adverts indicated that schools did not necessarily operate along the lines of the 'four fields' and that the Minimum Competences document was out of step with the existing practice at the time. As Martin (2013) pointed out, the curriculum content of Design and Technology has changed considerably over time. This further questions the relevance of static statements in guiding the development of those wishing to teach the subject.

Banks and Barlex (1999) used the model of personal subject construct developed by Banks et al. (1999), and explained in section 2.3.2, to develop what they called the DEPTH tool. This model located subject knowledge as a key element of the professional knowledge needed by pre-service teachers. On revisiting the model developed, and taking on board critique from Ellis (2007a) about the static view of knowledge it suggested, Banks (2008) proposed that it should be seen as existing in dynamic equilibrium. He suggests that a knowledge construction metaphor is appropriate in explaining the interaction between the different elements involved. More recently, MacGregor (2013) explored the life histories of pre-service teachers through the use of narrative analysis in order to throw light on factors affecting the formation of professional identity. She highlighted the importance of personal beliefs in mediating professional identity and draws attention to ways in which their existing subject knowledge helped to support them when establishing themselves as teachers. From her study it was clear that confidence with subject knowledge can help to counter the feelings of incompetence that pre-service teachers of Design and Technology can experience (Lewis, 1996).

The level of existing knowledge of those beginning, and on, courses of teacher education has been another focus for those researching and writing about teacher education for Design and Technology. This has included comments from teachers in school who suggested, in one study by Banks (1997), that PGCE students did not know enough. Research by Lewis (1996) identified that the students involved in his study had a limited skill base. Further research, some years later, by Banks and Barlex (2001) suggested that pre-service teachers were very aware of the gaps in their subject knowledge. This observation was compounded by further work suggesting that their understanding of the nature of subject knowledge was low. Barlex and Rutland (2008) found that pre-service teachers' main concern was about making skills.

With the formation of the subject in 1990 it is not surprising that a number of authors such as Owen-Jackson and Fasciato (2012) have since written about the process of becoming a Design and Technology teacher, and exploring the impact of training courses. For pre-service teachers of design and technology there is much to learn about the subject on a range of different levels. Not only do they need to understand what elements of the subject are to be taught to pupils in a school context, but for most pre-service teachers, they need to develop their own level of knowledge about materials and processes in general. The work of Lewis (1996), for example, looked at the qualifications of those entering teacher education courses and the amount of practical work involved in those qualifications. His interviews of pre-service teachers, however, were broad in nature and captured their views about teaching per-se rather than throw light on how they view subject knowledge. Nevertheless, he identified a gap in their knowledge commenting that most of the participants felt that their subject knowledge fell short of what was required. Banks and Barlex (1999) too recognised that few degree subjects neatly match the subject knowledge skills base.

2.5 Constructivist views of learning

In looking at knowledge development in context it has been important to explore the different perspectives on learning and arrive at a position on the factors affecting knowledge acquisition. It was anticipated that this would help when it

came to analysing the data. As part of this exploration it was necessary to look at individual and social aspects of learning and consider some of the theories that have been put forward in relation to these. Constructivist views of learning were selected because of the philosophical position that was adopted for the study and their established use within education and teacher education.

Lerman and Stephen (1989) usefully cite the words of Kilpatrick (1987) in describing constructivism as a process where knowledge is actively constructed by the cognizing subject, not passively received from the environment. The origins of an interest in social aspects of learning, particularly in education, tend to be attributed to the work of Piaget (1970) and Vygotsky (1930) who both undertook empirical research that indicated that learning was an active social process and that interaction with others was seen as advantageous when learning. As Phillips (1995) points out, there are many other faces of constructivism with different authors adopting different positions in regard to such things as the extent to which the individual is an active agent. For the purposes of this literature review, however, it is useful to explore three perspectives that are frequently discussed in teacher education, namely cognitive constructivism, *social constructivism* and *radical constructivism*.

Piaget (1970) is probably the most widely known individual in relation to cognitive constructivism in education and his theories can be seen extensively in much of the literature around child development over the last few decades. Central to his theory of development proposed by Piaget was the concept of equilibrium where individuals sought balance in their constructs of reality. Processes of accommodation and assimilation come in to play when new ideas or information cause disequilibrium or what is sometimes referred to as cognitive conflict. Piaget is often misunderstood as purely being interested in the individual but he did explore the social aspects of constructivism. It is, however, Vygotsky (1930) who is more widely known for another type of constructivism highlighted here. Moving beyond a simple view of the learner as someone who simply absorbs knowledge is the notion of learning from, and with, another. For cognitive psychologists such as Vygotsky (1930), however, it is beneficial to learn with another. Ideally this should be an experienced other

and the interaction with them will result in improved knowledge acquisition. Salomon and Perkins (1998) refer to this as the social mediation of individual learning.

When considering cultural-historical perspectives on education, Smagorinsky (2010) discusses the similarities and differences between the work of Vygotsky (1930) and Leont'ev (1981). He points out that Vygotsky emphasised the individual internalisation of cultural practice whilst Leont'ev emphasised the mediated actions of collectives. Whilst activity theory has developed from both of these perspectives it is important to remember that there are differences in the focus. Within the current study the emphasis is on the individual so a Vygotskian approach focusing on tool-mediated, socially and culturally conditioned, action would be more appropriate.

Vygotsky (1930) suggested that the additional use of speech enables children to progress from a simple use of tools to more sophisticated use of tools and develop higher order thinking.

> *A child's speech is as important as the role of action in attaining the goal. Children not only speak about what they are doing: their speech and action are part of* ***one and the same complex psychological function****, directed towards the solution of the problem in hand… (original emphasis)*

> *This unity of perception, speech, and action, which ultimately produces internalization if the visual field, constitutes the central subject matter for any analysis of the origin of uniquely human forms of behaviour.*

(Vygotsky, 1930, pp. 25-26)

In exploring the factors affecting subject knowledge development of participants it is possible to gain insights into the extent to which actual tools and machines, workshop practices, lesson plans and other resources have played a part in shaping the knowledge that is acquired.

It is important to recognise that Vygotsky carried out his research and developed his thinking in relation to children's development and then used that to develop theory for human behaviour. Having said that, of all of the above views on knowledge development, the theory of Vygotsky with its emphasis on tool-mediated action seems to have the greatest affinity with the study. Within the literature on subject knowledge for Design and Technology there appears to be little in the way of research on the development of subject knowledge that makes use of such a theory. The study therefore makes a valuable contribution to the field

The term radical constructivism is largely associated with the work of Glasersfeld (1984) and concerns the relation of knowledge and reality. Rather than looking for knowledge that matches reality, Glasersfeld (1984) suggests that we need to consider the relationship in terms of how new knowledge fits our existing constructs. He suggests that our existing structures of knowledge are tested through our experiences. If they stand up to experience and enable us to make and to bring about or avoid phenomena, then good. He suggests that:

> *... if knowledge does not serve that purpose, it becomes questionable, unreliable, useless, and is eventually devalued as superstition.*
>
> (Glasersfeld, 1984, p. 5).

For Glasersfeld, knowledge originates as the product of an active subjects activity which he refers to as operating - a term taken from the work of Piaget (1970). With reference to assimilation he talked about the process being one of actively assimilating only what fits existing cognitive structures. That which does not fit is rejected. If at some point the existing scheme does not provide an adequate framework for experience then a new scheme is required.

Glasersfeld readily admits that his constructivism is perhaps not that radical given that it builds on the work of Vico (Pompa, 1990), who suggested that the only way of 'knowing' a thing is to have made it. Whilst the meaning of the term 'making' used here does not necessarily mean working with materials and tools,

it is interesting to consider this given the focus of the study on a practically based subject. Overall, radical constructivism seems to fit well with the idea of pre-service teachers' existing knowledge frameworks having an impact on their learning. The concept of radical constructivism is not, however, without its critics. Phillips (1995) suggests that Von Glasersfeld's epistemology has been developed in a flawed way and d'Agnese (2015) goes further to suggest that the concept is of no use at all within education because it reduces the world and reality to subjective knowledge and indicates the uselessness of communication.

Of significance to thinking about how we learn when in new situations is the seminal work of Lave and Wenger (1991) who argue that:

> *...a community of practice is an intrinsic condition for the existence of knowledge.*
>
> (Lave & Wenger, 1991, p. 24)

They discuss how newcomers coming to existing communities of practice move from an outsider to insider position through a process of what they call legitimate peripheral participation. Their thinking sits well with what pre-service teachers seem to experience whilst on placement, beginning with periods of observation and gradually taking over responsibility for managing groups then whole class situations. Knowledge is brought to the school placement by the pre-service teacher but is also developed on-site as a result of working with specific groups of pupils. The concept of communities of practice is not, however, without criticism. Ellis (2007a), for example, discusses the danger of knowledge becoming static within communities of practice and the notion of granting participation to newcomers with their own viewpoints. More recently, others exploring the development of knowledge consider the ways in which cultural practices can affect how the knowledge is developed and indeed the very nature of the knowledge itself.

The above consideration of constructivism raises a number of questions that need to be taken into account during the study including the extent to which pre-service teachers co-create subject knowledge for teaching, with their mentors.

In addition, there needs to be an exploration of how much use pre-service teachers make of the knowledge that is developed prior to placement.

In exploring the significance of the workplace to the development of learning it is useful to consider the constructs of *arena* and *setting* as described by Lave (1988). For Lave, arena refers to the physical space within which activity takes place. In this study the arena would therefore be the placement school, or perhaps more specifically, the Department of Design and Technology within the placement school. The term setting refers to a more specific action-oriented context within the arena, occurring at a specific time with specific individuals. Activity in different settings combines to form experience in the arena. Smagorinsky (2010) suggests that individuals construct settings within arenas through their interpretation of the space and in relation to other individuals within that space. For this study, the term *arena* will refer to the placement environment as a whole and the term *setting* will be used as Lave suggests in referring to a very specific action-oriented context such as an individual lesson.

In relation to arenas it is worth considering the notion of knowledge 'transfer'. As many pre-service teachers of Design and Technology are likely to come to courses with limited experience of the exact processes and materials found in classrooms there is usually some subject enhancement prior to the commencement of their placement experience. Given the acquisition of knowledge during such courses, and their experience of materials as part of their school education, it is worth considering the extent to which their previously held knowledge is 'transferred', or transferable, to the arenas of placement. What is meant by transfer, however, is not straightforward and the extent to which knowledge can be useful in different contexts is debated by a number of authors. In this regard it is appropriate to look at the literature surrounding knowledge and the workplace. Salomon and Perkins (1998) make a distinction between forward-reaching and backward-reaching transfer. Universities for example prepare students for placement to support forward-reaching transfer. In the workplace, however, students are expected to recall prior knowledge, thus reaching back into their prior experience. Establishing

which areas of knowledge may be relevant in the workplace is not easy and, they argue, is best learned through participation in practice. This consideration of the development of knowledge whilst on placement is very much backed up by the experience of teacher educators.

2.6 Subject knowledge for teacher education in Design and Technology

Very little of the literature on teacher education has been produced in relation to Design and Technology as a subject. A simple search for literature on subject knowledge in initial teacher education resulted in just over 300 articles being identified, Of these, just 2 were related to Design and Technology and neither presented empirical research. Some consideration of potential issues is, however, possible from the limited amount that has been written.

The subject of Design and Technology involves practical activity to develop three-dimensional products. Some of its roots lie in the various craft professions where a narrow range of processes were available to make clearly defined outcomes in ways that could be repeated. The acquisition of practical knowledge was through apprenticeship which enabled newcomers to learn the very specific techniques required, along with tacit knowledge required to develop ‘mastery’ (Penfold, 1988). Currently, with the wide range of tools, machines and techniques available it is possible to use different manufacturing techniques to achieve the same outcome. As a consequence of this, there is, for many processes, no correct way to do it. This can lead to a situation where different teachers go about even the simplest task, such as marking out a piece of wood, in different ways. For pre-service teachers this is not always helpful and can lead to tension when working on placement where processing techniques are different than those that they have developed themselves.

Given the open-ended nature of the subject, the experience of the subject that pupils have is shaped by the teachers and departments within which they are designing and making. Any limitations in the skills and knowledge of teachers can therefore limit the experience that pupils have, making it important that those entering the profession have a clear understanding of how materials can

be processed in order to realise design intentions and create useful products. It could be argued that more important than the prescribed curriculum as defined by government is the curriculum experienced by pupils in schools. Whilst the curriculum has developed considerably over time (Martin & Owen-Jackson, 2013) the extent to which departments and individual teachers have kept up to speed is unknown. Grounded research on this needs to be undertaken if we are to truly know the skills that pupils have developed through units of work defined by practitioners across the country.

Defining the subject knowledge that is required to teach Design and Technology is not straightforward given the contextual nature of the subject where the realisation of design intentions may involve the use of a wide range of materials and a unique set of processes. Historically, in England, there has been a degree of specialisation within schools where large departments might be staffed by teachers with a good level of knowledge in one of the traditional material areas of control, food, resistant materials and textiles. More recently, with curriculum re-structuring and changes in GCSE options, teachers have increasingly been required to develop expertise outside of their specialism.

Another area of writing and research within the subject that is related to teacher education is that focused on *pedagogical content knowledge*. Despite the fact that it has come under considerable critique, as mentioned earlier, the use of PCK to explore the subject continues to the present day. Many of those that write do so from a scientific perspective. Williams, Eames, Hume, and Lockley (2012) for example, explore the use of the scientifically derived Content Representations (CoreRes) conceptual tool to develop teacher knowledge but, in doing so, highlight the difficulties in defining the fluid nature of subject knowledge in Design and Technology. Other studies making use of PCK have been done in relation to Engineering but there is little else for Design and Technology as a subject.

In 2012, some 17 years since the original version of the Minimum Competences was published, they remained as part of the orthodoxy of teacher education. Phrases such as ‘In the UK D&T teachers are required to teach in two material

areas' (Owen-Jackson & Fasciato, 2012) show how embedded they are, given that there is no actual requirement for them to be used as a tool with those becoming teachers of the subject. They have also failed to take account of the rapidly changing nature of knowledge that can be used and the open-ended nature of design activity.

What is meant by competence, and who is to say what level of competence is enough for pre-service teachers to be allowed to begin their career and work independently as a qualified teacher, is not clear. Eraut (1996)highlights difficulties in articulating and representing the nature of competence including: level of detail; developing a consensus; capturing the essence; part-whole problem; difficulty in covering all aspects; changing nature of what counts as competence. He continues with a discussion of stages of expertise development and then goes on to discuss problems with the model of novice to expert put forward by Dreyfus and Dreyfus (1986), which gives little attention to novel and complex situations which the expert tackles. In other words the move from novice to expert is more than developing competence, it is managing to tackle more complex problems. As a result of this, Eraut rejects competence in favour of learning trajectories. These were developed as a result of a number of research projects on professional learning and have been classified under a number of key headings: task performance, role performance, awareness & understanding, personal development, academic knowledge and skills, teamwork, decision making & problem solving, and judgement.

In his work a year later Eraut (1997) defined competence as:

> *... being able to perform the tasks and roles required to the expected standard ...*
>
> (Eraut, 1997, p. 42)

The standard can therefore vary and is open to personal interpretation. The competence is bounded by the domain. Key aspects of the domain in this regard are contexts, conditions and situations. People may be competent but not perform due to a number of reasons such as personal disposition, lack of capacity, context and conditions. In some of his other work, Eraut discussed the

use of learning trajectories as a better fit, to the data they collected at the time, than a set of competences (Eraut, 2007).

Having questioned the nature and status of the competences at a conference in 2008 it was with some surprise that another version of the competences was produced by the Design and Technology Association. Rather than review the concept of competences as a whole, as suggested by Martin (2008), what was published resembled a slightly modified version of the original 1995 document. Recognising that the very notion of competence was not helpful in defining levels of expertise, and that the Minimum Competences document was very much entrenched in the community of Design and Technology educators, it was decided to undertake a significant piece of research that looked fundamentally at the development of subject knowledge of pre-service teachers. Approaching subject knowledge from the perspective of pre-service teachers themselves would, it was anticipated, throw light on the factors affecting knowledge development and provide an genuine insight into how individuals dealt with the challenges they faced. The empirical data gathered could then be used to challenge the existing orthodoxy of competences and provide guidance on how pre-service teachers could be supported during course of initial teacher education.

Given the breadth of the subject, it was necessary for the authors of the Minimum Competences document to privilege and codify certain aspects of the subject. How this matched with the ways in which teachers' privileged particular aspects of the subject was not known. If there was a mismatch then there is likely to be tension between what pre-service teachers are told they need to know, from their course tutors, and what teachers felt they should know in order to work in school. What counted as competent practice within the subject has been hard to define and even with a set of discrete statements was open to subjective judgement. Take, for example the following statement from DATA (2010):

M.M.3.2: Accurately mark out, using appropriate hand tools and take account of critical dimensions and tolerance when using wood, metal and thermoplastics (e.g. engineers squares, marking gauges, centre punch, odd leg calipers.

Who is to judge what is meant by accurate? Does this need to be a specific level of accuracy? Is there a specific number of hand tools that need to be used? Given the subjective nature of the subject, a subjective judgement is the only one that can be given. This may vary from institution to institution and indeed between university and school-based tutors.

2.7 Summary

The literature review above began with an exploration of how knowledge has been conceived within the subject of Design and Technology. This was followed by a review of the literature in teacher education that relates to subject knowledge. The literature within the subject area related to teacher education was covered along with an overview of constructivist views of learning. The review was, for clarity, split into different sections.

In considering them together a complex system emerged, one that could only really be explained by understanding the experiences of individuals.

It was decided not to use any pre-existing model or conceptual framework and to use a more grounded approach to capture the essence of pre-service teachers' experience as they developed their subject knowledge. Anecdotal evidence from discussion with pre-service teachers suggests that appropriate preparation is difficult due to the variability of practice in schools. The mismatch between the demands of particular workplaces and the skills that can be developed in preparation has clear links with the work of Salomon and Perkins (1998) mentioned above.

Considering all of the above, we can see the complexities of the area under study. Not only was it necessary to consider the form of knowledge appropriate

for teaching but account must also be taken of the environment in which the teaching is taking place. Such environments (schools) are complex social organisations, and unique in themselves, making the creation of generalisations nearly impossible.

Following the literature review, it was important to re-visit the research questions and refine them in the light of what others have written about the area of study. This resulted in a greater focus on factors affecting the individual and the challenges they faced. Consideration of the role of teachers was included and a more open mind was adopted in relation to theoretical models. The resulting questions were:

- What factors affect the kind of subject knowledge that pre-service teachers developed during their placements?
- What new knowledge have they had to acquire?
- How was new knowledge acquired?
- What challenges have been faced when developing knowledge in placement arenas?
- What role did teachers play in mediating subject knowledge?
- What theories might be useful to help understand what goes on?

The next chapter explores the methodologies and methods that were considered to collect data that would help to address these research questions.

3 Methodology

3.1 Introduction

This chapter provides the rationale for the methodology that was selected for the study along with the data collection methods that were employed. It begins with a discussion of the terminology used in social research and the terms that have been selected for use in the rest of the thesis. This is followed by sections on the theoretical perspective and research strategy that have been used to frame the study. Given the complex nature of phenomenology and its various interpretations, there is a section devoted entirely to it. This covers key issues that need to be considered by anyone selecting a phenomenological research strategy and how they are addressed for this study. Issues of quality and ethics are covered along with details of the researcher's perspective on the area being explored. The final section provides a rationale for the research method that was employed to gather empirical data.

3.2 Terminology

The whole area of social research design suffers from complex terminology and contradiction about what the different terms mean. Prior to describing the choices made in arriving at appropriate data collection methods, it was felt important to define the terminology used and reasons for using specific vocabulary. Of the body of literature on research methods, the most useful sources to support the development of research design have been those that provide an overview of the different perspectives. Authors such as Crotty (1998), Denzin and Lincoln (2011), Savin-Baden and Major (2013) as well as (Cresswell, 2013) provide useful explanations of terms and emphasise the importance of philosophical positioning of the researcher in structuring theses and reports.

This chapter has been strongly influenced by the work of Crotty (1998) who provides a clear and logical explanation of the ways in which a researcher's philosophical view relates to theoretical frameworks and data collection methods. He suggests that there are four levels at which research study needs to be defined namely *epistemology* (our understanding of what constitutes knowledge), *theoretical perspective*, *methodology* and *methods* (Crotty,

1998, p. 5). The methods of collecting data need to be those appropriate for the chosen methodology. The chosen methodology is, in turn, determined by the theoretical framework adopted which is itself dependent on the researcher's philosophical view of knowledge or epistemology. All of these levels need to be appropriately related to each other for the research to have integrity. The work of Crotty was helpful in framing the study and highlighting the importance of philosophy, and an understanding of different theoretical frameworks, to ensure that the design of the study would hold up to scrutiny.

Crotty presented this view of research design as 'scaffolding' that supports the understanding of those engaged in research, and suggests that individuals will determine their own way of framing research study. Denzin and Lincoln (2011) also present a logical model of the research process involving five phases namely: the researcher as multicultural agent; theoretical paradigms and perspectives; research strategies; methods of collection and analysis; the art, practices, and politics of interpretation and evaluation. In their view, when developing research, it is necessary to begin with philosophical questions and then move on to look at theoretical perspectives that address these issues. It is, however, hard to separate philosophy from theoretical perspectives as specific views of the mind, and individual, are implicit within all theoretical frameworks. Savin-Baden and Major (2013) clearly define this linkage in tabular form whilst, for others such as Crotty (1998) the representation appears more hierarchical with theoretical perspectives resting on philosophical beliefs. Whatever model is adopted it is clear that in any research study of this kind it is important to clarify assumptions made about the nature of knowledge and how individuals are viewed in relation to the world around them.

For this particular study three specific terms were adopted. Firstly the term *theoretical perspective* was used and includes philosophical, epistemological and ontological (the nature of being) perspectives, or standpoints, from which the research was undertaken. Using this term was helpful in moving beyond a discussion of paradigms which might have limited the approach taken. Secondly the term *research strategy* was used to define the research design as a whole.

This frames the role of the researcher and their relation to participants, the likely methods of data collection, and the way in which the data analysis will be undertaken. Finally, the term *research method* was used to define the specific way in which empirical data was gathered. It was hoped that using these specific terms would help to clarify the choices made in structuring the study as a whole.

Prior to discussing the theoretical perspective adopted it was important to consider the overall focus of the study. The focus is defined by the key questions arising from the experience of the researcher and informed by the literature review above. As can be seen they are centred on the experience of individuals. For example, when considering the question 'What factors affect the kind of subject knowledge that pre-service teachers gain', data in the form of personal accounts would be helpful. Given the personal and open-ended nature of such questions, the type of data that was needed was likely to be qualitative in nature and focused on the individual. This focus enabled specific theoretical perspectives to be considered.

3.3 Theoretical perspective

The presentation of a theoretical perspective can be seen as a way of making explicit the epistemological and ontological perspective that has been adopted. For some such as Cresswell (2013) it is also important to consider the values of the researcher which he refers to as the axiological perspective.

One of the factors affecting the choice of theoretical perspective was the way in which knowledge has been codified by literature in the field of Design and Technology. The structured model of the Minimum Competences (DATA, 2003) used to audit the knowledge of pre-service teachers has been criticised as inappropriate (Martin, 2008). From time spent working with individuals developing their subject knowledge, it appeared that the experiences involved are unique to the individual and cannot be generalised. From researching the literature above, there seemed to be little understanding of what the experience of pre-service teachers of Design and Technology is and the factors affecting their individual development. Given this lack of empirical research it was logical

to adopt a theoretical approach to the research study where an inductive, rather than deductive, process is used to uncover the processes being undertaken. The various theoretical perspectives that could have been selected will now be considered.

Denzin and Lincoln (2011) suggest that there are four major theoretical perspectives that can be considered as useful for structuring qualitative research: positivist and post-positivist; constructivist-interpretive; critical (Marxist, emancipatory) and feminist-poststructural. Given the focus of the research study and the data that is needed, there are some of these that would be inappropriate and can be discounted. Positivist and post-positivist perspectives to understand participants of subject knowledge, for example, would be inappropriate as they would exclude an approach that was interested in the experiences of the individual. The journey of becoming a teacher is a uniquely individual experience and developing subject knowledge part of that unique experience. Whilst it may be of interest to analyse what knowledge is developed, through the collection of quantitative data, this would be unlikely to reveal insights into the process of knowledge acquisition. It would be the experience of individuals in that process that could give rich data on which teacher educators can act.

Studies undertaken from a critical or feminist-poststructural perspective tend to focus on wider issues and the ways in which embedded social and political systems influence individuals and communities. It was not, however, the intention of the study to look at the wider influences of the social and political context but to focus on the experience of individuals. Of the potential theoretical perspectives that could be the most helpful in answering the questions raised, interpretivism seemed the most appropriate. Whilst interpretivism comes in different forms, the underlying assumption is that meaning is not discovered but constructed. Subject knowledge was recognised as something that participants already had and could be added to, or re-constructed, in some form or other. Also, due to the experience of the researcher, it was possible to undertake semi-structured interviews that would be more dialogical in nature.

3.4 Research strategy

Underpinned by the selected theoretical perspective, a research strategy defines the research design as a whole. Having selected a theoretical perspective that used inductive processes, to reveal meanings about a phenomenon, it was necessary to consider a research approach that could be used to best fit the phenomenon and participants. The description by Cresswell (2013) of research design as a whole, includes the use of the term research approach to define the ways in which data collection and data analysis will be handled within the study. He outlined five key approaches that may be adopted, namely narrative, phenomenological, grounded theory, ethnographic and case study. Denzin and Lincoln (2011) refer to 'research strategies' and also include life history, historical method, action and applied research as well as clinical research. Savin-Baden and Major (2013) further add to the list with pragmatic, collaborative, evaluation and arts-based approaches. The choice of approach to be taken needed to be both appropriate for the focus of the study and also compatible with the philosophical position outlined above.

The study was focused on the development of subject knowledge for pre-service teachers of Design and Technology in secondary schools in England. Specifically the study sought to explore the acquisition of new knowledge, adaptation or transformation of existing knowledge. It also sought to explore the influence of others in shaping the knowledge that is developed during placement in schools. Direct observation of social interactions between the pre-service teacher and others was felt to be difficult given the nature of partnership arrangements and access to the settings. From experience with managing placements in the past, it was clear that pre-service teachers develop different types and amounts of knowledge. Consequently it was felt that the only way to understand the processes of subject knowledge development on placement was to ask participants to look back at their experiences.

The term *experience* can usefully be seen in two ways: firstly as the physical actions that were undertaken in order to develop the cognitive knowledge and

motor skills related to the subject; secondly as the meaningful processes of knowledge development including any emotional effect. This, it was hoped, could reveal the significance of social interaction, in and out of the workplace, that shaped the knowledge that was acquired. Of all of the strategies given at the beginning of this section, there were three in particular that stood out as having potential for the study of individual experience, namely grounded theory, narrative inquiry and phenomenology. The use of activity theory was also considered given its effective use by authors such as Snoek (2013) in describing the experience of pre-service teachers. The following paragraphs explain how each of these approaches was considered in relation to the study and the collection of data.

A grounded theory approach as outlined by Charmaz (2014) could have been helpful in developing completely new knowledge about the processes of subject knowledge development but, to be true to the methodology, it would have required access to the participants whilst on placement. By exploring their work as individuals and the discussion with mentors it could have led to new insights. In addition, the starting point of the research was personal discomfort with the existing practice of managing students' subject knowledge through the use of audits and competences. The depth of experience of the researcher and their existing writing about the subject was felt to be of importance in informing the study. Consequently a grounded theory approach was not felt to be appropriate.

The use of narrative inquiry (Clandinin & Connelly, 2000) was considered but much of narrative inquiry is based on exploring the journey that people have been through with the end point of establishing story patterns or narratives. Looking at the backgrounds of students entering the course over the years, it is clear that they come from quite a variety of backgrounds and have differing qualifications and work experience. To develop narratives of different people who would have different experiences in school was not felt to be very useful as it was likely that there would be as many different narratives as there were participants. More importantly, however, the focus of the study was not so much on the individual's story but of finding out about their experiences of the

phenomenon of subject knowledge development that happens when on placement.

The theory of activity systems was one such perspective on the relationships that individuals have within organisational systems. This has been successfully used by authors such as Snoek (2013) to look at the experience of pre-service teachers as they enter workplace settings as part of their course of teacher education. This would appear to suit the nature of the study and allow some comparisons to be made with prior research. However, it was decided not to pursue such an approach as the focus of the study was very much about the experiences of individuals rather than the workings of an entire system. Gaining access to all of the stakeholders necessary to develop the model of the system was also felt to be difficult and a more pragmatic approach was sought.

The purpose of a phenomenological approach, as Cresswell (2013) explains, is to develop phenomenological insights into participants lived experience of a concept or a phenomenon. Cilesiz (2011) suggests that phenomenology, as a research methodology is unique in that it is designed to study lived experience of phenomena from the perspective of those who experience it. The aim of this particular research study was to develop insights into the factors affecting subject knowledge development of pre-service teachers of secondary Design and Technology. By illuminating the processes and influences involved, it was hoped that new insights could be gained and alternative ways of looking at subject knowledge could become possible. Whilst the research inevitably involved working with individuals who have unique experiences, the original aim of the study was get to the true nature of what is involved in developing subject knowledge. Their experience, in this sense, was what pre-service teachers actually do and how they feel about the processes of acquiring knowledge for teaching. Of all of the approaches considered above, phenomenology was felt to be the most appropriate in focusing on the individual and their lived experiences of developing subject knowledge whilst on placement.

Before looking at research methods it is necessary to provide a more in-depth exploration of phenomenology and the specific strategy undertaken for this study.

3.5 Phenomenology

Phenomenology is both a philosophy and a research methodology that focuses on the lived experiences of others. As Giorgi (1997) points out, it offers a method for accessing the difficult phenomena of human experience. Phenomenology can be inaccessible and hard to understand. This is mainly due to the variety of authors that have been involved in its development and the sometime starkly differing philosophical stances that they adopt. The philosophy has also gone through different periods, starting off with German philosophers such as Husserl (1931) and Heidegger (1962), moving to those in France, such as Merleau-Ponty (1962), and ending up more widely written about by authors from around the world such as Van Manen (1990) in Canada. This section will explore the different approaches adopted by phenomenologists and identify the differences between them on philosophical and practical grounds. In addition it will identify the key issues that need to be considered by anyone adopting the approach and explore how these were taken into account throughout the study. As Moran (2000) says, the term phenomenology was used in philosophy texts as far back as the work of Kant and later Hegal who used it in the title of one of his books. It was, however, the work of Franz Bretano (1838-1917) that inspired Husserl (1931) to write about pure phenomenology and how a phenomenological approach might be used to explore the essential nature of human consciousness and experience. In the history of philosophy there have been two main distinctive types, namely *transcendental phenomenology* and *existential phenomenology*. These will be outlined first before discussing subsequent approaches that arose from them. This will be followed by describing the specific form of phenomenological inquiry that has been adopted for this study.

The first chapter of the book *Ideas* by Husserl (1931) is particularly useful in trying to get to the heart of phenomenology as a philosophy. Given that all types of phenomenology grew out of his work, or through its critique, it is worth

providing some account of the thesis that he presented in his description of *transcendental phenomenology*. Husserl first discusses what he calls the 'natural standpoint' where one is intuitively aware of the world spread out endlessly around oneself. In this world we are aware that real objects are there without them being perceived. That which is perceived is through our senses and includes objects and people that are immediately to hand. Other objects continue to exist in the world even if they are not close at hand and cannot be fully perceived. The world for Husserl is also not just one of objects, but a world of values and a world filled with relationships. The world that is intuitively experienced, is the same world that others exist in. Differences between oneself and others, in how we apprehend the world, are purely in terms of those things that affect consciousness. It is clear therefore that Husserl takes a highly objective view of the world 'out there'.

Husserl continues by exploring how his thesis could be verified through a process of doubting, citing the approach taken by Descartes. He argued that such verification, by doubting 'Being' entirely, was impossible. However, rather than to doubt everything, he suggested that it is possible to put the natural standpoint 'out of action', 'disconnect it' or 'bracket it' and therefore to make 'no use' of it when looking at experience as lived (*erlebnis*). Husserl was interested in epistemology and, in particular, the unbiased study of things as they appear 'pre-reflectively', without resorting to interpretations. This view he described as transcendental phenomenology (Husserl, 1931). This experience of the lifeworld (*lebenswelt*) should be viewed without the bias of subjective and theoretical constructs, thus without interpretation. Husserl devised a concept of phenomenological reduction which can be seen as reducing the world to pure phenomena. In order to understand such phenomena from Husserl's perspective it is necessary to 'bracket' one's own experiences. Such an approach can appear distinctly positivist, as Dowling (2007) suggests. However, in exploring what Husserl actually said, it is clear that he aimed to develop an approach that was outside of any previously existing theoretical framework including positivism.

Despite studying the work of Husserl, and being trained by him, the phenomenology of Heidegger (1962) differs significantly in terms of the focus. Husserl pursued epistemological goals whereas Heidegger was more interested in ontology and understanding the experiences of people through interpretation. He based his phenomenology on the concept of *dasein* which translates as 'being in the world' meaning the way in which human beings exist in relation to phenomena. Consequently people make sense of the world from the viewpoint of their existing reality. As a result his perspective is usually referred to as *existential phenomenology*. Importantly for the processes of data collection and analysis, Heidegger rejected the idea of bracketing put forward by Husserl and argued that it was not possible for a researcher to entirely separate a description of phenomenon from their own interpretation of it. As Cilesiz (2011) points out, he emphasised the uniqueness of individuals who have social dimensions of their being through relationships with others and are embedded in culture. Such a perspective appears to reflect a constructivist view where understanding the phenomenon is focused on individuals' interpretation of it. Indeed, as (Laverty, 2003) points out, Heidegger suggested that 'to be human was to interpret'.

Another significant figure in the history of phenomenology, as philosophy, was Maurice Merleau-Ponty whose focus was also existentialism (Merleau-Ponty, 1962). He took the same view as Husserl in the need to undertake phenomenological reduction but looked at it in a different way. He suggested that the goal was to view our experience in a new way rather than our reflective or pre-reflective experiences. His most significant work for the field was *Phenomenology of perception* (Merleau-Ponty, 1962) in which he used four 'existentials' to explain the structure of the lifeworld, namely: lived space (spatiality); lived body (corporeality); lived time (temporality) and lived human relation (relationality or communality).

As well as these two key variations in phenomenology described above, there is also *hermeneutic phenomenology* which, like existential phenomenology, has a focus on interpretation. The best known exponent of this is Hans

Gadamer who took the involvement of human experience a step further than Heidegger (1962) in his version of phenomenology. In his book *Truth and method* (Gadamer, 1989) he proposed that the researcher themselves take an active part in developing understanding and that this should be done through dialogue. The intersubjectivity between researcher and participant affects the development of knowledge so it is important to make explicit the position of the researcher and to involve participants in the discussion of outcomes. This type of phenomenology is called hermeneutic due to the process involving cycles of interpretation.

The work of Max van Manen is more contemporary than the previous authors and his focus has been very much on the *lived experience* of individuals as a means of understanding phenomena. His book 'Researching lived experience' (Manen, 1990) is frequently cited and he provides some useful explanations of key aspects of phenomenology. Much of his writing is about pedagogy and how learning can be understood as phenomena experienced by the individual. Manen (1990) proposed that it is necessary to look at individuals experience from a variety of perspectives in order to better understand it.

Through this brief exploration of key authors in phenomenology it can be seen that there are a variety of perspectives. As (Cresswell, 2013) points out, phenomenologists reject the subject/object dichotomy and spread across the intersubjective continuum between the two extremes. However, one of the key differences between the authors is their position in relation to the subjective / objective nature of reality that they adopt. Husserl, for example, is very much towards the objective end of the scale with an emphasis on description. Gadamer, on the other hand, is very much towards the subjective end of the scale with real emphasis on the co-creation of knowledge with participants and interpretation by the researcher being central. Finlay (2009) views description and interpretation as a continuum, a view supported by Manen (1990). This perspective is more pragmatic for those undertaking research using phenomenology as it means that the approach taken is not one between two options but rather one that is unique for each study.

Having outlined some of the types of phenomenology and some of the differences between them, the phenomenological approach chosen for the study needs to be described in detail. In doing so it is necessary to discuss a number of key issues and describe the ways in which this particular study will take account of these. Some of the processes put forward by different authors are quite similar, however, many like Hycner (1985) and Giorgi (1997) point out that there cannot be one specific method for all phenomenological studies, and that being true to the nature of the phenomenon is what is important. This issue stems from phenomenology being a philosophy with different traditions that has over time been interpreted in different ways that have led to different methods of undertaking phenomenological research. As Devenish (2002) points out, for the beginning researcher looking for help with methodological issues, such a variety of approaches is not helpful. Having said that, there are a number of specific issues that need to be addressed in any study when explicating the data. What these are and how they affect this particular study will be covered in the next few paragraphs.

An important concept in phenomenology is *intentionality* which, like many concepts in phenomenology, can be difficult to understand. Put simply, as (Cresswell, 2013) describes, intentionality is the idea that consciousness is always directed at an object. For Husserl (1931) the object can be tangible but can also be imaginary. For a more in-depth understanding of intentionality it is necessary to consider the concepts of noema and noesis, introduced by Husserl in his book *Ideas*, which are two inextricably linked components of meaning that together make up the essence of experience. Ihde (1977) provides some clarification of the terms:

> *Noema is that which is experienced, the what of experience, the object correlate. Noesis is the way in which the what is experienced, the experiencing or act of experiencing, the subject correlate.*
>
> (Ihde, 1977, p. 43)

Perhaps even more usefully, Cilesiz (2011) provides the following diagram of the relationship between the terms and how the textural and structural descriptions, derived from the noema and noesis, combine to form the essence of experience.

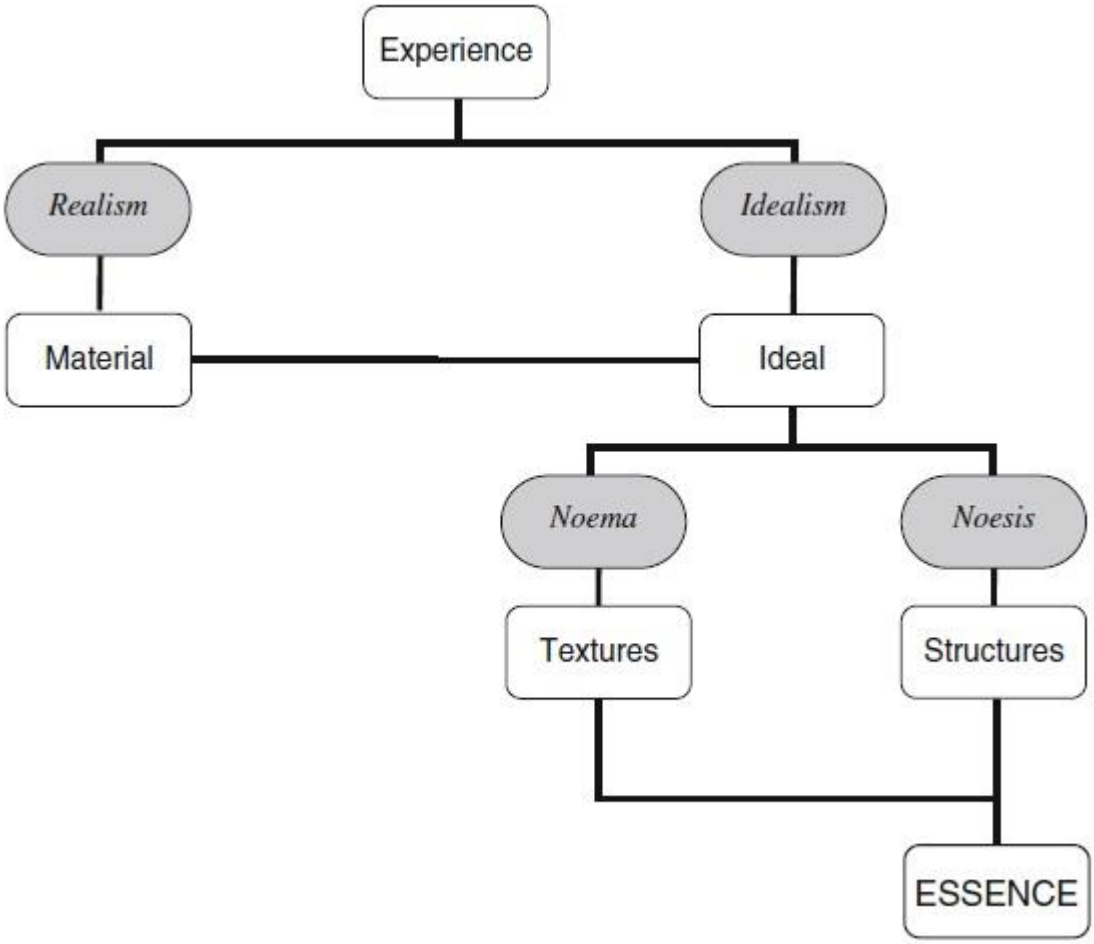

Figure 5: The essence of experience (Cilesiz)

(Cilesiz, 2011, p. 497)

This view of intentionality and experience was significant for the study as it highlighted the need to capture not only the ways in which subject knowledge developed but also how participants felt about their experiences. This was something that the researcher was conscious of when interviewing participants. It was also recognised that in the processes of data analysis, the identification of textures and structures was likely to be important. The diagram does,

however, suggest that the essence of experience can only be determined from an idealist perspective which seems to go against the views of key phenomenologists, such as Husserl (1931) and Heidegger (1962) who suggest that such an extreme perspective is unattainable.

The concept of *bracketing* (also referred to as epoché or εποχή), and the extent to which it is taken into account for a research study, is important for anyone undertaking phenomenology. The term was used by Husserl (1931) in his description of the process of focusing on a specific phenomenon by putting the 'natural attitude' to one side. Moustakas (1994) provides some useful guidance:

> '*In the Epoche, the everyday understandings, judgements, and knowings are set aside, and phenomena are re-visited, freshly, naively, in a wide open sense…'*
>
> (Moustakas, 1994, p. 33)

For Heidegger (1962), however, it is not possible to completely set aside the 'natural attitude'. Rather the exploration of a phenomenon should be described in terms of how it fits with a researcher's existing constructs.

Epoche, or bracketing, was seen by Husserl (1931) as an important part of the process of undertaking phenomenological research. However, any notion of being able to separate the researcher's background in this study surely goes against the ontological and epistemological position that have already been adopted for the study? Yet some form of bracketing does seem useful in providing an opportunity to look afresh at the issues under scrutiny. So how is it possible to resolve the tension between the tradition of Husserlian phenomenology and existentialism? Le Vasseur (2003) suggests a way of overcoming the tension with the adoption of curiosity as a way of bracketing the 'natural attitude'. The very act of becoming curious about a phenomena requires a questioning of one's existing beliefs and knowledge.

Dahlberg and Dahlberg (2004) provide further help with the suggestion of using the term bridling rather than bracketing. Their dislike of the term bracketing is

due to its precise mathematical meaning which they see as incompatible with an approach that demonstrates sensitivity towards the views of participants and the phenomenon they have experienced. For this study writing about the phenomena, and what has brought about curiosity, will serve as an appropriate from of bracketing in the way that LeVasseur (2003) suggests. As a result of adopting a curious frame of mind, existing beliefs and knowledge of the author will be made explicit and prepare the ground for data collection and analysis that privileges participants and their experience.

The concept of *distantiation*, developed by P. Ricoeur (1991), takes this a step further in treating the text of interview transcripts as an object independent of the participant and the researcher thus making its interpretation possible by anyone. This is a significantly more objective approach to working with the data. An example of this approach can be seen in the work of Tan, Grief, and Couns (2009) who have a focus on the text itself and search for in-depth description rather than meaning. Their method involves repeatedly re-visiting the text to move from appropriation, to explanation, to interpretation and finally to understanding. The effect of the researcher is constantly reviewed to keep the focus on the phenomena being explored.

For other authors, the role of the researcher in interpreting the meanings within the statements made by participants is central. It is the experience of the researcher, within the field being studied, that enables appropriate meanings to be identified and sense made of them for others to understand. Hycner (1985), for example, suggests that a degree of openness (towards the phenomenon) is essential when exploring data. Indeed he goes so far as to say that complete objectivity is not possible, a view also expressed by Merleau-Ponty (1962). The extent to which researchers should pay attention to their own experience is also discussed by Finlay (2009) who emphasises the need for researchers to be self-aware and cites the work of Gadamer (1989) in support of this perspective. Here we can see some clear references to the issue of bracketing that was mentioned earlier on as a key consideration when developing phenomenological research.

Overall, it was important to select a phenomenological approach that suited the phenomenon and makes the best use of the different theoretical and conceptual ideas available from those who have written extensively about them. Consequently, for this study, it was not the intention to adopt the approach of a specific author such as Husserl (1931), Heidegger (1962) or Gadamer (1989) but rather to adopt a standpoint that would facilitate the most extensive understanding of subject knowledge.

3.6 Quality

Issues of quality are an important consideration in all research study. As Savin-Baden and Major (2013) point out, in positivist scientific research the terms validity and reliability have been used to determine quality. For this study, that was interpretive in nature, an exploration of different terminology associated with qualitative inquiry was undertaken. Hammersley (2007) suggests that criteria, in the form of guidelines to judge the quality of research, are desirable but hard to define and notes that there has been little agreement amongst scholars since Lincoln and Guba (1985) developed a view of *trustworthiness* in their book titled *Naturalistic Inquiry*. One of the reasons for the lack of consensus within qualitative research is due to the number of different paradigms and approaches that exist. Ravenek and Rudman (2013), building on the work of Denzin and Lincoln (2011), usefully provide an analysis of several approaches used to consider the quality of qualitative research. They suggest that this might be done in four different ways, using qualitative as quantitative criteria, paradigm specific criteria, individualised assessment, or bridging criteria.

Firstly, they suggest qualitative as quantitative criteria using such things as the terms validity, reliability, generalisability and transferability. The use of such qualitative and quantitative criteria is more appropriate for positivist and post-positivist methodologies where it is important that the resulting data can be quantified and accurately measured alongside that which exists already. This was not the purpose of the study and did not fit well with the philosophical

stance taken for the study, so were discounted. Secondly, they suggest paradigm-specific criteria as a means of measuring quality. An in-depth discussion of criteria associated with phenomenology is given after the section that discusses more general criteria for quality.

Measuring the quality of qualitative inquiry through individualised assessment was a third approach that was developed in order to take account of the widely different approaches that are now possible and the lack of consensus amongst those undertaking qualitative inquiry. Whilst such internal rigour was important, the use of individualised criteria was also discounted as it was felt necessary to be able to locate the study in relation to other work in the field. In an attempt to provide an all-encompassing way of measuring the excellence of qualitative research, Tracy (2010) developed eight *general criteria* for quality. These are what Ravenek and Rudman (2013) would call bridging criteria that can be used for any form of qualitative inquiry. In discussing quality for this study it was decided to use her structure and the following paragraphs explain how the study was designed in order to address each of the criteria that she identified.

The first of the criteria is what Tracy (2010) refers to as *worthy topic*. This is a measure of the worth, or value, of a topic for the subject area it is related to. This study into pre-service teachers' experiences in school came at a time of considerable change in the design of courses of teacher education with a greater emphasis on the role of schools. It was therefore timely to explore their experiences in order to make a significant contribution to the discussion of how teacher education should be managed in the future.

The second criteria is *rich rigour* and a measure of the thoroughness with which the research has been undertaken. This study has adopted a phenomenological approach and, as such, it needed to address the issues associated with phenomenological research such as bracketing. These are addressed in the next section. In relation to data and time in the field, the study was designed to be undertaken throughout an academic year with data collected from 11 participants at three specific times. Another important

consideration to ensure rigour, identified by Tracy (2010) relates to the processes of data analysis. As can be seen in the chapter on data analysis, a number of strategies were adopted in order to look at the data in different ways so determining the most appropriate way of explicating findings from the data.

The level of *sincerity* is another criteria to measure quality. One of the key considerations in measuring the quality of qualitative research study is the extent to which a researcher is self-reflexive and makes explicit their subjective values and, as Morse (2015) highlights, to clarify researcher bias. The researcher involved in this particular study has more than 20 years of experience in the field and was likely to have developed a unique perspective. This is articulated at the beginning of the chapter on data analysis where the philosophical position and experience in relation to the issues are outlined. Another criteria of Tracy (2010) in relation to sincerity is the extent to which there is transparency about the methods used and resulting challenges. The particular challenges that occurred have been placed within each section of the thesis in order to contextualise them. An overall critique of the study as a whole forms part of the chapter on Conclusions.

For quality research, another term that Tracy uses is *credibility*. The extent to which a study provides 'thick descriptions', where significant detail is provided for each of a small number of cases, is a measure of the credibility of the research. This is in contrast with quantitative research where a large sample can be seen as important for validity. The aim of qualitative inquiry is to privilege the voice of participants rather than the voice of the researcher. Cope (2014) suggests that in this way the study can be seen as authentic and can faithfully report what has taken place. This study was designed to make use of semi-structured interviews in order to focus the attention of participants on their experience but in such a way that allowed them to explain what happened. The findings were also written using direct quotes from participants so that they provided an authentic account of the phenomenon.

Tracy (2010) also uses the criteria of *resonance* which has been written about extensively by Poulos (2008). For Tracy and Poulos, resonance refers to the engagement between the research and audience. If a qualitative study report captures the intended audience, to the extent that they can make connection with what is being said, then it is considered of good quality. In this study, the researcher was involved within the subject community of Design and Technology and also the higher education community of teacher education. This means that the researcher was well aware of the intended audiences of this study and was able to design it with those specific audiences in mind.

One of the other areas that Tracy (2010) also suggests should be considered is the extent to which the research makes a *significant contribution*. In this sense she is using the term significant to refer to such things as the theoretical, practical or methodological significance of the study. This study makes a contribution to the award of Doctor of Education and, as such, it identifies implications for the field resulting from what has been found out. In this sense it will clearly make a practical contribution to future practice. In addition, the study uses phenomenology as a research strategy and a reflection on its use forms part of the discussion and conclusions.

Another criteria that is important in all qualitative inquiry is the extent to which the study is *ethical*. Apart from the usual ethical issues associated with work of this kind, there were the additional issues associated with my role as lecturer and the participants being enrolled on a course at university. A full account of how ethical issues have been considered in the study can be found in section 3.9 later in this chapter. The final criteria from Tracy (2010) is what she calls *meaningful coherence* which is a measure of the quality of what has been written. In order to ensure that the study completes its objectives, elements from the literature review will be built into the data collection methods and revisited later on in both the findings and summary sections.

As well as considering general criteria for qualitative research it is valuable to explore specific quality criteria, or considerations, for a research study using a

phenomenological approach. Rashotte and Jensen (2007) suggest that for phenomenology, a new way of approaching validity is required. They proposed that the trustworthiness of research should be based around three key relationships between: researcher and participants; researcher with the data; researcher with the readers. A number of other authors, including Crotty (1996), Moustakas (1994) and Van Manen (1990), discuss the issues that researchers should consider and also identify, as key, the extent to which the data represents a true reflection of the experiences of pre-service teachers.

Ensuring that participants' voice comes through the study can be taken quite literally by using the words of participants to form the units of meaning that will be further reduced when explicating the data. Hycner (1985), along with Geanellos (2000), support this view. Some authors go even further than this and suggest there are potential benefits of including participants as essentially co-researchers. This is discussed by Tuohy, Cooney, Dowling, Murphy, and Sixmith (2013) and forms a key part of the work of Gadamer (1989) who viewed the process of phenomenology as essentially one of co-construction. The method of explication proposed by Fleming, Gaidys, and Robb (2003) is also very much influenced by the work of Gadamer (1989) and involves participants at every stage of the process. With the use of several interviews over time, data analysis occurs between sets of interviews and is shared with participants. For this study, however, it was felt that the relationships between the researcher, as university lecturer, and participants, as students on a university course, were such that working as co-researchers was untenable given the potential power differential.

The involvement of fellow academics as co-researchers to validate the selection of meaning units was proposed by Hycner (1985) to counteract any possible subjective judgements of the researcher. Such a strategy for reliability can also be seen in the process of analysis put forward by Van Kaam (1959) who suggested the use of what he called judges. A more recent example of this can be seen in the work of Rich, Graham, Taket, and Shelley (2013) who worked as a team in looking at the data and explicating the meanings from participants' transcripts. For this study, however, the involvement of co-researchers was

considered difficult to enact and of limited value given the extensive and unique experience of the researcher and the unique nature of the study.

3.7 Researcher perspective

As part of the phenomenological approach taken it was necessary to outline the researcher's perspective on the phenomena prior to analysing the data from interviews. This was a means of being aware of what Husserl (1931) called the natural attitude. LeVasseur (2003) suggests that expressing curiosity about a phenomena is already enough to demonstrate a questioning of existing beliefs and has the effect of 'bracketing' the researcher perspective in the way that Husserl (1931) suggests is necessary for phenomenology.

The ontological position adopted by the researcher involves a conception of reality as something that is interpreted by individuals. Such *multiple realities* are constructed as a result of the experiences that they have in the world. In the exploration of the chosen area under research, value is given to individual accounts and they are seen as collectively providing insights into the phenomenon being explored. From an epistemological perspective, the subjective accounts from participants in the study count as knowledge. From these accounts, an inductive process has been used to draw out issues of significance. Such a position can be seen to present a more subjective than objective view of the world. However, as Savin-Baden and Major (2013) point out, it is more useful to see objectivity and subjectivity as more of a continuum. In this way, the philosophical position adopted would be better described as intersubjective with a tendency towards subjective rather than objective views of reality. In terms of the implications of the philosophical position for the study, it was important for any questions posed to be relatively general so that participants are able to construct their own meanings. This would quite likely be through some form of interaction between them and the researcher.

The trigger for undertaking this research study was discomfort with an existing system of measuring subject knowledge within the subject domain of Design and Technology. Given the long history of involvement with the subject it would be extremely difficult for the study not to be affected in some way by the

background of the researcher. The philosophical position was one that acknowledges that research study is always affected by values, history, culture and relationships with participants. As such, the values of the researcher will always be inseparable from the outcomes. This, however, raises questions of validity and the extent to which researcher bias has affected the overall outcomes of the study.

As part of the philosophical position that has been adopted, validity is not an appropriate term. Being true to the participants as a trustworthy researcher is of more importance. In order to be trustworthy, it is necessary to review the adopted role as a researcher at all stages of the study. Recognising familiarity with the area being studied the researcher identity would be more of an insider than an outsider. Consequently it was important to be explicit about the personal position towards that which was being researched, and the extent to which values and bias were taken into account.

Personal view of teacher education

Having been involved in teacher education in higher education for the past 20 years I have developed a strong personal view on the significance of subject knowledge. In all subjects, a good level of knowledge is required in order to teach. Of more significance, however, is the recognition that knowledge is constantly changing and teachers need to be constantly updating their understanding of subjects. In addition it is important for pre-service teachers to recognise the limits of their subject knowledge and recognise that not knowing everything is part of being a teacher.

In highlighting the significance of subject knowledge there was a danger of focusing on the measurable acquisition of skills and knowledge through audits and lists. This can result in the perception of learning to teach as a process of training to gain specific competences, rather than developing an understanding of the processes of education and the role of the teacher in facilitating learning by pupils in school contexts.

Personal view of subject knowledge development in D&T

I am skeptical and wary of a competence-based system to which pre-service teachers are expected to work with. This stems from my experience of working in teacher education for the last 20 years. More detail on this can be found in my conference paper *Competence in question* (Martin, 2008) .

Despite students completing initial audits of subject knowledge using the DATA Minimum Competences document, and filling in the gaps through the course, it has been evident that they develop different amounts of knowledge. Much of the difference appears to be related to their experiences whilst on placement. Indeed, the goal of achieving a common experience for pre-service teachers to develop 'the' required subject knowledge seems to be more of a political ideal than an achievable reality.

Important for the phenomenological approach taken was the adoption of an open mind towards the phenomenon. In addition, there was the need to explore the experience of participants and how they felt about it. The use of face-to-face interviews is seen by Brinkmann and Kvale (2015) as offering one of the best ways of access participants' feelings and deeply held belief about the world around them. It was for this reason that interviewing seemed to be the most appropriate form of gathering data, whether that be on a group or individual basis. Another factor affecting the choice of data collection methods that was used was access to participants. For this study participants undertook periods of placement in schools and consequently the opportunities to meet with them was limited.

3.8 Research method

Having provided a rationale for the selection of phenomenology as a research strategy in the previous section, the focus now turns to the method chosen to collect data and the consideration of a number of factors that determined the sample of participants that were involved. These included a consideration of the nature of data that would be useful, when data should be collected, the institution used and course to focus on. In addition, the selection of participants to make up the sample was also considered along with recruitment processes.

Nature of data

The focus of the study was on the development of subject knowledge by the individual. Consequently the type of data that would be useful were personal accounts of the experiences of individuals. In order to acquire in-depth accounts that gave thick descriptions (Charmaz, 2014), the use of interviews was selected. For phenomenological research using interviews is common as they have the advantage of capturing the how phenomena affects the individual in a personal, and often emotional, way. When exploring potentially sensitive areas of human experience, a more conversational approach can be more effective in capturing essences (Husserl 1930) than that provided by questionnaires. A potential disadvantage of using a face-to-face interview approach was in participants being selective in what they discuss. As a consequence, it was decided to make use of a semi-structured form of interview where additional and supplementary questions could be asked in order to get as much information about their experiences as possible (Brinkman & Kvale 2015).

Timing of data collection

The type of course selected was the Postgraduate Certificate in Education (PGCE) which was the most common course for secondary teacher education in England at the time of the study. For this type of course, placements were undertaken in two different schools firstly spanning the period between the end of September until the middle of February, and then secondly from mid-February until the course ended in the middle of June. The first couple of weeks of the course was a period of induction at the University. During this time there were a number of subject knowledge development sessions focused on different material areas of Design and Technology. This was then followed by a period in which participants were in school four days per week. After Christmas this became full time until the end of the placements. Given the changes taking place across the year, tracking their experiences over time was felt to be important. In order to capture different perspectives on the phenomenon at different stages of the course being undertaken, the same participants were interviewed at the end of each phase of their school experience throughout the academic year – three in total.

One of the advantages of interviewing over time was being able to identify changes in how participants felt about their experience and to understand how they coped with change. In addition it facilitated the development of a stronger and more trusting relationship between the researcher and participants. A potential drawback with using such an extended time period of data collection was losing the cooperation of participants as they became increasingly busy and did not wish to continue being involved. In addition, there was a risk that participants might not remember all of the issues that they had difficulty with along the way.

Institution

Whilst recognising that each participant would have a different experience it was felt helpful that they all be following the same course of study with similar patterns of timing for school placements. Given the existing work of the researcher in teacher education, there was the opportunity to draw participants from a course based at the same institution. The advantage of using students based in the researcher's institution was familiarity with structure of the course and the contexts in which they are working. Working with participants based in other institutions, as Ellis (2007a) did, was possible but there would inevitably be access issues. The potential limitations of drawing upon those studying at the same institution were associated with the tutor/student relationships and potential bias associated that might be with these. Being aware of this at the point of collecting data was important in maintaining the quality of the data collection process and the quality of the study as a whole.

Sample profile

In selecting potential participants, it was important to consider the makeup of the sample that would help to throw light on the experiences of pre-service teachers. Ideally, it would be helpful to have participants who were certain to have different experiences when on placement. This was, of course, impossible to determine so the strategy was to aim for a typical or representative sample that would provide rich descriptions of their time on placement. The aim was not to directly compare participants but to explore the experiences of individuals to throw light on processes of subject knowledge development.

In terms of demographics, those embarking on teacher education courses for secondary Design and Technology come from a mixture of gender and ages as well as a variety of material specialisms, academic qualifications and professional backgrounds. In order to gain the broadest data about the experiences of pre-service teachers it was therefore important to adequately represent these different attributes when determining an appropriate sample for the study. Consequently, it was planned to invite the entire cohort to participate and then to review the composition of the sample once initial recruitment had taken place to see if a further recruitment process was needed.

Recruitment

In order to recruit participants it was decided to explain the study then to ask for volunteers to complete the consent form. A total of 11 volunteers from the whole cohort of 18 PGCE pre-service teachers offered to be interviewed. Fortunately, when reviewing the sample, the demographics and backgrounds of participants was such that no further recruitment strategy was needed to get a typical sample.

From the 11 pre-service teachers that volunteered, the sample could have been further reduced in order to make the interviewing workload more manageable. This was an important consideration given the limited time that participants would have back at university between blocks of placement. It was decided, however, to maintain the sample at 11 as it was possible that the demands of the course might have an effect on their willingness to participate as their placements progressed. As it turned out, some of them were not able to take part in the final round of interviews but a broad sample still remained.

Ethical issues

As Savin-Baden and Major (2013) point out, taking account of ethical issues when undertaking qualitative research study is extremely important. This perspective is supported by the work of Denzin and Lincoln (2011) who suggest that much of the qualitative inquiry that takes place is aimed at exploring potentially sensitive issues that involve the feelings of individuals. This study

was aimed at uncovering the lived experience of pre-service teachers and, as has been mentioned, consideration of ethical issues was central to ensuring that a quality piece of research was undertaken.

Critical to ensuring that any research study is ethically sound is the consideration of participant confidentiality. For this study, not only were participants likely to discuss personal feelings about their experience but also quite likely to discuss teachers with which they were working. Consequently it was important that they felt able to do so confidentially and without any repercussions for their course of study. This was emphasised during the presentation of the study and highlighted in the participant information and participant consent forms. In addition, there was further assurance at the beginning of each of the interviews and sometimes during the interview if felt necessary. A further step to ensuring confidentiality of participants was in anonymizing the digital recordings of the interviews prior to them being transcribed. Whilst it was possible for the interviewer to identify each participant, making the recordings anonymous prevented the transcriber from knowing the names of individuals.

Participants were recruited on a voluntary basis following a presentation to the entire cohort of PGCE students. The presentation provided a brief background of the study and what would be involved for those taking part. This was important to ensure that the purpose of the study and the role of participants were completely transparent (Savin-Baden & Major, 2013). It was emphasised that involvement was not expected by all and that the research would be carried out in line with the university policies which ensures the anonymity of participants. No exclusion criteria were applied in the selection of participants and the only selection criteria for recruitment to the study was that they be on the PGCE course for Design and Technology. No other requirement was made in terms of material specialism, age or gender. Following the presentation about the study, participant information sheets (Appendix A) were given to all of the cohort so that they might make an informed choice to participate in the research or not. Those wishing to be involved were asked to complete a consent form and pass it back to the researcher at some time during the day.

As Thomas (2013) notes, gaining informed consent is essential if the research is to be based on ethical principles. The design of the study was such that participants needed to take part in three separate interviews and there was some concern by the university ethics committee that this might place unreasonable demands on the participants. However, the interviews were to be separated by several months and consequently the demands were not considered to be unreasonable. Following the presentation, participant information and consent forms were then made available and individuals were left to complete them in their own time if they wished. From a cohort of 18 pre-service teachers, a total 11 individuals with varying materials specialisms provided their consent.

At the commencement of the study the researcher had very little involvement in the course undertaken by the pre-service teachers. However, as time went on the researcher became responsible for visiting some the participants in their placement setting and making joint judgments on their progress against the teaching Standards. Given this professional role of the researcher it was important to recognise what Cresswell (2013) refers to as the potential power imbalance between researcher and participants. Consequently, throughout the study great efforts were made to manage the tension between the role of researcher and course tutor. This helped in securing the three interviews with most participants. For Bev, however, when it came to asking about her participation in the June series of interviews she declined, feeling that it would be difficult to do given that the researcher had taken on the role of Liaison Tutor and was responsible for assessing her progress.

No adverse effects were anticipated and interviews were arranged at convenient and safe locations and at times to suit the participants to minimise any stress or interruption to their working life. The questions used were highly unlikely to distress participants but in the unlikely event they were affected in any way they were able to withdraw from the study at any time. It was hoped that through informal discussion about their work in university and school,

participants would benefit from reflecting on their subject knowledge and how it may be developed further in the future.

The key interview questions were submitted as part of the paperwork for ethical approval and so were scruitinised by the university ethics panel to ensure that participants would not be put under duress or be obliged to discuss something that was very personal. All interviews took place on university premises where it was felt that participants would feel more comfortable. The space used for interviewing was one of the rooms in which teaching sessions would regularly take place and was very familiar to all participants. The next section discusses the interview process and describes how research approach affected the ways in which they were undertaken.

Another consideration in relation to ethics was in the way that the data was analysed and reported. Here there was the need, particularly with the phenomenological approach adopted, of retaining the ‘voice’ of participants. This was achieved by making use of direct quotes from the interviews to illustrate the issues that were highlighted. Whilst it was recognised that it was the researcher that would select the quotes it was, at least, a means of improving the integrity of ethical nature of the study. Further considerations of ethics, in relation to the interviews, are discussed as they appear in the next section on interviewing.

3.9 The interview process

The most common form of data collecting in phenomenological studies is through interviewing (Cresswell, 2013) and, in exploring the subject knowledge development of pre-service teachers, it was felt to be an appropriate method as it is a way of gathering data directly from participants. It is also possible to capture not only what they experienced but how it was experienced by the ways in which they expressed themselves.

The theoretical perspective adopted by the researcher affected how the interview process was undertaken and how the data was subsequently analysed. Brinkmann and Kvale (2015) use the metaphor of traveler to describe

the position of a researcher interested in developing knowledge with participants. This was highly appropriate for the study as, in exploring what the nature of subject knowledge as a phenomena actually is, it was important to approach with an open mind. Pre-existing structures of codified knowledge were recognised as being inappropriate and in looking for alternatives to the Minimum Competences it was essential to have open conversations with participants.

Tied up with the view of epistemology was consideration of the relationship between interviewer and interviewee. As Brinkmann and Kvale (2015) point out, the interview is a specific form of professional conversation in which there will always be a power differential. The question is to what extent the interviewer makes an attempt to equalize the power relationship. For this study it was felt that the researcher was in a good position to do so with lots of experience that facilitated a conversation using common language. Having worked with a good number of pre-service teachers over a 20 year period, it was felt that the researcher could establish an effective rapport, resulting in a level of intersubjectivity that would benefit the study as a whole.

In outlining the study to potential participants it was made clear that the focus would be on the way in which subject knowledge developed and not the quality or level of knowledge developed. In this way it was hoped to encourage participants to view the study as looking at something experienced by the individual and not a measure of the capability of the individual. In order to maintain consistency, and to keep an open mind when interviewing the semi-structured questions asked remained similar.

Fitting in with the work pattern of participants was seen to be very important. It was decided to interview participants whilst they were at university, between blocks of school placement. This had the advantage of easy access to a number of participants in one place and them being able to reflect on a block of experience without them having to plan and prepare lessons. The disadvantage of undertaking interviews at this time was that participants were expecting a break from thinking about school work. The time available to meet and discuss

was quite limited and resulted in the need to conduct several interviews back to back. A specific room was booked for all of the interviews which was next to their usual working space, where tea and coffee was made available. The interviews were digitally recorded to remove any distraction from note taking and to be able to repeatedly listen to them. Such familiarization with the data was an important part of adopting a phenomenological approach.

For this study, participants have been very much part of exploring the nature of subject knowledge but have not been involved in the process of data analysis. This was, in part, a pragmatic decision due the limited availability of participants whilst on school experience. It was also decided to analyse all of the interviews across the year the same way once they had all be undertaken. This holding back of analysis was aimed at reducing the influence of one set of interviews on the subsequent set so that a naïve understanding (Tan et al., 2009) could be developed. The questions to all (Appendix B), arose from professional experience and consideration of the overall research design, combining thinking from the Literature Review and methodology sections. Some consideration was given to the order in which the questions would be asked with the first question being very open in order to focus the conversation on the responses of participants.

All interviews were audio recorded and then transcribed shortly after each set of interviews had been completed. The first two interviews were transcribed by the researcher but it was clear that this was going to take too long and would hold up the beginning of the data analysis process. It was then decided that all of the interviews would be transcribed professionally so that more time could be devoted to working on their content. It is suggested that researchers transcribing their own interviews is good practice at it enables them to have an in-depth understanding. However, with the repeated reading and listening, note taking and highlighting required by a phenomenological approach, using an external transcriber was felt to be acceptable and would not adversely affect the quality of the study as a whole.

3.10 Summary

This chapter has outlined the theoretical perspective adopted for the study along with the choices of research strategy and the ways in which the data was collected. The phenomenological approach was largely interpretive and the next chapter provides details of how the data that was gathered was managed.

From what has been found through the literature review phenomenology has not been used to collect empirical data in the field and provides a unique insight into Design and Technology education and how such an approach might be useful for other researchers in the future.

4 Data analysis

4.1 Introduction

This chapter provides an overview of the various processes of data analysis that were explored to determine the best way of dealing with the interview data that had been collected. Whilst there are a good deal of authors who explain what they have done in their particular phenomenological study such as Devenish (2002) and Rich et al. (2013), there is little agreement on what is the best method to use. The exploration of different approaches was undertaken in order to find the most appropriate method to ensure that the study was both rigorous and trustworthy. Issues related to coding and the use of computer-based systems are also discussed. The chapter also includes justification of the selected methods of analysis that were eventually used for all of the transcripts.

Groenewald (2004) suggests that for phenomenology the term *analysis* can be problematic, as it implies some sort of separation of the phenomenon into parts. Such division is not in keeping with the views of many phenomenologists and it is suggested by Hycner (1985) that keeping the 'whole' in mind provides a context for emerging meaning units when exploring them in depth. The term *explication* is preferred by Groenewald (2004) to describe the process of working with the data. For others, such as Devenish (2002) the process is one of gradual distillation to get to the essence of the experience that participants have of the phenomenon.

In phenomenology the choice of terminology to use is not trivial with the words selected being important in reflecting the approach taken. The word explication has several meanings including:

> *... unfolding, bringing out what is implicitly contained in a notion, and also removing obscurity to make meaning clear ...*
>
> (Groenewald, 2004).

This revealing of the phenomenon through processes of unfolding and clarifying is exactly what is required for this study that makes use of a phenomenological approach. Consequently, the term explication was adopted throughout the remainder of this thesis.

One-to-one interviews were undertaken in December, March and June during the course of the 2012/2013 academic year. In December and March it was possible to interview all eleven participants but in June it was only possible to interview seven of the eleven. Most of the interviews took between 25 to 30 minutes and were digitally recorded. The interviews all started with the same question which proved helpful in framing the interview in a similar way across participants. This also ensured that participants worked with their own understanding of what they meant by subject knowledge as the researcher's interpretation was not put forward at the beginning. All of the interviews were successful in allowing the participants to explain how their subject knowledge had developed and been affected by a number of factors. Not surprisingly, some participants were able to answer questions more readily than others. In terms of analysing what took place, the data available took the form of audio files of the interviews along with typed transcripts that could be explored using a variety of methods.

In qualitative inquiry, the degree of reflexivity maintained by the researcher is often a significant consideration when collecting and analysing data. Phenomenological research is no exception and for Finlay (2009) reflexivity is the process of continually reflecting on the interpretations of both self and the phenomenon being experienced by participants. For others such as Manen (1990), however, the undertaking of analysis without imposing external frameworks, or undertaking researcher reflection, is seen as an important feature of phenomenological research. Rather than bring in ideas from the outside, the way that data is structured should be derived from an understanding of the phenomenon itself. Husserl (1931) highlights this when he talks about 'from the things themselves'. For this study, the researcher's perspective was important in locating it in the wider subject context. Whilst explicating meanings from the data, however, the researcher's perspective was held back until the data interpretation process had been completed.

Despite the need to be clear about the nuances of the approach taken, much of the research done using phenomenology has involved the four stages that Cresswell (2013) outlines:

> 1. *Highlighting significant statements (a process sometimes referred to as horizontalisation;*
> 2. *Identifying 'clusters of meaning' or 'natural meaning units' from the statements;*
> 3. *Developing both a textural description of the phenomena (the 'what') and a structural description of the phenomena (the 'how');*
> 4. *Writing a clear description of the essence of the phenomena from the combination of the textural and structural descriptions.*
>
> (Cresswell 2013, p.121)

In the last two steps we can see the clear link with the phenomenological concept of essence as shown in the diagrammatic form by Cilesiz (2011, p. 497) which can be seen in the Methodology chapter. Variations on this core process have been carried out by a number of key authors such as Van Kaam (1959), 1978 Colaizzi (1978) and Giorgi (1985) who, as Crotty (1996) points out, have been very influential in the methods subsequently used in later work such as that undertaken by Devenish (2002). There is much debate, among those that write about phenomenology, concerning the appropriate way to analyse interview data. The detail of this is given above and there appear to be two main ways of developing meanings from the data – either as a whole or by what are called significant statements. Considering the advantages of both methods it was decided to analyse some of the interviews using both techniques, develop themes from each method and compare. In this way, the method of explication of all of the interviews could be decided from an informed position.

Given the developmental nature of the course it seemed logical to assume that the subject knowledge acquired by participants would be different at different times of the year. Consequently, it was felt important to begin data analysis by treating the interviews in groups according to the time of year. Below is an

explanation and justification of the stages undertaken in this study to determine the process of explicating the data.

4.2 Significant statements

In determining a process for data explication, the work of Crotty (1998), Devenish (2002), Giorgi (1997), Hycner (1985), Moustakas (1994), Thomson (2008), Van Kaam (1959), Yüksel and Yıldırım (2015) have been explored in depth. This has also been underpinned by the work of Gadamer (1989), Husserl (1931) and Paul Ricoeur (1981). Each transcript was dealt with one at a time to ensure the focus on the experience of an individual in the first instance prior to developing descriptions of the phenomena as a whole. This is in keeping with a phenomenological approach as the emphasis is on understanding the phenomena as experienced by individuals. Another alternative could have been to combine all of the data together and analyse the 'pool of meaning'. This, however, reflects more of a phenomenographic approach (Akerlind, 2012) with its emphasis on the collective experience and subsequent hierarchical categorisation.

For each of the December interviews, the following steps were undertaken based on the approach taken by Devenish (2002) in explicating the data:

> - *Listen to the audio recording, and read the transcript, to become familiar again with the interview.*
> - *Manually highlight statements that relate to the phenomena*
> - *Electronically code each highlighted statement using 'in-vivo' coding (the actual words used by participants) to retain the original meaning.*
> - *Generate a list of coded statements for the entire transcript.*
> - *Reduce or refine each statement with more descriptive terms where necessary.*
> - *Develop categories of meaning (or add to existing ones) directly from the refined statements.*
>
> (Devenish 2002, p.35)

Horizontalisation

After repeatedly listening to the audio recording, each interview transcript was taken through the process of horizontalising (Husserl, 1931) to identify every expression that related to the phenomena. As (Van Kaam, 1959) stated, it was important to include all statements in this process whether they are worthy in the eyes of the researcher or not. Hycner (1985) agrees that such a process needs to be done in a very open way in order to be true to the participants. For Paul Ricoeur (1981) the adoption of an open approach would constitute 'naive reading' which he sees as an important first step in getting close to the text but without attributing value to it. Thomson (2008) emphasises that determining the separation of text into different expressions, or statements, requires real familiarity with the text. Listening to audio recordings and reading each transcript several times prior to analysis, as Giorgi (1997) says, ensured such familiarity. Initially each expression was highlighted by hand and this was translated into electronic form to generate a list of expressions for the entire transcript. At this stage the words in the list were exactly those spoken directly by participants for example:

happy to have a go	1	1
harder though when you are teaching by yourself	1	1
have a go	1	1
have to go back to the teacher and ask her	1	1
I did one lesson plan and sent that	1	1
I have got to know how she has done it	1	1
I have narrowed it down	1	1
I know how to do it	1	1
I will get there eventually	1	1
I would love to get more ideas	1	1
If I could I would probably take the easy route	1	1
If I had time to practice it	1	1
if you don't have that you can't practice it	1	1
if you teach me how to make pastry I'll teach you how to do felting'	1	1
it is a risk but, you know, we will see how it goes'	1	1
it is all one knowledge	1	1
it is always a risk doing something new the first time round'	1	1

Figure 6: Horizontalised nodes

Reduction

The next step involved the phenomenological reduction (Husserl, 1931) where natural meaning units (Devenish, 2002) are derived from the horizontalised statements. Practically, the statements were refined or reduced to more exact descriptive terms. For Van Kaam (1959), each meaning unit must be relevant to the phenomena and also have the potential to be given a label which can uniquely identify the statement, but not lose its original meaning. Expressions not meeting this requirement should be discarded. Similar to the initial horizontalising, such structural analysis (Flood, 2010) needs also to be done in an open way without any pre-selected terms in mind. Below is an example of the refinement of text:

In-vivo text	**Refined / reduced description (meaning)**
Difference between one teacher and the other.	Teacher attitude.
If you don't have that you can't practice it	Resources to hand.
If you teach me how to make pastry I'll teach you how to do felting.	Support from peers.

Where the reduced descriptions were the same, a number was added (i.e. Confidence 2, Confidence 3, Confidence 4…) so that the frequency of natural meaning units could be seen. Each reduced description could then be coded in order to refine the data in a more meaningful way.

Coding

Saldana (2013) defines a code *as 'a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data'.* He suggested that there are two cycles as a minimum for coding. First cycle coding can range from a single word to a paragraph. In Second Cycle coding processes, the portions coded can be

the exact same units, longer passages, analytic memos about the data, and even a reconfiguration of the codes themselves developed thus far. He talks primarily about Descriptive Codes (that summarises the primary topic of the excerpt), In Vivo Codes which are actual words from the text and Eclectic Codes which are first impression phrases derived from the text. He also talks of Process Codes – words or phrases that capture action as well as Simultaneous Coding which is the application of two or more codes to the same section. For this study In-vivo coding was initially used in order to keep as close as possible to the words of participants.

Following some coding by hand and experiencing the process of marking up interview scripts, it was decided to go further and explore the use of Qualitative Data Analysis Software. Bazeley and Jackson (2013) suggest that there are four concerns about the impact of computerisation on qualitative analysis, namely:

- *The concern that computers can distance researchers from the data;*
- *The dominance of code and retrieve methods to the exclusion of other analytic activities;*
- *The fear that use of a computer will mechanise analysis, making it more akin to quantitative or positivist approaches;*
- *The misconception that computers support only grounded theory methodology, or worse, create their own approach to analysis.*

(Bazeley & Jackson 2013, p.47)

All of the above concerns are legitimate but can be argued against, as Bazeley and Jackson do. For them, key to dealing with the concerns is the adoption of a critical standpoint that recognises the tools for what they are - tools to be used if useful. For this stage in data analysis descriptive codes were generated for each of the reduced statements.

Categorising

The next step in working with significant statements involved categorizing or clustering in the way that Yüksel and Yıldırım (2015) suggest. Where there seemed to be a good number of nodes related to each other a folder was created. As each interview was subsequently coded, further folders were also created where it was felt possible. The change in the folder structure for the first four interviews is illustrated below and shows the progression of folder creation from left to right.

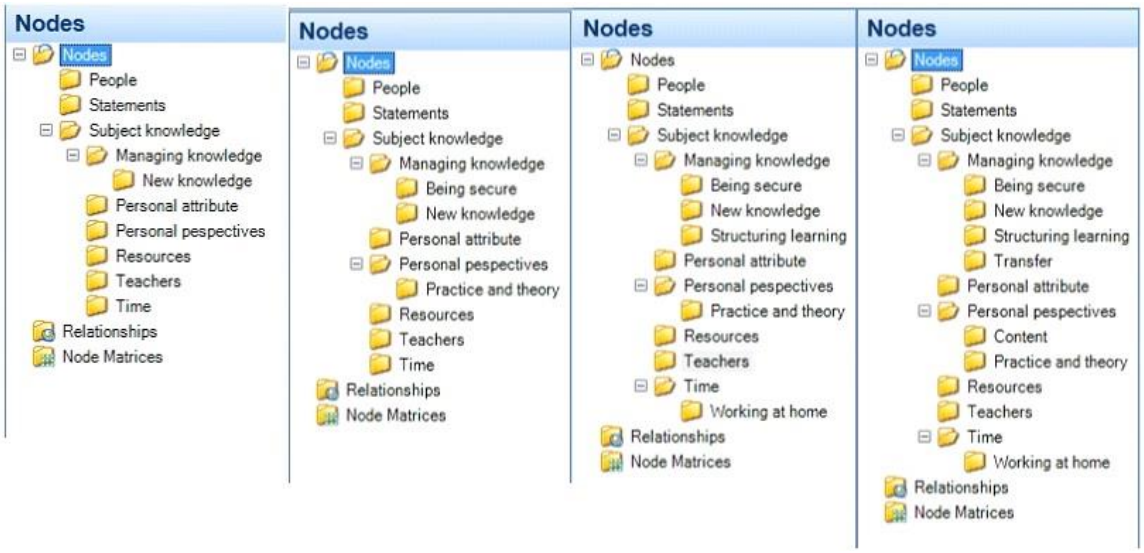

Figure 7: Reduced folders

At this time the nodes were left as they were and a process of further reduction and combination was planned once all of the December interviews had been processed. From this categorisation, it was anticipated that themes based around the phenomena would be generated. Such 'core themes of the experience' (Moustakas, 1994) could then be used to develop a textural description of the phenomena. Once this was done, the whole process was then be undertaken for subsequent groups of interviews.

Reflection on categorising

Following the analysis of the first four interview transcripts it was decided to review the process of data analysis. In doing so it was clear that the transition from raw In-vivo text to the natural meaning units was too open to interpretation and a better process was needed to ensure integrity of the study. As a result of

this reflection a number of alternative methods were explored. For example, by using longer phrases directly from the transcript and focusing on the verbs used in phrases it was speculated that it should be possible to better convey the meaning of what the participants have said, and end up with useful text that could be further analysed.

The first method of data analysis, used in this study, involved deliberately reducing the number of words used to write natural meaning units with the aim of quickly identifying significant issues. This process, however, meant that a single word or short phrase was needed to express the meaning contained in the significant statements. At times this was difficult and, inevitably, short statements only convey limited meaning or meaning that can be open to interpretation. For Umpleby (2014) her first stage of analysis involved writing interpreted meanings alongside interview transcripts. The comments (sometimes more than one for each statement made by the participant) reflected her initial thoughts on the meaning of the extract or statement. These interpreted meanings were then used to develop larger themes about the phenomenon. Recognising that the identification of meaning needed cross checking, she used qualitative data analysis software to fragment the statements and code them. The emerging nodes were then used to refine themes, create new ones and reject others.

The process undertaken by Umpleby (2014) highlighted the need to review and refine outcomes of data analysis when using a phenomenological approach. Any first attempt at developing meanings from the data is just that – a first attempt. Subsequent methods of cross-checking and periods of reflection on the data in relation to the phenomenon are required, and seem to be the hallmarks of a rigorous approach. There is a constant need to keep close to the data and return to the original transcripts as with layers and layers of interpretation and derived meaning, there is a danger that the original essence of the phenomenon will become lost.

This process of deriving interpreted meanings was undertaken with the first interview transcript (Andrea 1). Comments were added to a pdf version of the

transcript (Appendix D). The comments alone were then extracted and put together in a list. Where there were similar comments these were clustered together and the result was the generation of a number of categories. This was then compared to the categories generated by the first method of data analysis:

Categories from interpretation by researcher	**Categories derived from participant statements**
Personal attribute Working with knowledge Opinion Emotional reaction Situation Learning	Managing knowledge - New knowledge Personal attribute Personal perspectives Resources Teachers Time

As can be seen, there is great similarity between the categories but terminology has been used in different ways for the same aspect of the phenomena.

The approach to data analysis was modified in the light of reflection on the initial process undertaken and some associated exploration of related literature. As can be seen, the generation of units of meaning that will be used for further analysis are the words of the researcher. Such researcher comments need to be written at the level of ‘meaning’. During this process, the researcher needed to be careful not to add interpretation and just report what the participant meant.

The derivation of units of meaning direct from the text (In-vivo) involved using the participant’s words exactly. Whilst this would appear to be a better method, it relied on participants verbalizing exactly what they mean. This may not always be the case in an interview situation given the request to talk about things that will have happened sometime in the past. The researcher, however, as someone present during the verbal exchange should be able to write a clear description of what the participant meant in the context of the entire interview. Once themes are established, the derivation of ‘in-vivo’ codes should be helpful

as a check to ensure trustworthiness of the data and analytical process as a whole.

4.3 Wholist interpretations

The alternative to working with significant statements is to work with larger portions of what participants said, treating them as a 'whole'. Such wholistic interpretation of the data was seen by Manen (1990) as important so that the experience of the individual was understood in its entirety. When studying the interview transcripts it was clear that while there were different sentences with slightly different meanings, each time the participants spoke there was a general message about an aspect of the phenomenon or their experience in school more generally. Taking the participants' reply to each question as a whole, a short interpretive comment was added to the transcript and made distinctive by using a different colour and placing in italics. This method was similar to that used by Umpleby (2014) as outlined above. If, as was sometimes the case, several meanings could be identified then further comments could be added. To enable the comments to be gathered together at the end, to develop overall themes, they were coded in their entirety using the InVivo function of the software used.

The next phase of data analysis using this approach moves from the generation of researcher comments as summaries, to the identification of themes or meanings through a process of further reduction. In undertaking this process it was, once again, necessary to adopt a phenomenological state of mind that focuses completely on the comments. These were isolated as much as possible from the researcher's predispositions and biases. Prior to explaining how this was done in detail, it is important to consider how others have categorized meanings when using a more wholistic approach.

Themes, fractions and existentials

The extent to which a particular study tends towards objectivity or subjectivity has an impact of the approach taken to working with the data and the way in which it is reduced to reveal the essence of experience. For example, some authors such as Devenish (2002), building on the work of Van Kaam (1959)

rank the meaning statements according to frequency and intensity and use this measure of importance to create a rank of themes. This form of reduction, however, works with the assumption that those meaning units that appear most frequently are the most important. This reflects a more descriptive and objective view of phenomenon where the researcher has a limited input on the way in which the data is reduced and interpretation is not required. This study adopts a more interpretive approach and such ranking of statements was not felt to be appropriate.

In clustering meaning units in order to develop themes, Hycner (1985) highlights the need to be careful of researcher presuppositions and draws attention to the significance of context. Once reduction has taken place, a process of *imaginative variation* can be undertaken to check that the categories, or themes, that have been developed, are an essential part of the phenomenon being studied. Such an approach is suggested by Van Manen (1990) in order to discover the universal or essential quality of a theme. The process involves the questioning of inclusion of a theme as part of the overall description of the phenomenon. In other words, if the theme is imaginatively changed or removed, does the phenomenon lose its fundamental meaning? How this has affected the study will be discussed later.

Van Manen (1990) warns of the danger of accepting 'theme' as it is understood in literature as an element that repeatedly occurs in the text and something that can be quantified. He suggests that the process of conducting thematic analysis might be better described as a search for meaning and structures of experience. Rather than a mechanical process, he suggests that:

> *... search for meanings through linguistic transformations is a creative and hermeneutic process.*
>
> (Manen, 1990, p. 96).

The use of lifeworld existentials, attributed to the work of Merleau-Ponty (1962) outlined earlier, is suggested by Van Manen (1990) as an alternative guide for reflection and analysis. Such phenomenological lifeworld analysis was also

adopted by Finlay (2009) with particular reference to the work of Ashworth (2003).

Phenomenology being the study of lived experience is therefore the study of what psychologists would call lifeworlds. In writing about hermeneutic phenomenological reflection Manen (1990), drawing on the work of Merleau-Ponty (1962), suggests that there are four existentials that could be useful to help to guide the processes of explication, namely:

> *lived space (spatiality), lived body (corporeality), lived time (temporality) and lived human relation (relationally or communality)*
>
> (Merleau-Ponty, 1962, p. 101).

Although written about reflection, the categorisation of experience into four overlapping areas prompted reflection on their use in the process of data analysis given their generic nature. In a development of the work of Merleau-Ponty (1962), Ashworth (2003) lists seven 'fractions' of the lifeworld:

> *Selfhood – related to social identity;*
> *Sociality – how the situation affects others;*
> *Embodiment – relating the situation to feelings about the body;*
> *Temporality – affecting the sense of time;*
> *Spatiality – the physical environment'*
> *Project – central activities in people's lives;*
> *Discourse – the terms used to describe the situation.*
>
> (Ashworth, 2003, pp. 147-150)

In their work on pedagogical language, Van Manen and Li (2002) use similar terms to describe what they call pathic knowing:

> *(a) Actional knowing: knowledge resides in action; knowledge is action.*
> *(b) Temporal knowing: knowledge resides in our temporal being.*
> *(c) Corporeal knowing: knowledge resides in our corporeal being.*
> *(d) Situational knowing: knowledge resides in the world.*
> *(e) Relational knowing: knowledge resides in relations..*

(Van Manen & Li, 2002, pp. 220-221)

These five ways of looking at pathic knowing suggested a method of data analysis where each interview transcript could be looked at through one of five lenses and statements identified using language appropriate for type of knowing. A similar approach, using the original existentials from Merleau-Ponty (1962) was used by Rich et al. (2013) who analysed interview transcripts using each of his four lifeworld existentials one at a time. Whilst such existentials are a way of looking at every aspect of human life, it can be suggested that what Rich et al. (2013) did was essentially to apply an existing theoretical framework to the data, rather than allowing units of meaning to emerge from the data. In doing so there was surely a danger that some units of meaning would not emerge from the data to create a structure appropriate for the phenomenon. This indicates the questions to be addressed about the next steps of data analysis.

When undertaking an analysis through specific lenses there was likely to be a danger that the essence of the whole would be lost in the process. Consequently, for this study, the use of pre-existing categories was not adopted as it was felt to be important to understand the participants' experience in its entirety as a first step.

4.4 Further explication

So far the data had reduced from full transcriptions to significant statements or researcher comments that reflect the meaning within each of the statements. The next stage involved further reduction of the researcher comments to identify idiographic themes and meanings for each of the interviews undertaken. Once this process had taken place it was possible to explore the idiographic themes over time and across individuals to more fully describe the nature of the phenomenon.

The process of reducing lists of researcher comments to a smaller number of themes or meanings was a difficult one and took time. It was tempting to place similar statements together or to look for word frequency as a means of categorising the data. Neither of these, however, were appropriate for the more

interpretive forms of phenomenology. Such structured categorisation belongs with pure descriptive phenomenology and reflects a more positivist approach to handing the data. The process that was required involved looking at each of the researcher comments one at a time and considering the level of importance given to it by the participant during the interview. After reading all of the comments the next stage was to write down meaningful phrases, in relation to the phenomenon, that came to mind whilst continuing to scan the comments. Once meaningful phrases have been explicated, the comments relating to the phrase were identified. This process assured that each of the meaningful phrases had some link back to the comments and consequently to the significant statements made by the participant at interview. An example of this can be seen in Appendix E.

Critical to undertaking the process of further reduction of the data was adopting what Devenish (2002) refers to as the phenomenological attitude where there is full attention given to reading the comments and reflecting on them. This needed to be done in a quiet space with the mind clear of all distractions so that it was possible to hold researcher comments in the mind and focus on their possible meaning(s) for the participant. During this process it is necessary to keep in mind a number of questions in relation to the phenomenon (subject knowledge), such as:

- What was of significance to the participant?
- What was meaningful'?
- How significant or meaningful?

The overall aim was to explicate, or reveal, the essential meanings of a participants' statements and get to the essence of the phenomenon as experienced by an individual. The process of reflection continued until the phrases that can be identified become meaningless in relation to the phenomenon as a whole. At this point the process of imaginative variation, as explained by Van Manen (1990), was applied to ensure that all of the themes

that have emerged are necessary in order to represent the perspective of the participant expressed in the interview.

4.5 Dealing with the findings

Whilst both significant statement and wholist methods of analysis were valid, it was felt that the use of researcher comments better reflected the experience of the individual within their workplace context. It was also felt that this method made better use of the researcher's understanding of the phenomenon. At times what the participants actually said was not explicit enough but the researcher, from experience, knew what they meant. This reinforced the importance of intersubjectivity when undertaking phenomenological interviewing. This type of data was also more in keeping with interpretive phenomenological research with its emphasis on the individual. Consequently the subsequent phase of analysis used the researcher generated comments for each of the interviews undertaken.

This phenomenological approach adopted was very much towards the interpretation end rather than the descriptive end of what Finlay (2009) as well as Savin-Baden and Major (2013) have called the continuum of phenomenological study. As has been explained above, this was due to a variety of factors not least the personal experience of the researcher. From years of working with pre-service teachers it was my understanding that they appear to have different experiences when on placement in terms of where and what they teach as well as who they teach with. Looking at the researcher interpreted meanings from the data, it is clear that many of the participants discussed similar issues. Following an exploration of individual narratives of subject knowledge development over time, it was decided to look at the data as a whole and to see what general issues emerged. Such 'analysis' is seen by some, such as Giorgi (1997), as fitting more with a descriptive approach. The approach taken here was not, however, one of trying to find a definitive description of subject knowledge as it was experienced for all pre-service teachers. Rather, it was to draw out aspects of the phenomenon that were significant and provide an insight into the common experience of pre-service teachers.

A number of authors have written about highly structured ways of looking at data, such as Devenish (2002). It was however, felt to be important that, initially, no structure or system be imposed in order to allow the significant elements to be revealed. The earlier process of explicating meanings from interview transcripts, and further identification of themes from researcher comments to develop phrases of meaning, was initially done in isolation from any existing conceptual structures or perspectives by others. A number of authors, including Finlay (2009), Moustakas (1994) and Manen (1990) emphasise the importance of such an approach where one becomes immersed in the data. The value of looking at the whole was as a means of identifying common experiences amongst the group of participants in this particular study. When undertaking such a method of explication it was important to be wary of falling into a process of quantifying statements and giving weight to those themes that appeared several times across the transcripts. It was useful, in this regard to adopt the same approach used earlier to weigh up meanings, consider what was of 'significance' and how it resonated with the researcher's understanding of the phenomenon as a whole. Once an aspect was identified it was subjected to the type of imaginative variation described by Manen (1990) to make sure the aspect was a key part of their experience.

Given the success of developing researcher interpreted meanings from the lists of comments for each transcript, it was decided to adopt a similar approach when exploring those researcher meanings for the first time. Meanings were considered across time and participants were considered together. The process was undertaken in a quiet space, free from distractions and the 'noise' of everyday work in order to focus completely on the meanings. In this first look at the data, no organisational system was used and time was spent just reading the statements and reflecting back to what was discussed in interviews. This facilitated recall of not only what was said that generated the statement, but how it was said. This was seen as important in contextualising the abstracted meanings. The process was also helped by the already extensive process of data presentation, through which there was real familiarity with the words used by participants and this helped to begin identifying general themes that

represented the collective experience that they had of developing their subject knowledge.

The term *aspect* was chosen for this section, rather than themes, as it was felt important to explore specific ways of looking at the data without separating it out. Aspect is used here in a similar way to when it is used in architecture in the sense of looking from a specific aspect to reveal something of the whole. In this way the combination of multiple aspects is effective in describing the phenomenon without losing its integrated nature. The aspects that are outlined in the findings are those that have successfully undergone the process of imaginative variation. Whilst it was recognised that many of them overlap and are interrelated, they are dealt with separately in the findings chapter. The associations and overlaps are dealt with in the discussion chapter.

The phenomenological approach adopted was predominately interpretive and there was a danger that, through the different levels of abstraction, the participants' voice would be lost. As a result it would then be the perceived experience of the researcher, remembered from transcripts, which would dominate rather than the voice of participants discussing their experience. In order to deal with this issue of trustworthiness, in the findings of the thesis, it was decided to illustrate many of the key points made with direct quotations from interview transcripts. In this way a level of authenticity could be given to the findings. In returning to the interview transcripts and listening to the original recordings it was also easier to provide a context for each quotation used and provide a greater sense of how the phenomenon was experienced. In identifying quotes, it was also felt necessary to draw upon all participants whilst reporting the sense of the whole phenomenon of subject knowledge development as experienced by them all.

In descriptive phenomenology, as Cilesiz (2011) points out, the structural and textural can be considered as separate elements that together describe the essence of the phenomenon. For this study, however, no separation is made between the structural and textural as they both form part of the same

experience of phenomenon and to separate them, in the initial stages of reporting findings was felt to be inappropriate.

4.6 Summary

This chapter has explored a number of different ways in which the data from the study has been analysed. A considerable time of the study as a whole was devoted to an exploration of the data and it was felt important to provide insights into the work that was undertaken and that eventually resulted in what was felt to be an effective approach for the study. It has provided a critical view on the different approaches that could be undertaken whilst maintaining a phenomenological approach. Whilst the use of computer-aided approaches were considered and evaluated, it was time spent dwelling with the data in audio and paper form that proved the most fruitful and was the way in which the findings were explicated from all of the interviews.

5 Findings

5.1 Introduction

This chapter explores the nature of the data from participants. In doing so it was important to maintain the phenomenological approach adopted and ensure that the voice of participants was clearly communicated. This was done to ensure the integrity and rigour of the study as discussed earlier. The chapter begins with descriptions of some of the individual experiences that participants discussed during the interviews. This was felt to be important in demonstrating the variety of issues that had emerged and to emphasise that the experience of the phenomenon of developing subject knowledge was unique to the individual. Having described some of this personal experience, the chapter then develops aspects of experience that were common to more than one individual. In order to add credibility to these emerging aspects, quotes from individuals were used to illustrate them throughout. For ethical reasons, the real names of participants have not been used. The findings do, however, make use of pseudonyms so that the narratives are easier to read and appear as more personal accounts.

5.2 Individual experiences

As Finlay (2014) points out, it is not enough to identify themes when undertaking phenomenological explication. Such use of themes risks the phenomenon being divided into parts and the whole can be lost. This section will illustrate how the phenomenon was experienced by the individual. In doing so it is possible to illustrate the interrelated nature of the different aspects of the phenomenon such as the ways in which relationships affected both pedagogical approaches and the confidence to work with pupils.

The use of individual narratives was very much for illustration of their experience so the decision about which narratives to include was important. In order to decide what made an individual worthy of attention, consideration was given to the extent to which there were, for the individual, an interesting and rich series of interviews. Rich in the sense of containing a wide range of aspects and rich in the sense of having meaningful examples of the phenomenon that could be used for illustration. Another consideration was the extent to which aspects were mentioned repeatedly over time so that they might illustrate how

the experience changed and in what ways. Overall, however, a good example was felt to be one that helped the reader appreciate the experience that participants had in terms that they can understand. It was hoped that such resonance (Poulos, 2008) would contribute to the quality of the study.

Writing individual narratives is not straightforward. A decision needed to be made whether to just look at the transcripts and the reduced meanings or actually listen to the recording of the interviews. In order to get to the very essence of an individual's experience it was felt necessary to return to the audio recordings themselves to further increase familiarity with the data as Manen (1990) suggests. This involved listening to all of the interviews for a selected individual one after another. In this way it was possible to understand their entire captured experience and so pick out what was of significance for them overall.

In conversation with Clare there were several aspects that kept appearing throughout the interviews undertaken. There were also others that appeared significant at particular times during the course but were less so at other times of the course. Coming to the course with a Product Design degree, Clare seemed well suited to the course in terms of her knowledge and expertise. Quite naturally she chose to take on electronics as her second subject given its closer association with resistant materials and the structure of the course on offer. This division of the material areas into historically gendered pairings still features within some courses on offer today and shapes the experience of individuals. Although having developed some new knowledge of electronics, Clare did not feel confident to teach it. Reflecting back at the end of the course it was clear that she resented the way in which her options for materials had been restricted. In spite of the restriction within the structure of the course she had, on placement, sought out opportunities to teach food as an alternative to electronics. In this sense, placement offered more possibilities than the implied choices that the Minimum Competences and course structures suggested.

During her second placement Clare took the opportunity to teach resistant materials but the level of content was very low meaning that the possibility of

extending her existing knowledge of resistant materials was not realised. Talking opportunities to teach food technology whilst on placement, having not done it as part of the enhancement course at university, meant that a good deal of new knowledge had to be acquired. This was most significant towards the end of the first placement when theoretical content for Year 9 had to be developed. With her mentor off ill at the time, and the only teacher to work with being a textiles teacher, it was down to Clare to develop both plans and resources in a new area of knowledge. Concerned that she was doing a good job, this was a stressful time. It was offset, however, by a positive relationship with the teacher that was also working outside of their specialism.

Related to the discussion of material options above was the way in which different relationships with teachers varied across the placements and even within each of the placements. This aspect featured in the adaptation of Clare to working practices in her first placement. Despite coming to the subject area with what might be considered a very relevant degree in product design, she still experienced problems in matching her skills and knowledge with the content of the school curriculum. Not only did Clare have to 'disembody' her existing knowledge but she also had to adapt her understanding of working practices in order to support pupils as they worked with materials unfamiliar to her. Not only was such adaptation, and accommodation, to a new working environment necessary but there was also the need to undertake work with pupils in a way that met the expectations of the teacher who had particularly strong views of how materials should be processed. Quite capable of teaching appropriate skills and knowledge for work in resistant materials, Clare was on one occasion corrected for using a particular approach and told to demonstrate specific technique again in a way that the teacher desired. Her relationship with that teacher was, on a personal level, congenial but when it came to discussing practice and seeking advice it changed. Thus it was necessary for Clare to seek to identify how the teacher wanted things to be taught. In one case, an attempt to make work easier for pupils by the use of templates and worksheets was 'corrected' and pupils were then expected to work with more difficult traditional equipment. In her second placement Clare seemed to have more opportunity to try new things but when she did so, there was usually disapproval and

questioning about her rationale for making changes given the existing codified practice that ‘worked’. The amount of teaching of resistant materials increased but, due to limited amount of content, and low expectations of pupils, there was little in the way of development of her subject knowledge.

The experience of Clare was clearly one of trying to fit in, working with, and sometimes working against established practice. Her account provides an insight into the long-established practices of two departments of Design and Technology where not only what was taught but how it was taught, became hardened and codified as an effective way of delivering the curriculum and achieving results. Attempts to change practices were tolerated then critiqued in a way that reflects a protective and defensive way of working. Subject knowledge development was clearly shaped by the placement and by the teachers working there. The knowledge that was developed in electronics was never used for teaching and some of the knowledge developed for food technology was developed purely by the individual. The most help that she received was from a non-specialist where the relationship was clearly more symmetrical in nature and resulted in a high level of collaboration.

The narrative of Clare illustrates some of the feelings that pre-service teachers can experience during their time on placement. These feelings ranged widely from fear of teaching specific materials, such as electronics, to the enjoyment of learning new skills and knowledge in food technology. There were feelings of suppressed anger resulting from confrontation with teachers over content and resentment of the way in which her knowledge development was defined by historically gendered divisions within the subject as a whole. Compliance with, and accommodation of, the different views of others featured as Clare sought to survive her time on placement. Throughout there was a sense of constant questioning and occasionally disbelief at the ways in which individuals and departments worked, as they retained established practices that delivered codified content to pupils. Feelings of powerlessness are not something that pre-service teachers are prepared for and for those entering the courses with significant experience and knowledge it can be a frustrating experience.

The first placement in which Molly worked was one in which there was quite limited expertise in food technology, her specialist area. The content, focusing largely on practical aspects of food preparation was in sharp contrast with her own experience and there was a significant learning journey in terms of practical making skills. The work in university prior to placement was clearly significant in supporting the development of such practical skills and also the ways in which theoretical aspects could be taught at the same time. Given the timetabling of teaching spaces there was virtually no opportunity to practice new skills and processes so much of the testing of new processes was undertaken during teaching. As a result of the expertise of Molly compared to other teachers in the department she was able, and to some extent encouraged, to change content and to take ownership of the structure and pedagogical strategies used. However, the limitations of timetabling were not seen as helpful in supporting the ways in which she wanted the content to change with quite limited time for pupils to develop theoretical knowledge.

Whilst quite confident with food, taking on knowledge across different materials was patchy and ultimately affected the ways in which her practice developed. Very much like Clare, the choice made by Molly to take on textiles as a second specialism was as a result of the historically gendered split within the subject. The expectation therefore was that, following subject sessions at university, she would teach textiles on placement. However, her experience with textiles did not develop confidence and Molly took up the opportunity to teach resistant material and electronics rather than textiles. Again we can see how placement offers pre-service teachers the opportunities to work in different materials in a way that was not foreseen by university tutors. In developing knowledge of new materials, Molly recalled her experiences from her own education at school. Critical to the development of new knowledge and the associated pedagogy was the support of teachers. In her first placement time was given by teachers to go through the specific skills and processes needed in order to make the products that pupils were taking on. As a result, Molly was able to teach outside of her specialist material but recognised the limits to her knowledge and her inability to take on additional classes without further support from the teachers. Such an experience suggests that there is a threshold of knowledge below

which support is needed but above which more independent teaching can be undertaken. This is an area to be discussed in the next section.

In contrast to her first placement, her experience in the second school was quite different with very limited development of subject knowledge. This was mainly as a result of the pre-set timetable and set content for the curriculum offered to pupils. One of the features of the experience was the contrast between two teachers and the levels of knowledge that they had about the subject. The relationship with the teacher who had limited knowledge was strained and the feedback received very limited. One comparison that can be made between placements relates to the extent to which the teachers were open to disclosing shortfalls in their knowledge. In the first placement the teacher was aware of their lack of knowledge and so gave Molly the freedom to develop her own ways of working. In the second placement the teacher was protective about their limited knowledge and appeared to avoid discussion that might reveal it.

One of the significant aspects of the development of knowledge for Molly was the way in which subject knowledge for teaching was acquired. Significant amounts of time were spent researching independently, in her first placement, with no real means of validating the knowledge acquired due to the limited expertise in the material area. This level of independent work continued, to some extent, in the second placement but there was a specialist teacher who was able to validate the quality of knowledge that had been acquired. The nature of Design and Technology as a subject is such that the acquisition of new knowledge is ongoing as different materials and processes are adopted by the subject community. The extent to which pre-service teachers can check the quality of the knowledge they acquire relies heavily on there being sufficient expertise in their placement arena. Without a knowledgeable ‘other’ to discuss or mediate subject knowledge with, it is entirely possible that some pre-service teachers may adopt working practices that are inappropriate or incorrect. This will be discussed further in the next section.

For Gordon it was clear, on entering the first placement, that expectations for subject knowledge were high for pupils and for teachers. Lessons contained

high levels of technical vocabulary and were also highly structured to ensure coverage of content and the achievement of good results at the end. Pre-service teachers were clearly expected to maintain the existing culture and deliver content in the way that staff expected. Variation from this was criticized and Gordon experienced frustration at the lack of flexibility in approach and seeming lack of attention to pupils' learning. The culture of the placement was in contrast to his own school experience making it necessary to spend a good deal of time researching areas of knowledge in depth in order to be able to field questions from pupils. At times Gordon planned content to be delivered in a particular way only to be faced with the teacher's expectation of different content and a different form of delivery in the classroom. Gordon felt that there were assumptions made about the level of his existing knowledge and a lack of understanding about the work involved in pre-service teachers gaining new knowledge to suit the expectations of teaching staff.

As the placement continued Gordon took on work with older pupils which raised still further expectations on his knowledge. He also took on the teaching of electronics which was a new area and demanded that his knowledge developed rapidly. With the 'just in time' knowledge he had developed came a lower level of confidence and concern over the ability to answer questions outside his own experience. Towards the end of the placement Gordon felt that he had moved his practice closer to that of teachers in the school with a greater emphasis on theory than he really felt was necessary. Despite this alignment with the codified practice in the department, he felt that there was still a distance between him and the teachers and continued to be treated very much as an outsider.

This experience was in sharp contrast to the second placement where there was less emphasis on following a specific and codified curriculum and more emphasis on maintaining the interest of pupils. Here there was greater interaction with teachers about subject knowledge and associated pedagogy. They were felt to be more approachable and encouraged risk taking and the development of new knowledge with an understanding of the journey undertaken by pre-service teachers working in unfamiliar situations. Despite not having complete in-depth knowledge of graphics and limited real-work

examples from professional practice to draw upon, Gordon still felt confident in teaching and able to handle difficult questions about content knowledge. In this sense, the differences in culture between placements affected not only the knowledge acquired but the degree of autonomy felt by the pre-service teacher. This aspect will be returned to in the discussion chapter.

For Louise, one of the significant aspects of subject knowledge development was the use of language during the demonstration of skills and techniques. She saw the practical demonstration as an opportunity to link the theoretical and practical knowledge together. Having the university-based sessions with a tutor that did link the theory and practical was clearly invaluable in understanding what could be said but also to understand that opportunities exist to engage pupils in dialogue when using active pedagogical approaches. Throughout the course, Louise also developed her knowledge of textiles, moving from a nervous state in the beginning to one of increasing confidence. Reflecting towards the end of the course it was clear that for Louise, she had not only developed confidence with that material but developed confidence in approaching any new material. Learning how to learn the new is an important skill for any pre-service teacher of design and technology and this will be discussed further in the next section.

The aim of providing the narratives above has been to illustrate the ways in which the phenomenon was experienced by individuals and highlight some of the key issues that participants faced whilst on school experience. For those participants not included above there were only couple of specific individual issues that it was felt should be highlighted and these are outlined in brief below.

The first of these was highlighted by the experience of Andrea who observed the ways in which different people have different ways of working with materials to the same end. Textiles was relatively new to Andrea and whilst at university she developed confidence in using basic techniques. However, when starting her placement, she was faced with pupils using different techniques and an expectation that she would teach appliqué in the way in which it was usually

done in school. This caused not insignificant problems for her and was a source of tension between her and the teacher. Working in more open-ended activities with pupils demands a greater mastery of skills and processes as the unexpected arrives. For Andrea learning 'just enough' knowledge was sufficient when undertaking simple closed activities. When pupils were allowed the freedom to do what they wanted, however, she was thoroughly out of her depth and unable to support the activity. This raises questions about links between activities offered to pupils and the extent of teachers' subject knowledge that might be limiting them.

The second issue related to embodied knowledge. When facing new contexts for working and dealing with new materials it is quite natural to draw upon one's existing knowledge. For Richard this recalling of prior knowledge, in order to deal with the seemingly unfamiliar, uncovered the embedded knowledge of his past. During the first interview in particular he expressed genuine surprise at how much he remembered from his own experiences of working with materials. Not only had he developed the skills and knowledge through his education but it had been used in a professional capacity which had clearly added to his tacit knowledge.

5.3 Findings as a 'whole'

Placement experience was diverse but the issues arising were very similar so it was logical to explore the extent to which the same issues were identified across the experiences of participants. From looking at the researchers explicated meanings for the whole, ten distinctive aspects of the phenomenon of subject knowledge development were identified. These can be found in tabular form in Appendix G (Matrix) and are presented one at a time below. They are given in the order in which they were identified and do not represent any hierarchical order of importance. It is also important to mention that the aspects are highly interrelated and in reading these findings it is necessary to remember that they provide an insight into the phenomenon as experienced by a particular set of individuals within the context within which they were placed as part of their course of teacher education. It is also important to keep in mind

that they have been subjected to imaginative variation, as described by Manen (1990), and so are all essential. Without one of these aspects being present, the experience of the phenomenon is incomplete.

With a qualitative study of this nature it was important to keep an open mind during interpretation of the data and consider the *language of number*. Care was needed not to be drawn into numerical approaches where the most commonly occurring aspects is deemed to be the most important. Avoiding this was made harder by the fact that there were a fixed number of participants, most of whom were interviewed on three separate occasions which quite naturally led to representing what they said in a grid form. With the creation of such a matrix, numerical analysis is easily done and might appear obvious. Within phenomenology, frequency counts have been used by some authors in analysing their data. Devenish (2002), for example builds on the work of Van Kaam (1959) used a formula (frequency x intensity = priority) to rank interpretive themes in order of importance. Such an approach, however, runs the risk of missing important issues that might only be mentioned by a single individual but exemplify the phenomenon is a unique and valuable way.

The matrix used in this study, to tabulate the findings, was effective in visualizing patterns and identifying aspects that were more frequently referred. It was also useful in looking for aspects that were unusual and perhaps unique to a specific individual. Despite an approach that rejected frequency counts to validate data, it was possible to indicate how significant aspects were across all of the participants. Consequently, terms such as ‘some’, ‘most’ and ‘all’ are used in the following sections to add emphasis.

One of the most significant findings was the impact that *relationships* with teachers had on participants and the ways in which it affected the development of subject knowledge. This aspect was not only significant in terms of the number of times it appeared across the data, but also in terms of the weight that it carried for their experience overall. Where a positive relationship was

developed with teachers it clearly supported the participants' acquisition of subject knowledge and this had an impact on their development as a whole.

> *I think listening to advice from my mentor was massive for me. He gave me resources to learn from so he gave me, some examples of GCSE textbooks to read through and when I was planning my lessons he gave me the Curriculum, stuff like that and what they were measuring on the criteria and it was just really myself, learning myself*
>
> (Ian 2)

Not only were some mentors responsive to questions, asked by pre-service teachers, but they were proactive in anticipating the needs of the individual. For Clare, the relationship that formed with one teacher involved the collaborative planning of new teaching material.

> *…me and the other teacher had never taught it before so we just sort of bounced ideas of each other but wasn't so much going into … about it, it was more team work.*
>
> (Clare 2)

Such high levels of intersubjectivity, on the side of the teacher, were clearly welcomed by several participants. For others, however, the relationship was more strained. Simply asking questions of the mentor, or seeking advice, was seen as problematic.

> *Not the Resistant Materials teacher, he kind of assumes that I know everything and if I ask he can be quite funny about it.*
>
> (Clare 1)

Here, assumptions of existing knowledge, and the experience of the pre-service teacher, had an effect on the interaction and, as a result, made it

harder for the individual to gain the support needed to develop their subject knowledge. Other examples of where the relationships with teachers were less favourable, included high levels of intervention in the activities being undertaken by participants. Significant levels of micro-management during lessons increased expectations on their subject knowledge and the ability to incorporate it into lessons.

> *... and then she would keep coming in and go 'alright, well you can put this in, you can put that in, you could do that' and I'm just like 'oh, sh**!'.*
>
> (Andrea 2)

Dealing with this, some participants discussed the importance of developing people skills and the need to manage working relationships in order to endure their placement. It appeared that in some placement arenas, pre-service teachers were treated as outsiders or visitors that were tolerated but never welcomed as full-fledged members of the working community.

> *...it was a good placement but I still, even on the last day, didn't feel like I fitted in to that department, erm, which made it quite difficult at times*
>
> (Gordon 2)

In some of the literature on communities of practice it is suggested that the relationship would change with time as the 'outsider' became more included into the work of the community. The ideas of legitimate peripheral participation put forward by Lave and Wenger (1991) would suggest that over time, newcomers become part of the working culture. However, this was not the case for as some, such as Gordon above, felt excluded. For others they experienced quite different cultures in different placements.

> *I think at the first placement I was made to feel like a teacher, erm, and I was given responsibilities and you know, I don't know, just treated more*

> *like a teacher whereas the second placement it was very much 'this is our Department and you are the outsider' and, you know, it was quite difficult with them, I found.*
>
> (Clare 3)

Such feelings of exclusion resulted in some participants taking on the preparation of resources and planning quite independently. Others sought the support of peers in developing their subject knowledge. In one such case this was a mutually supportive activity with specialist knowledge being shared. Whilst constructivist theory suggested by Vygotsky (1930) would indicate that an individual learns more from an experienced other, practice is that there can be higher levels of intersubjectivity between peers than between peer and mentor. This can make the exchange of skills and knowledge easier.

With schools being large organisations, often with good numbers of staff, it was not surprising to find that participants experienced a variety of relationships with staff and that comments were made on the variability of the relationships. Learning to navigate carefully between the demands of different teachers was clearly significant for some. The extent to which teachers adopted symmetrical relationships with participants, and adopted working practices based on mutual respect, was variable. It was clear that for some, there were specific practices, adopted by school departments, in relation to pre-service teachers with roles and expectations that those entering the workplace arena were expected to adopt. For others, they felt treated as colleagues, supported in the work being undertaken and were welcomed into subject departments.

Becoming a teacher within secondary schools can be demanding for anyone with a good deal of pre-existing subject knowledge and can place *emotional* demands in individuals. For those pre-service teachers who are acquiring new subject knowledge in order to teach pupils in unfamiliar environments, with unfamiliar equipment and resources, the demands can be quite significant. It was clear from the data gathered that for some of the participants their experiences on placement had been emotional at times. Whilst only mentioned

by a minority of participants, emotional reactions were clearly significant and needed to be included in order to illustrate how the phenomenon can affect the individual. The emotional responses had clearly affected their subject knowledge development as well as playing a part in shaping their school experience as a whole.

> *... then when she turned round to me last week and said 'can you do Fair Trade?' I kind of went 'yeah sure' and my whole stomach went eeuurrrgh and I was just like 'oh my god, okay, it's going to be fine, going to be fine'*
>
> (Andrea 1).

Here were feelings of anxiety when asked to take on new areas of the subject. In the case of Andrea, her concern was not expressed verbally to the teacher. Rather, there appears to have been an acceptance that the role of the pre-service teacher necessarily involved doing what the teacher asks and it is not their place to question decisions or say no. Others, such as Bev, expressed other emotional responses.

> *Absolutely terrifying. It has been the scariest bit of the whole thing, baking. Baking is my arch nemesis.*
>
> (Bev 1)

Despite having previous experiences observing teachers' practice before commencing courses of teacher education, there is often surprise at how the job of teaching actually feels and the emotional investment that is necessary to work with pupils in school environments. Another participant (Richard) talked of feeling exposed in a new situation, using tools and materials, with which they were unfamiliar. As a teacher of a practical subject it is necessary to demonstrate how to use tools and equipment in front of pupils. Any insecurity about what to do with the resources and uncertainty when faced with difficulties can be a significant problem for those beginning to teach and may undermine their role. Adding to the feelings of anxiety was also the awareness of being

assessed on their subject knowledge and skills, by experienced practitioners, against a specific set of subject-related standards. This anxiety to please was highlighted through interviews and, in the case of Clare, resulted in a participant relinquishing their approach to working in favour of one adopted by the teacher.

Not all emotional reactions were negative, however, with one participant (Ian) expressing genuine excitement after taking on a new material to work with.

> *I think the main thing for me though, it is interesting what you said there, is enjoyment. I mean I thought I'd hate teaching Food but … I knew a lot more than I did and I really enjoyed it in the end, I really, really enjoyed. I enjoyed it, especially the practical side, I loved that.*
>
> (Ian 2).

Given the mismatch between the experience of those entering the subject domain of design and technology and the demands of the prescribed curriculum it is necessary for pre-service teachers to work with materials and processes that are new to them. The comparison that individuals make between practice in school and their own experience is covered in the next section.

Pre-service teachers choosing to undertake a postgraduate course of study in teacher education generally begin with at least some relevant subject knowledge and it is not surprising that some *comparisons* were made between their own personal experience of the subject and what they found whilst on placement.

> *I know Electronics because in school I did some Electronics, like in Technology back home you did Product Design and Electronics was altogether so it was as one.*

(Molly 1).

A number of participants talked about drawing on their own skills from the time when they were at school and university and how previously buried knowledge re-emerged. For Richard this was something that continued through the course and was the subject of conversation during interviews.

> *I was able to come up with more examples than what I originally thought. It is just buried and then it comes back.*
>
> (Richard 1)

> *it was quite similar to the kind of stuff we do with wood joints and that kind of thing and I felt like with it being a few years since I've done all this, but you know, it just comes back*
>
> (Richard 2).

Several talked about trying to essentially re-create the experience they had when in school, in terms of content and pedagogy. Their feeling was that the way in which they had develop their skills and knowledge was very good and the right way of doing things. For many pre-service teachers, their desire to become a teacher is often as a result of experiences at school and their admiration for an inspiring teacher. The desire to reproduce the positive experiences they had is therefore not too surprising.

Comparisons were also made between the subject knowledge developed through university session and that found at school. The extent to which this linking was useful was variable, with some expressing very positive synchronicity between university sessions and teaching on placement

> *that is my secondary subject so Justine has actually been really good and I remember saying this to her, I have learnt so much and for some reason the way she has planned all of our little practicals has worked within the school so she has taught us a roux sauce and then for some reason in our school*

> *we did it that week and honest to god, it has been invaluable cos it is not my subject and then I have had to do it so I have learnt practically*
>
> (Zara 1).

For others it was a source of internal conflict as mixed messages were compared. With practical activity there are often different ways of doing things and in professional practice this takes form in the different ways in which products are made. In school arenas there is often the establishment of a specific way of forming and joining materials so there is continuity across teaching groups and also to ensure progression across year groups. For those entering arenas of practice it can be necessary to have to adopt a quite different approach to working. Such adaptation is explored in more depth in the next section.

As the course developed, comparisons between pedagogical approaches to teaching subject knowledge, were also made. Such comparisons were multi-layered with variations in content mixing with the variable relationships with teachers.

> *…that kind of theory ramped up a few levels in teaching FE and then it has just, erm, okay, it is down to basics but I think it has developed me as a teacher a lot more because in the context of Key Stage 3 okay you are breaking it down, you are explaining it in more steps*
>
> (Richard 3).

Adjusting to the role of the teacher was one of the forms of *adaptation* that most of the participants experienced on entering their placement settings.

> *I think being in the school environment, I think you just are thrown into it so you have to adapt, you have to learn and you have to develop.*
>
> (Ian 1).

Interestingly, adaptation was a feature of the conversations that took place at the beginning of the course but was not mentioned at all in relation to moving to their second placement. Sometimes this was a case of finding ways of fitting in to the departmental culture getting used to resources and routines. At other times this was a case of managing confidence over time in order to move from observer to teacher within a relatively short period. When under pressure to demonstrate subject knowledge in unfamiliar situations, it is quite natural to draw on personal experience as there are no other frames of reference. As part of the process of adapting to new situations, the establishment of identity as a teacher of the subject was significant. For Molly it was important to have significantly more subject knowledge than the pupils.

> *the only thing is if lots of people ask me a lot of questions like 'Miss, what do I use to cut this?' and me being like 'aaargghh' and I have had to prepare myself to know exactly what to tell them but like, with some of the things … with some of the finishing techniques I wasn't too sure about cos it was, I don't even know what they are called … I didn't want to make a fool out of myself, you know, for the pupils to think 'oh, we know more than her'*
>
> (Molly 1).

Perhaps of more significance was the adaptation required to work with people where there was difficulty with the relationships that participants had developed. Non-verbalised disagreement with teachers on the content, planning and pedagogical approaches to be used, created tension. Acceptance of the role of pre-service teacher within a placement environment, and a desire to not 'rock the boat' or draw attention to areas of disagreement, meant that adaptation to the circumstances was necessary. For Zara the adaptation that was required came as a result of staff absences.

> *… it was a case of just getting on with it cos the Department was so stretched with the Food teacher and the Textiles teacher being off and they*

were obviously my point of contact, both of them, so with both of them not being there it was a case of I just got on with it with the cover teacher and we just managed it ourselves."

(Zara 2)

Not surprisingly, there were limitations to the extent to which adaptation was possible. Limitations of subject knowledge constrained the extent to which pre-service teachers were able to adapt to working outside of their comfort zone. At times differences in the level of subject knowledge or pedagogical approach of the teacher had an effect on how they were perceived and the interaction with them. For Molly, observation of a teacher just confirmed the limited knowledge of a non-specialist.

... just watching her lessons didn't help me make like my lessons better because her subject knowledge was so poor and the way she taught the pupils was awful that in watching her I was like 'right, I do not want to do that!

(Molly 3).

Such an example highlights the difficulties within the subject that takes place when non-specialists take on teaching. As can be seen from the findings, this process actually starts during courses of training and is something that will be explored further in the discussion chapter.

Another significant aspect from the findings was the *placement arena effect* on the development of subject knowledge. This was identified by most of the participants at some point during their time in schools. The nature of the specific teaching environment created constraints on what could be taught and consequently what was learned in terms of subject knowledge by both teacher and pupils. The availability of practical resources, for example, instantly framed what outcomes could be produced and to some extent, how they were made. This was further compounded by limitations of staffing expertise across specific

material areas where participants sought to further develop their expertise. In one case, the pre-service teacher was working in a placement where it was recognised that they were themselves the most knowledgeable person in their specialism. The way in which the curriculum was interpreted, by departments and individuals, also acted as a constraint on what could be taught. Given the loosely defined curriculum of Design and Technology it is up to department teams and individuals how they interpret the programme of study and set expectations for pupils. This will be discussed later.

Further limitations in the subject knowledge development of pre-service teachers occurred as a result of timetabling issues and the year groups taught as a result. Early in the academic year the course was structured with four days per week in school and one at university. Classes taking the subject on the pre-service teacher's university day could not be taught by them and in some cases these were pupils in higher year groups. This had an impact of the depth of knowledge that was necessary for the pre-service teacher to acquire in order to teach effectively in the classroom. When asked about opportunities to develop subject knowledge beyond what they were teaching, all participants that mentioned it talked about limitations. Even within the detailed content, with which they were working, there were clearly constraints and, at times, this raised some questions for participants such as Dawn.

> *It's not even that, she actually does do bread and carbohydrates but literally you are only learning about that, if you do that one thing that one year so you know about carbs and you know what carbs do and what they are for and everything but you don't know any of the others, so you don't know what fat does … So I think that is just where I have an issue but obviously it again depends on the school that you are in cos if you don't have the standard of learning in the class that can pick up on that then you won't be able to teach them it*
>
> (Dawn 1)

The above factors illustrate how placement arenas can affect what is made by pupils and consequently what is learned by pre-service teachers. In addition there were also embedded cultures of pedagogy, established over long periods of time, which provided further limitations of complexity and depth. These inevitably shaped the placement experience and the consequent development of subject knowledge. One participant (Zara) reported that even when the teacher was absent, there was an expectation that the established scheme of work be taught in line with the established practice.

> *I think if the teacher was there, the Textiles teacher was there, I would have been way more creative with what I was wanting to include but because I was very conscious that she was e-mailing constantly and we constantly had this 'are you on task, are you on lesson 12, are you on lesson 13 this week?*
>
> (Zara 2).

Reasons for this level of monitoring were not made explicit but fitting the scheme of work into the available curriculum time would seem to have been a factor. This need to keep a good pace in lessons led to significant expectations that the pre-service teacher would be developing their subject knowledge ahead of teaching.

> *… then obviously I went away and had a, you know, with the amount of time that I had which wasn't an awful lot, I went away and tried to practice 2D design which obviously 2D design is vast and, erm, oh god, yeah, I just didn't know enough*
>
> (Andrea 2).

Inevitably, for some pre-service teachers, there was disagreement with approaches taken by the department and teachers with which they were working.

> *I actually found the lower ability class to be more challenging because I have got a great passion for literacy and that is something that I like to include in the classes but, erm, with the low ability group it was like all of that theory, you know, wasn't appropriate. They weren't expected to do it, they weren't expected to do homework, erm, and I found that more challenging actually lowering my expectations*
>
> (Bev 2).

Overall, the arena can clearly have a major impact on the subject knowledge development of pre-service teachers.

In relation to specific subject content, there were a number of participants for whom the relationship between *theoretical and practical* aspects of subject knowledge was of significance for their personal development. In some cases this related to their previous experience when at school or university, where they had been exposed to high levels of theoretical content, and were now faced with the prospect of delivering more practical approaches to the acquisition of subject knowledge. Learning the different ways in which practical skills and knowledge could be taught became the focus for personal development. Combining theory with practice was, for some, expected in both their planning and their teaching.

> *It wasn't all 'this was a practical task so we will talk about skills'. Maybe that was just in that school in particular but they were very much 'always try and add it in, question them throughout and you know, make sure they know about the skills plus the nutritional'*
>
> (Allison 3).

Some comments were related to the arenas within which participants worked as they perceived significant bias related to the weighting between practical and theoretical aspects of the subject. This again shaped the nature of knowledge developed through activities with pupils. Some participants expressed strong

feelings about the balance between theory and practice, often making clear links with their earlier experiences at school and university. At times they sought to embed this in their own practice. Related to this, participants also identified differences between placement arenas. This highlights the ways in which teachers interpret the prescribed curriculum and shape the curriculum experienced by pupils in schools.

> *... what I would always try to do is find a balance of practical and theory so that I sort of felt that they were going away knowing something other than the practical element of what they were actually cooking cos I sort of felt ... that that was really important*
>
> (Allison 1)

The aspect of confidence emerged in several different ways as a finding from the experience of participants. A number mentioned a lack of confidence with subject knowledge in the early stages of placement. For Louise, the lack of confidence related to her recently learned new knowledge. Such was the effect on her confidence that it led to a state of helplessness where she was unable to continue to teach.

> *we did Bread, bread rolls and I have made bread loads of times but when it came to the shaping of it, I think because I knew my mentor was so experienced and she spoke about it with such, like you could tell, it was just something that came so naturally to her, when it came to dem'ing the shape of bread rolls, I just completely, that one afternoon, just completely like lost it and I couldn't remember anything. She had to come and take over and I was so embarrassed*
>
> (Louise 2).

With growing experience through the course, the significance of confidence was something that changed to the point at which it was not discussed at all in

relation to subject knowledge. Exploring this issue in further depth, it was clear that the problems of confidence were related to the materials that were being used. This links to the next section of findings about working with 'new' materials. Given the variable backgrounds of those embarking on courses of teacher education, it is not surprising that some were asked to work with less familiar or even new materials.

Linking to the aspect of relationships was the extent to which teachers in school supported pre-service teachers and helped them to gain in confidence.

> *... I would never have been able to do that in the first week but that had just been built up through researching myself and my mentor giving me confidence, saying 'look, you can do this, you know what you are doing, your lessons are really good, you just need to be a bit more confident' and it just developed that way*
>
> (Ian 2).

It was also the case that, as a result of teachers' interventions, confidence was lost. Intentionally or not, for Clare the behaviour of the teacher undermined their teaching.

One of the features of the placement experience for most of the pre-service teachers was *working with the new* as they needed to learn new skills and knowledge outside of their previous experience. Even for the experienced craftsperson there are always new challenges when entering new workplace arenas as Clare found out.

> *So, working with different woods is just a bit, I have worked with MDF a lot and [unclear] on my degree which transfers and then you go to the typically cheaper woods and they don't so like your plywood, that is not something that I have worked with from my degree so I am having to learn which bits you can and can't do.*

(Clare 1)

This was not only within their specialist area but involved working with material areas outside their previous experience. There seemed to be an acceptance from participants that this was not negotiable, rather like being given a job to do.

> *… it is Child Development, it is a GCSE so, erm, I went in anyway and I was like 'I can't believe this is on my timetable, what am I going to do?' and I really didn't know what to do at all*

(Allison 3).

This perception of school as a workplace is reinforced by expectations of professionalism such as punctuality, dress and behavior. The consequences of such compliance, however, can be feelings of hopelessness. A more pragmatic attitude towards taking on new knowledge was expressed by Molly who recognised the limitations of her own experience and the limited extent to her knowledge.

> *Yeah I felt fine. I felt good doing a different subject. I was confident yeah, it was grand but I wouldn't want to go too in depth like into what all the symbols of the battery stand for and the resistor and that, I probably wouldn't have a clue about that.*

(Molly 2)

This raises interesting questions about how much knowledge is enough to teach a subject. This will be discussed further in the next section. The acquisition of new subject knowledge, seeking support from peers and teachers, and the challenges of developing appropriate pedagogical strategies were all significant.

The development of practical and pedagogical knowledge through *activity* of different kinds was also a significant aspect of the phenomenon. One of the ways in which participants developed their subject knowledge was through

observation and working with pupils during lessons taught by other teachers. This is exemplified in the words of Andrea who took the opportunity to further her knowledge throughout the course seeking opportunities for observation prior to teaching with new materials.

> *... she had a great booklet that had all the embroidery stitching in so I would look at the pictures and sometimes I didn't know how to do it and the kids would go 'oh I want to do that' and I would go 'right, okay let's sit down and figure it out' and then sometimes the kids would go 'oh it's like that miss' and I'd be 'ok okay, brilliant' so sometimes you would do it with the older kids*
>
> (Andrea 3)

The value of such hands-on activity alongside pupils, using the tools and materials which they have to use, cannot be underestimated. The consequences of undertaking this kind of work, for Andrea, was clearly considerable and built confidence and an awareness of potential misconceptions and pitfalls that pupils might fall into.

> *It was when I was observing ... it was a practical so I got up and I helped and what I said to my mentor was that maybe perhaps I could make one myself so that then, you know, I am taking away something that I have done and that I feel at the end I have been able to do as opposed to just assisting in parts of it. So, I went away and I done it myself and then I was showing that to the pupils and working alongside them really. I was like a pupil at that stage and then, from then, after Christmas, having to do it again, I felt then that because I had already made it and helped assist with pupils, I was just so confident in the delivery and I knew, you know, all the knowledge behind what I was saying and, you know, why they were carrying out certain steps at certain times and why they were using these machines and*

> *that was something I feel developed because of actually making it myself and helping them, assisting them with it as well.*

(Allison 2)

Here is not only a journey of learning skills and knowledge but also a journey of discovery. Discovery of the real value of making in order to embody processes and practice to develop genuinely useful tacit knowledge. Even without the involvement of pupils in the process there were clearly benefits to be involved in making resources for several participants.

Not surprisingly, perhaps, issues of *pedagogy and planning* were widespread amongst the findings. All participants mentioned pedagogy in at least one of their interviews and, across the whole set of data, this aspect emerged as one of the strongest – appearing in the majority of transcripts. For Andrea, the identification of knowledge for teaching was fairly straightforward.

> *... as far as I can see, it is all one knowledge, it is just you can break it down ... I will know what I will mean but obviously with, you have got to break it down for the kids to explain to them exactly what methodology you need to use and why*

(Andrea 1)

This breaking of existing knowledge into digestible chunks for pupils was mentioned by other participants across all stages of the course. Some participants, however, experienced difficulty in deconstructing their existing embodied knowledge into a form that was understandable by pupils in a school environment. Embodied knowledge and taken for granted working practices used by professionals needed to be re-thought in order to be put into a digestible form for pupils. This will be discussed further in the next chapter.

Often tools and equipment were different between university and placement arena with the higher levels of specific subject knowledge, developed at

university, often hindering planning. The creation of learning resources and activities for even the brightest of pupils demanded thought and consideration about how they could be used within the defined curriculum. Taking on the resources of others was also problematic and Bev experienced difficulty in discussing them with her mentor.

> *It didn't make any reference to where she had found the information. No, I don't think I did ask for that, *** has got a very full timetable, you know, she has perhaps got two free lessons a week, one of which she had already given to me as my weekly meeting thing and you know, there were often other things to discuss in that so I felt that I didn't want to kind of, you know, be too demanding*
>
> (Bev 2).

Further challenges for the participants were the selection of subject content and the development of appropriate pedagogy to match the needs of pupils.

> *I find that aspect quite challenging, not in terms of the knowledge of the subject itself but in terms of putting it into a context where they can understand it*
>
> (Richard 2).

Another aspect was the extent to which teachers sought to manage the planning of pre-service teachers and expected specific pedagogical strategies to be used during their teaching. At times participants were supported by teachers and in one case included in staff development on pedagogical approaches.

> *... he is actually training his staff on some of the RM stuff so he said 'well come along and see how everything is done, even if you are not teaching it,*

> *it will be useful for you to pick up that knowledge' and I said I would be more than happy to do that cos the more knowledge the better*
>
> (Zara 1).

At other times, however, the level of micro-management experienced was problematic. Another pedagogical aspect related to teacher and pupil conversation in the workspace. Talk and action were integrated together with technical vocabulary being associated directly with tools and processes.

> *I learn best that way from seeing it and then I will remember 'oh she did that and she did this' but also because I don't only see her, I can watch how the kids are interacting with what she is telling them cos I have obviously observed quite a few lessons now so for me I think I know what kind of techniques will work with what kind of learners they are*
>
> (Zara 1).

This link with tool mediated activity and the work of Vygotsky (1930) will be discussed in more depth in the next chapter.

5.4 Considering temporal aspects

When considering the nature of the phenomenon over time it was felt necessary to consider the general characteristics of the participants' experience as captured through the interviews. This provided a perspective on the general nature of the phenomenon after each of the three large blocks of school experience that structured the PGCE course. Considering the interviews that took place at one period of time (December, March and June) was considered but discounted as the initial focus of the study was on what happened to individuals. One of the aims of the research study was to explore the ways in which the subject knowledge of pre-service teachers developed through a course of study. It was anticipated that there would be *changes over time* and the research was designed in a way that captured the lived experience of the phenomenon at key moments. The findings have been explored as a whole and

through individual narratives. This section explores how aspects changed in significance over time.

Whilst in no way looking to use distribution and frequency to explore the findings, there are some distinct patterns in the data that can be seen. Identifying these was helped by colour coding each statement in the matrix (Appendix G) according to the aspect with which it belonged. Straight away it is clear to see that there was a reduction in the overall number of statements over time. In addition, there was a reduction in the variety of statements made as time progressed. It was clear that some of the issues that emerged at the beginning were not visible at the end. One of the possible reasons for this could be that interviews were revisiting the phenomenon and so aspects previously discussed were seen as 'covered' so not of significance to revisit.

Looking at the findings as they appear graphically, and also reflecting on the overall sense of the experiences that participants had, it is clear that the development of subject knowledge has multiple aspects in the early stages of the course. Entering a placement arena for the first time, establishing relationships and becoming familiar with routines and resources makes big demands on those taking on the role of a pre-service teacher. All aspects that were identified through the data as a whole feature in the first series of interviews.

Looking across the researcher derived meanings, and reflecting on the interviews as a whole, there was only one aspect that continued to remain of high *significance* over time. This was the aspect of relationships with teachers which, for some changed in nature over time, but which continued to dominate the dialogue of interviews at all stages. Whilst the aspect of comparisons appeared throughout, there were clear differences between the comparisons made at the beginning of the course and those made at the end of the course. During the early parts of the course the comparisons made tended to fall into two categories. Firstly comparisons were made between their personal experience of individuals during their time at university and school. Secondly comparisons were made between their experiences of developing subject

knowledge and that during the experience when on placement in school. During the latter part of the course the comparisons made tended to relate to the differences between placement arenas

From the number of participants that discussed pedagogical issues it was clear that this aspect was of great significance in the first and second phase of the course. In the final set of interviews there was very little mention of pedagogy. Similarly, emotional reactions as part of the experience of subject knowledge development featured significantly in the first and second interview but had disappeared completely by the time of the third interview. The need to adapt to working practices in the workplace, and to the changing relationships with teachers, was also a significant feature of the participants' experience in the first and second interviews. However, there was no mention of this aspect in any of the final interviews. Given the explanation of difficult relationships continuing into the second placement it was surprising that adaptation was not discussed. This could be as a result of developing the ability to adjust to new situations early on and then being able to adapt quite naturally when a new placement was taken on.

Taking on the new, in terms of specialist materials to teach, featured throughout but was noticeably more significant in the second set of interviews. At this point participants had settled into teaching their specialism and were taking on work with different materials. Developing knowledge in areas outside of their experience was significant in terms of the demands it made on their time and the development of an ability to acquire new skills and knowledge in a short space of time. For some this was a positive change in order to expand their repertoire of skills but for others it was a difficult process with limited support and expertise to draw upon.

5.5 Overall interpretation

Having explored general aspects of subject knowledge development derived from data explication, along with some examples of the narratives of individuals, it is now possible to provide an overall interpretation of the phenomenon as experienced by pre-service teachers on a course of initial teacher education.

Given the methodological approach used throughout, this overall interpretation is derived from considering all of the findings described above. This involved time spent reading through the findings and trying to identify the essence of the phenomenon.

Developing subject knowledge is a multi-layered experience. At a fundamental level is the acquisition of facts and information about materials and equipment. This propositional knowledge can be acquired directly from interacting with others but also is available through a variety of media including books and, increasingly, through the internet. In addition to the acquisition of propositional knowledge is the development of process skills related to the materials being used. These are often context dependent and strongly affected by the level of interaction with others whilst on placement. The replication of 'ways of working' that occurs when a pre-service teacher learns from an experienced teacher can vary from a model of apprenticeship to one of collaboration. In acquiring new propositional and procedural knowledge, existing conceptual structures held by the individual, and related to the domain, may be re-shaped. Another layer of development is related to what might be called the *skills of knowing* which can be measured by the ability to assemble knowledge for a specific purpose in a defined context at a particular moment in time. Getting better at being able to research for propositional and procedural knowledge, as well as selecting the embodied and the tacit, is a sign of development of the individual and enables them to work with increasingly unfamiliar materials and processes. A final layer of the experience relates to the ways in which an individual adapts to their working environment and is able to manage their time on placement through careful handling of relationships and working practices. Overall the development of subject knowledge, whilst on placement, is an experience that affects the whole person with activities having an impact on what Bloom (1956) refers to as the cognitive, psychomotor and affective domains of knowledge.

5.6 Summary

This chapter has provided some insights into the experience that pre-service teachers have had when developing their subject knowledge whilst on placement in schools. In keeping with a more interpretive phenomenological

approach it started with some longer sections relating the experience of individuals in a narrative style. This was then followed by insights into areas of common experience across participants. Whilst not necessarily in keeping with the historical tradition of interpretive phenomenology, this way of looking at the data provided useful information for academics involved in teacher education looking to improve the experience of those on courses involving periods of placement in school arenas. The chapter also looked at the experiences of participants over time and identified aspects of experience that remained the same and those that changed. This made it possible to see that, as placement experience progressed, the issues that pre-service teachers dealt with changed. It may also be a reflection on the changing relationship that the researcher had with participants where there was a degree of assumed knowledge about their prior experience. The chapter ended with a summary of the phenomenon as a whole.

6 Discussion

6.1 Introduction

This section deals with issues that have arisen from the findings that raise questions for the practice of teacher education in relation to pre-service teachers of design and technology. In doing so, it links the findings as described above with the issues explored in the literature review. The first two sections deal with knowledge and placement separately to provide some clarity of the issues before being combined in the third section. The last section of the discussion relates to methodological issues arising from the study.

6.2 Knowledge

Experiencing knowledge development is an active and *complex* process that simultaneously involves all forms of knowledge from the provisional and procedural to the tacit and embodied. The findings suggest that active engagement with materials and processes to be used is a necessary part of developing knowledge for teaching. They also illustrate that subject knowledge is bound up in the relationship with individuals and the context within which it is developed as the constraints of equipment immediately have an effect on the type of knowledge that can be developed. The study has shown that, in some cases, teachers make quite specific decisions about how the pre-service teacher should be using materials and equipment. Where the relationship between mentor and pre-service teacher is more strained, there was a greater focus on the individual developing their knowledge independently as the narrative of Molly illustrates. Despite having worked with materials in the past, the findings show that participants experienced differences between knowledge from their own experience and the knowledge required for teaching. Such differences did result in difficulties for a number of participants.

Ellis (2007a) developed a model of subject knowledge that illustrates individual knowing and collective knowledge as separate but related to each other. However, findings from this study suggest that such separation is not possible and that the development of the individual's knowledge is completely interrelated to the arena and settings in which activities take place. This was clearly illustrated, on a practical basis, by the experience of Gordon where the

teaching of electronics with specific equipment was required. The model of Banks et al. (1999) also shows a difference between school knowledge and subject knowledge with a degree of overlap in relation to their concept of subject construct. Given the active nature of subject knowledge development indicated through the findings, a model of personal subject constructing might be more appropriate.

For Design and Technology, a subject that did not exist before 1990 and one related to developments in manufacturing industry, new knowledge of materials and processes is constantly being made available. This also suggests that knowledge for the subject is, potentially, in a constant state of renewal (Martin & Owen-Jackson, 2013) and can only be represented by a dynamic model. One of the challenges emerging from this discussion of subject knowledge as a complex and dynamic phenomenon is the selection of terminology to describe it. When discussing pedagogical content knowledge Cochran et al. (1993) modify the terminology to pedagogical content knowing. In describing subject knowledge better, one option would be to adopt the term subject knowing. The ability to assemble knowledge appropriate for a particular context and moment in time is a skill and in this sense it is appropriate to consider subject knowing as a skill. What is of value here is the ability to research and structure propositional, procedural, strategic and tacit knowledge in a way that can be learned.

6.3 Placement

Throughout the findings there are clear indications that the *placement* arenas, and the interactions with individuals inside them, have been significant in shaping the subject knowledge of pre-service teachers. One of the emerging issues from the findings is in the ways that the curriculum seems to have been interpreted in schools by departments and by individuals. This may become the hardened project/activity history that is very much value laden in the way in which Gudmundsdottir (1990) suggests.

So far the discussion on placement arenas and settings has focused on the community and relationships. It is also worth considering theories surround an

individual's acquisition of knowledge and how pre-service teachers *adapt* to the workplace. For Piaget (1970) there are internal processes by which the individual adjusts their personal constructs through processes of adjustment, adaptation and appropriation. From the findings there are certainly cases where participants have adjusted their existing practice to fit in with the established practice within the department. There are also other cases where the practice of teachers has been appropriated and embodied by the individual. Of more interest are those cases where individuals have not agreed with the existing practice in a department or by an individual teacher. There is, as a result, a degree of both cognitive and affective conflict that occur. Resolution of this may be achieved through dialogue and compromise with the teacher. Where resolution of the conflict is not possible it is then up to the pre-service teacher to accommodate and work with the practice in the placement. In this case the pre-service teacher may not add any new knowledge to their existing repertoire but would rather develop their interpersonal skills and their ability to teach something that they do not necessarily agree with. Such was the case with Clare.

From considering the above discussion, it is clear that none of the constructivist theories explored earlier are useful in themselves of explaining the phenomenon that is experienced by pre-service teachers as they work in placement arenas. Rather, a combination of all of the theories is required with the individual, interpersonal and collective development of knowledge working together. Knowledge held by the individual is thus used in combination with that of others they are working with to co-create the knowledge used in practice. This then forms part of the collective knowledge within a community that is to say that, over time, it becomes codified and part of the culture of a community of practice. With such a model, any new forms of practice that a pre-service teacher wishes to introduce will need to be considered by teachers they are working with and then go through a process of validation and codification in order to become accepted practice with the community. For those looking to teach and develop their own practice, some understanding of this process will be important before they enter placement arenas and work with those who have formed the established practice.

The findings suggest that a combination of individual and social views of constructivism is required. This raises questions of whether the theories can be combined to create a useful theory of knowledge development whilst on placement. Some authors, such as Hutchins (1995) have used the metaphor of navigation to describe the process of entering new arenas of practice. Whilst this does appear appropriate for individuals looking to survive their time on placement, and avoid unnecessary conflict, it does not really take account of the necessary interactions with teachers that must occur. It is often the case that pre-service teachers are required to teach things out of their control and have to work with individuals that they do not necessarily get on with. Consequently, whilst one can consider 'navigating' through placement, there will be times when the path taken is dictated by others. The ways in which this could be handled can perhaps provide some indication of what is required of pre-service teachers on placement and help to prepare those looking to enter the profession.

In attempting to clarify the nature of what went on, some consideration of different theories surrounding *communities of practice* is required. On entering the placement communities, different participants experienced different reactions. For some, the department in which they were placed was welcoming and participants discussed how they had benefited from the support of teachers and gradually became part of the department. These experiences fit well with the community of practice theory of Lave and Wenger (1991) where newcomers move from legitimate peripheral to full participation. However, for other participants there was no such welcoming into the community and throughout their experience they felt an outsider whilst still working with teachers in the department. This suggests that the theory of communities of practice is an inappropriate theory to understand the experiences of individuals. It is also the case that the pre-service teachers are in their placement for just a short period of time and are not actually joining the school community on a permanent basis. If, however, we look at the experiences of individuals throughout the course and see them as a gradual way of entering the practice of teachers as a whole, then their work is of value. So on a macro level, one can consider pre-service

teachers as entering the community of teachers but on a micro level, placement by placement, another way of explaining what takes place seems to be required.

One of the theoretical concepts mentioned in the literature review was *activity theory*. It is suggested by the cultural-historical perspective of Vygotsky (1930) that knowledge, in this case for the purposes of teaching, is co-constructed through dialogues with teachers. This dialogue is mediated by tools, such as lesson plans, and the result is put into practice by the pre-service teacher. Certainly for those beginning to teach, there is dialogue about what will be taught but the degree to which the knowledge is really co-constructed is debatable. Again for some of the participants there is a positive relationship and, certainly in one case, genuine sharing of the planning. For others, however, there is an asymmetrical relationship between the teacher and the pre-service teacher which affects the resulting action undertaken in the classroom. The authority, or power, exerted by the teacher in their position of responsibility for pupils' learning is in contrast to the naivety and hesitancy of the pre-service teacher as they enter the domain of a school department. So whilst there will likely be co-constructed knowledge used by pre-service teachers in teaching pupils, the degree to which this knowledge is embodied by the pre-service teacher needs to be brought into question. The focus is, however, on the individual and it is not the aim of the study to explain the workings of school arenas as a whole.

6.3.1 Arena constraints

From the findings, it is clear that *arena constraints* have an impact on the subject knowledge that can be acquired by pre-service teachers. The degree of flexibility about, for example, the availability of resources, reflects the degree of openness to new ideas and change within placements arenas. Such constraints, acting on the work of individuals, lead to consideration on the use of activity theory to understand what happens to pre-service teachers as they work within established systems. In a similar way to the earlier consideration of communities of practice, the findings do not quite fit with the theory and provide

only part of the answer in understanding what happens to individuals. Placing pre-service teachers in appropriate school arenas would therefore appear to be of critical importance.

6.3.2 Teacher relationships

It is clear from the findings that *teacher relationships* established in school is of critical significance in shaping the knowledge that can be acquired and the degree to which pre-service teachers' existing knowledge can be both valued and built upon. When mentoring is good for pre-service teachers there is a high degree of intersubjectivity and responsiveness to the needs of the individual.

The experience of individuals was largely shaped by what might be called the *interpreted curriculum* and the access that pre-service teachers are given to it. The interpretation of the curriculum is that of the individual teacher within an arena of practice. Whilst there may exist a community of practitioners, the control appears to be very much in the hands of the individual teacher working with the pre-service teacher in specific settings. This is compounded by the assumptions made by teachers about what pre-service teachers can do.

The dynamic model of subject knowledge developed by Ellis (2007a), uses *agency* as a key concept alongside culture and activity. Becoming a teacher is a process of rapidly acquiring new skills and knowledge, becoming emotionally intelligent and developing an efficient way of working as a professional in unfamiliar surroundings. Seeing oneself as able to determine how placement is shaped to personal advantage requires a good deal of self-confidence.

Discussion of the timetable at the beginning of placement is critical as it shapes the knowledge that will be learned. The findings illustrate that pre-service teachers are likely to be more comfortable teaching the things that they know to build confidence and less likely to accept teaching of knowledge outside of their experience until self-confident. This highlights the importance of being able to adapt to the workplace. Pre-service teachers on placements that have been organised by others are in an unusual position and the study illustrates how

they feel obliged to accept the work they are offered even though at times this requires the acquisition of knowledge beyond what they already know.

6.3.3 Codification

One of the significant issues highlighted by the experience of Andrea was in the ways in which different people have different ways of working with materials to the same end. This can be seen as the *codification* of subject knowledge. Textiles was relatively new to Andrea and whilst at university she developed confidence in using basic techniques. However, ongoing to placement she was faced with pupils using different techniques and an expectation that she would teach appliqué in the way in which it was usually done in school. As a result, this caused not insignificant problems for Andrea and was a source of tension between her and the teacher. Such controlling of subject knowledge by the school supports the work of Herold and Waring (2011) and their finding that the subject knowledge of pre-service teachers links closely to that seen in their placement schools.

This example leads to a consideration of the contested nature of practical subject knowledge as it is manifested in schools. As an example, consider the marking out of a simple wood joint. The way in which this is done in schools varies considerably with some using traditional marking knives to others using pencils and even templates. To get a more accurate result a marking knife could be used but pragmatically teachers often steer aware from them on health and safety grounds. There is consequently a tension between what might be considered best practice and what pupils actually learn. This links back to ideas of the interpreted curriculum mentioned earlier

This research study was undertaken with the awareness that the term subject knowledge can be used to encompass a range of different things. When asking about their experience of development their subject knowledge, during interviews, no particular *interpretation* of subject knowledge was put forward by the researcher. Rather it was left to participants to work with their existing understanding when formulating answers to the questions asked. The findings as a whole tell us that pre-service teachers of Design and Technology have

interpreted subject knowledge in a number of different ways supporting the work of Ellis (2007b). In the main, subject knowledge was seen as content knowledge and skills with only a minority mentioning subject knowledge in the context of 'knowledge of how to teach it'. Such a narrow interpretation supports the views of Barlex and Rutland (2008).

6.3.4 Learning the new

For any teacher of Design and Technology*, learning the new* in terms of skills, knowledge and processes related to materials is an important and necessary part of the job. As Martin (2013) points out, there have been considerable changes in the materials used to make products in schools since the National Curriculum (DES, 1990) introduced the subject for all. This makes the learning of new knowledge inevitable unless the practices of the past are maintained. In the context of Design and Technology in the present day there are other drivers supporting the development of new knowledge. One of these is the shrinking number of specialist staff available in schools which means that, in order to cover a broad range of materials, teachers need to move out of their material specialisms and learn the new.

In developing new knowledge, it was found, in the study, that active engagement in the preparation of learning and teaching materials was very beneficial. Another aspect of learning the new was found to be the significance of talk when explaining practical activity and the development of dialogue that supports pedagogical strategies.

6.4 Knowledge and placement

The previous two sections have dealt with knowledge and placement as separate issues. However, the findings of the study as a whole suggest that knowledge development and the context in which pre-service teachers work are inseparable. New knowledge is developed whilst on placement and through the actions that are undertaken in order to teach in very specific environments. These school arenas and the day-to-day settings are unique and result in pre-service teachers having unique pathways through the course and developing unique skills of knowing. As a consequence of this individualised development,

it is clear that the historically located Minimum Competences published by DATA (2003) for the subject have no genuine value in developing pre-service teachers' subject knowledge. The knowledge that has been developed is very clearly driven in part by the teachers that have been involved with them on placement. Consequently the breadth and depth of knowledge that will be acquired will vary from individual to individual as was found in the work of Evans et al. (2008). Given that some of the knowledge acquired by all pre-service teachers will be new, is it not more appropriate to measure how knowledge was acquired and prepared for teaching rather than setting unrealistic expectations for those already under pressure?

6.4.1 Embodied knowledge

One of the findings that came from the study related to working with *embodied knowledge*. Here was the recognition from the pre-service teachers that they had to break down their existing subject knowledge into digestible parts so that pupils could make sense of them. Whilst it is recognised within the educational literature that knowledge needs scaffolding, it was the difficulty that pre-service teachers experienced in doing this that was surprising. For a practical subject such as Design and Technology, there is a considerable amount of practical knowledge. For experienced professional makers, this practical knowledge becomes embodied and takes on a tacit form. Processes of making become routine and the individual steps involved in manufacturing processes become blurred and lost over time. For such experienced people, when faced with teaching pupils' stages in making products, there is then difficulty in disaggregating the separate processes and working out how they can be made accessible to others.

If, however, the area of knowledge to be taught is one that is not familiar to the individual it is then necessary to learn about the processes from the beginning. Such a 'naïve' approach to new material allows the acquisition of the different elements of a process to be learned one at a time which makes it easier to understand how the skill, knowledge and processes can be taught to others. This presents a challenge to the idea of pedagogical content knowledge (PCK) discussed earlier.

6.4.2 Knowledge thresholds

For pre-service teachers entering unfamiliar placement environments it is quite understandable that they give importance to appearing confident, not only in the management of pupils but in the subject matter to be taught. *Getting to know the unfamiliar* is also of significance. When dealing with new processes, or indeed with completely new materials, it is necessary to rapidly develop sufficient knowledge to appear confident in knowing what you are doing. Once the necessary, or threshold, level of knowledge is reached, teaching can be undertaken with confidence. In a sense it becomes routine in the way that Eraut (2007) suggests. Working at this threshold point can be stressful for those new to teaching with an ongoing concern of being 'caught out' by pupils asking questions. This concept of threshold can be exemplified through the experience of Andrea who in one highly focused lesson felt completely in charge. In the following lesson, where pupils had the freedom to develop their own ideas, she was working beyond the level of knowledge that she had acquired and felt vulnerable, exposed and out of her depth.

The findings indicate that limited knowledge of pre-service teachers can be offset by a supportive culture as this changes the threshold. In contrast to the support given for the pre-service teacher highlighted above, there were examples of participants working with teachers who had quite limited subject knowledge as they were working outside of their original specialism. With limited subject knowledge of the teacher this resulted in a less supportive culture and no real progress in the subject knowledge development of the pre-service teacher. Such was the case with Molly.

Linked to this is a scenario where a teacher with limited subject knowledge is responsible for the development of a pre-service teacher. In this case it is possible that un-codified and potentially un-verified knowledge is passed on from the teacher to the pre-service teacher thus reinforcing poor practice. It is also the case that when working independently to research for appropriate resources, without any expert guidance, that similar 'bad practice' can be learned. This then increases the possibility of passing on bad practice to

learners such as the making of finger/comb joints in medium density fibreboard (MDF).

Working in more open-ended activities with pupils demands a greater mastery of skills and processes as the unexpectedly arrive. For Andrea learning new knowledge, there was success when undertaking simple closed activities but when pupils were allows the freedom to do what they wanted she was thoroughly out of her depth and unable to support the activity. This suggests that for teachers with poor subject knowledge they are unable to handle more open ended activities and so narrow the curriculum experience of pupils to make sure that they are working within the boundaries of their own subject knowledge.

6.5 Methodology

The study has used phenomenology which is recognised as being useful in capturing the experiences of phenomena by individuals. Through the use of this approach it has been possible to identify specific aspects of subject knowledge that have been of significance during pre-service teachers' placements in school. In explicating the data from the accounts of individuals, different approaches were taken in order to look at the phenomena in different ways. Reflecting back on the process, this use of more than one way of looking at the data has been useful in confirming what has been found. It has also helped to develop greater insight into the workings of phenomenology and how this approach might be useful.

The use of a phenomenological approach is not without criticism. One of the criticisms is the claim by phenomenologists to provide seemingly objective description of what participants have experienced without recognising the interpretation of the researcher. Another criticism relates to researchers' misunderstanding of the philosophical traditions of phenomenology in such a way that the ontological and epistemological decisions that have been made do not fit with the way in which data was collected or results analysed.

For this particular study the position of the researcher has been considered and attempts made to represent the experience of participants in a way that used their own words and privileged their perspective. For future research using phenomenology, however, it would be useful to involve participants in the process of data explication in the way that P Ricoeur (1971) suggests. It is felt that this would increase the trustworthiness of the findings and the overall value of the study.

Those writing about phenomenology, such as Devenish (2002) and Crotty (1996) suggest that researchers need to make decisions about the type of phenomenological approach will be taken based on a number of philosophical traditions. These traditions are often described in terms of the work done by individuals. So, for example, the research of Wilson (2014) is an application of Heideggerian phenomenology, and the work of Geanellos (2000) explores Ricoeur's theory of interpretation. Whilst making explicit links to philosophy is crucial within phenomenology, references in the literature to individuals rather that concepts or ideas makes it harder to design a research study that is fit for purpose.

6.6 Summary

This discussion in this chapter has drawn out some of the key issues from the findings and explored their meaning in relation to what has already been written in the field. It began by exploring the findings that related to knowledge. This was then followed by a discussion of the key issues related specifically to placement before combining knowledge and placement together. The chapter highlighted some of the factors affecting the knowledge that pre-service teachers developed and the influence of teachers in particular. The structure used in this chapter has proven effective in facilitating a discussion about separate, but related aspect of experience. For continuity this structure will be maintained in the next chapter.

7 Conclusions

7.1 Introduction

This chapter concludes the study by providing an overview of the contribution that it has made to the field along with a number of knowledge claims. These claims, or conclusions, follow from the discussion of the findings and are rooted in the data that has been analysed. These conclusions are in no particular order but rather have been organised in the same way as the discussion starting with knowledge, then placement and finally combining knowledge and placement together. There are also some conclusions related to the use of phenomenology as a research strategy for studies of this kind. The final section provides a summary of what has been achieved as a result of undertaking the study.

7.2 Overview

The starting point for the study was disquiet with the Minimum Competences (DATA, 2003) for those teaching secondary Design and Technology and focused on the experiences of pre-service teachers as they developed their subject knowledge whilst on placement. As a result of the literature review, the study shifted in focus from the narrow confinements of a single document to look at their lived experiences on placement using a phenomenological research strategy. The aim was to contribute to what is understood about subject knowledge through the account of individuals in a similar way to other qualitative studies that add rich examples to an existing body of research. Given the open-ended nature of the study, some of the findings have resulted in discussion about areas beyond the subject and into the nature of teacher education and workplace learning as a whole. The contribution that the study makes to the field, as a whole, is therefore on a number of different levels and overlapping areas. The list below provides a snapshot of the concluding statements and is followed by fuller explanations of each one.

- Knowledge is actively created for a particular purpose, in a specific context at a moment in time.
- The experience of developing subject knowledge simultaneously draws on the cognitive, psychomotor and affective domains

- The term ‘subject knowledge’ does not do justice to the nature of the knowledge acquired, and the processes that are involved, when pre-service teachers are on placement.
- The context in which the subject knowledge is developed, or subject knowing is undertaken, determines what is learned by pre-service teachers.
- Pre-service teachers necessarily adapt to their placement arena.
- Disembodying embodied knowledge is required in practical subjects.
- Working with new materials can present different and difficult challenges.
- A measure of how much knowledge is enough to teach is important for pre-service teachers.
- Decisions about phenomenological approaches are best informed by considering a number of continuum.
- There are benefits of using different processes in explicating the meanings from the data.

The first conclusion from the study is that *knowledge is actively created* for a particular purpose, in a specific context at a moment in time. Several individuals through the study found it necessary to develop subject knowledge specifically for the activity being undertaken in a specific context and a particular time. Such knowledge creation ‘on the spot’ supports the basic theoretical arguments underpinning activity systems as explained by Kaptelinin and Nardi (2006). For them, it is the activity itself that plays a part in determining the nature of the knowledge that is created. Within the subject of Design and Technology knowledge about materials and equipment is constantly changing. In some contexts the change is such that the knowledge created to support pupils in one academic year may well be different to that needed to support pupils in the next academic year. This suggests that a dynamic view of content knowledge is appropriate for the subject

This study also concludes that the experience of developing subject knowledge simultaneously draws on the *cognitive, psychomotor and affective*

domains. The literature on subject knowledge, particularly related to Personal Construct Psychology (PCK) focuses on cognitive knowledge. This study, however, illustrates that knowledge development can be a physical and emotional experience and that personal interrelationships can affect not only how knowledge is acquired but what knowledge is acquired. This highlights the importance of developing positive working relationships whilst on placement and the need to prepare pre-service teachers before they enter school arenas.

A third conclusion in relation to knowledge is in relation to *terminology*. The study suggests that the term 'subject knowledge' does not do justice to the nature of the knowledge acquired, and the processes that are involved, when pre-service teachers are on placement. It is more appropriate to consider knowing as a whole-person experience. It is clear from the findings that when developing their knowledge on school placement, pre-service teachers not only acquire propositional knowledge of materials and equipment but also acquire procedural and tacit knowledge about how they are used within a specific school arena. In addition, they develop their skills of knowledge formation and the ability to respond quickly when working in new areas. Still further, they adapt to the working practices found in placement and manage working relationships. The study revealed that such activity is not well served by the use of a single term such as 'subject knowledge'. Alternatives, such as 'subject knowing' or 'knowing skills' better describe what actually takes place. Such complex activity was at the heart of the experience of participants, as they worked as pre-service teachers of Design and Technology in secondary schools. The discussion above suggested that it could be difficult to find an alternative to the term but that continuing to use 'subject knowledge' would not be helpful in explaining what happens during placement in a course of teacher education. There is therefore the need for further work in this area and the need to challenge the current orthodoxy within Design and Technology and in teacher education as a whole.

With regard to placement the study draws a number of conclusions. The first one of which is that the *context* in which the subject knowledge is developed,

or subject knowing is undertaken, *determines what is learned* by pre-service teachers. The findings demonstrate that the school arena in which the pre-service teacher is working, and the teachers they work with, have a profound influence on what can be learned by pre-service teachers. With regard to subject content, teachers select different projects in different school arenas so work with different aspects of propositional and procedural knowledge. Even when undertaking similar projects there may be variation as a result of the many different ways in which materials can be processed. Thus, individual teacher's perspectives on subject content can affect the knowledge acquired. The study suggests that mentors, in particular, strongly influence knowledge development of pre-service teachers' in Design and Technology. How this influence is manifested appears to be dependent on the degree of intersubjectivity between the pre-service teacher and their mentor.

Staff in school arenas make quite deliberate choices of pedagogy depending on a number of factors including their own professional experience and their understanding of the pupils they are working with. Often, the decisions over pedagogy are taken collectively by teachers within a specific arena. On a day-to-day basis, however, it is the teacher involved with a specific class that will discuss pedagogical approaches with the pre-service teacher. Consequently, degree of intersubjectivity between pre-service teachers and mentors is likely to have an effect on their experience.

A further conclusion in relation to placement is that pre-service teachers necessarily *adapt* to their placement arena. The findings shows that pre-service teachers working in established contexts can meet highly codified practices and may have difficulty in using their own ways of working with materials. This discontinuity between their existing knowledge and that needed to teach has been a significant factor in shaping their experience. In order to survive the experience as part of a course of teacher education, adaptation is essential.

The next set of conclusions draw knowledge and placement together. The first of these is the conclusion that *disembodying embodied knowledge is*

required in practical subjects. The ideas of embodied and disembodied knowledge have been useful in making sense of the experience of individuals. The findings suggest that knowledge embodied in the individual is drawn upon and then dis-embodied for teaching. Pre-service teachers in this study experienced difficulties in breaking down (disembodying) their existing knowledge and this is something that should be included in courses of teacher education.

The second conclusion of the study in relation to knowledge and placement is in relation to getting to know the unfamiliar. The findings suggest that *working with new materials* can present different and difficult challenges. Taking on new materials is problematic as learning new knowledge is not only about learning propositional knowledge but also procedural, tacit, strategic and other forms of knowledge. Developing skills of knowledge creation are more important than knowledge recall. In terms of the nature of knowing as a skill for knowledge creation in context, is supported by the study. When learning the new, the amount of subject knowledge required, or the level of skill of subject knowing, in order to teach is related to the degree of support from mentors.

Emerging from the study is the concept of *thresholds of knowledge* which is the third conclusion of the study in relation to knowledge and placement. The findings suggest that a measure of how much knowledge is enough to teach is important for pre-service teachers. The notion of a context-specific threshold for subject knowledge is of more use in the development of pre-service teachers' subject knowledge than any fixed criteria. Competence implies that a finite measurable amount of knowledge is needed. The idea of a moveable and negotiable threshold of knowledge within a specific context is more realistic given that in different setting there will be different requirement on the knowledge to support teaching. The threshold level of knowledge required for teaching is dependent on the support available.

7.3 Research questions

In the introduction to the study, a number of key research questions were identified to focus the study so that an appropriate methodology could be used

to capture empirical data. Given the grounded nature of phenomenological research the study has generated a good number of findings and it is, at this point, worth returning to the original set of questions. In doing so it is important to state that the intention was not to see if the study has been able to answer the questions as a measure of its 'validity'. Rather it was to use the original key questions as a tool to reflect on the ways in which the study was carried out and shed further light on the phenomenon in question.

The first question asked *what factors affect the kind of subject knowledge that pre-service teachers developed during their placements*. It is clear that there are a number of factors affecting the knowledge that was developed with the placement context and the relationships with teachers being the most significant. The findings have demonstrated that the participants in this study have developed knowledge that is closely related to what they have taught and that placement arena constraints have provided them with specific forms of knowledge that have been interpreted by the teacher and codified within subject departments.

The second question was closely related to the first and asked *what new knowledge they have had to acquire*. Again the answer was very much related to what happened within their placement arenas and the ways in which the teachers shaped the placement experience as a whole. A good number of participants had to acquire completely new knowledge outside of their specialism. The processes by which they acquired new knowledge was the focus of the third question that asked *how new knowledge was acquired?* Here the experience or participants was mixed with some teachers taking time to go through new areas whilst others, due to a number of constraints, had to gain their new knowledge at home and through a variety of courses including YouTube.

The fourth key question asked *what challenges have been faced when developing knowledge in placement arenas?* Apart from the challenge of developing the new knowledge mentioned above, the findings suggest the pre-

service teachers faced a number of other challenges, some of which related to the relationships that they had with others inside and outside of the placement arenas. Learning to adapt to the placement was necessary to survive with several participants recognising that their role was seen by different teachers in different ways. This linked to the fifth question that asked *what role did teachers play in mediating subject knowledge?* The findings suggested that the answer to this was really that the teacher played a role but that there were other factors that affected what was learned.

The final question from the introduction to the study was *what theories might be useful to help understand what goes on?* This is covered across the discussion section above but overall, the findings indicate that current theories of subject knowledge, workplace learning, activity theory and communities of practice do not fully explain what takes place when subject knowledge is developed by pre-service teachers. This is an area that would need further exploration and research to develop a model, if indeed such a model would be genuinely helpful in understanding such a complex human phenomenon.

7.4 Methodology

In addition to the conclusions drawn from the data and findings of the study, there were a number of conclusions drawn about the methodology and data collection methods that have been used. The first of these was in relation to the phenomenological approach taken and the concept of intersubjectivity. Reflection on the methodological approach adopted highlighted that decisions about phenomenological approaches are best informed by considering a number of *continuum*. When working with phenomenology, the traditions associated with individuals are not helpful. One weakness of phenomenology is the assumption that a researcher will align with individuals as it tends to be presented in terms of the approaches that individuals have taken. Envisaging phenomenological approaches as a series of continua along with a researcher picking a point to locate their research approach.

The second conclusion from the study in relation to the methodology used is related to the use of using *multiple lenses* when explicating the data. Reflecting on the processes that have been used it is clear that there are benefits of using different processes in explicating the meanings from the data. In undertaking a phenomenological study it is important to be aware of the potential for researcher bias as there is always a significant degree of interpretation. However, using different processes helps to achieve greater understanding of the data as a whole and the intended meanings of the participants.

In using a phenomenological approach over time, the decision was made not to involve participants as co-researchers in the way that Gadamer (1989) suggested. However, on reflection, the involvement of participants in reviewing the emerging findings at different points across the academic year could have increased the trustworthiness of the study as a whole. By reviewing interview transcripts and the interpreted meanings generated it would have been possible to ensure that the voice of participants came through the findings as a whole. In addition, it is clear from the findings that the experience of pre-service teachers' changes throughout the year and further discussion with participants could have shed further light on the changes as they took place.

7.5 Philosophical reflection

An important part of the conclusion to the study was an expression of the philosophical position of the researcher in relation to subject knowledge and the individual pre-service teacher whilst on placement. In addition, it was felt important to have some commentary on moving beyond the Minimum Competences and outlining a model of professional development that might be explored in the future. This section provides a philosophical reflection on all of these areas.

Subject knowledge and the individual

The philosophical position of the researcher at the end of the study is that subject knowledge is complex, dynamic, context dependent and individual. At the same time it is also bound up in relationships with others. As a result it is difficult to quantify in absolute terms and it is more useful to explore the

processes of knowledge (re)formation for the purposes of teaching. The study has demonstrated that existing cognitive, psycho-motor and affective knowledge and skills are called upon as pre-service teachers actively create (new) or re-form subject knowledge in context. Such knowledge may be affected by teachers' views as well as the available arena resources. Such is the contextual nature of the subject knowledge used when teaching that its relevance is limited to the specific setting as defined by Lave (1988).

This view of subject knowledge and the relation to the individual pre-service teacher is certainly constructivist in character but no existing philosophical view fully does justice to what has been explicated from the data. Evidence from the study supports the notion of adaptation of the individual to their environment in the way that Piaget (1970) explained. It also, however, supports the views of Glasersfeld (1984) in the selective adoption of knowledge by those placed in new and challenging environments.

Beyond competences

This study has shown that the development of subject knowledge is highly personal and that it is pre-service teachers' ability to build on what they already know that helps them to cope with the demands of school experience. The Minimum Competences document contains a defined set of knowledge that pre-service teachers are expected to know regardless of whether they make use of that knowledge or not. In addition it is, by its very title, based on a competence threshold rather than a model of continuing development. The issue of competence is further compounded by the nature of the Design and Technology curriculum which is open to interpretation and can be delivered through a variety of materials to create an infinite range of product outcomes. As long as the curriculum does not contain a fixed body of knowledge, any collection of competences related to it will be open to interpretation. This suggests that the use of competence is not helpful in supporting pre-service teachers' development of subject knowledge.

It is the position of the researcher that for successful teachers of the subject it is their ability to make the best of subject knowledge 'in use' that is key. For pre-

service teachers, therefore, it makes sense to measure their ability to research, prepare and communicate subject knowledge for the purposes of teaching. What is needed therefore are ways for pre-service teachers to record how they have researched, (re)formed and put over subject knowledge on placement so that they can receive feedback on how to get better at managing those processes.

Model of professional development

Given the position adopted in relation to the nature of knowledge revealed in the study, and outlined above, it becomes apparent that attempting to create a pictorial model of subject knowledge, in the way that Banks and Barlex (1999) and Ellis (2007a) did, is a misplaced activity. This study has demonstrated that subject knowledge development for pre-service teachers is individual and affected by the contexts in which they have been working. For them, subject knowledge is anything but generic. To represent what has come out of this study with a fixed statement, or visual representation, of what subject knowledge is would be inappropriate. Learning and teaching are dynamic processes affected by individuals and should not be reduced to simplistic scientific representations. Design and technological activity at its best is a dynamic interplay between materials, processes and human decision making that results in unique outcomes suited for particular individuals in specific contexts. It is a form of naturalistic activity best represented by narrative and other qualitative forms of representation.

The study has shown is that what is important are processes and skills of working with knowledge. Consequently, a system to capture processes could be used as an alternative to a list of things that pre-service teachers must know and be able to do. Making use of individual portfolios could be considered as they can easily be personalised and can hold text and images to illustrate what has been done. Electronic blog tools could also be considered and have the advantage of encouraging a more narrative account of experience over time. They also have the advantage of building in opportunities for comments from others. Such tools readily facilitate reflection, encourage dialogue and may be shared with tutors and future employers.

The Design and Technology curriculum can be conceived in terms of a shared vocabulary of generic terminology (measuring, cutting, joining...) that can be exemplified through a variety of materials. Over time the materials and equipment may change but the generics would not - allowing for a defined curriculum that is capable of being updated. Such a list of generic terms could form the basis of an index to capture pre-service teachers' development of 'knowledge in use' over time.

From the study, the emerging model of professional development is one that involves teachers at every stage of their career developing case history of their ability to work with knowledge to support pupils learning in specific settings. This perspective is in line with earlier work done by Martin (2007) on the development of subject knowledge portfolios and is something that should be reviewed and further developed.

7.6 Implications for practice

This research study has focused on the lived experience of pre-service teachers during their time in placement as part of a one-year PGCE course. The implications that have been drawn relate to the subject domain itself, working with pre-service teachers and working with teachers in placement arenas.

The first implication drawn from the study is that there is a need to change the current orthodoxy of subject knowledge as a commodity and to change the ways in which it is conceived within teacher education. Moving from the current focus on audits and tracking of progress against fixed competences to a positive model that celebrates the ability to develop learning opportunities that involve the use of a range of forms of knowledge by pupils.

The second implication for future practice is in relation to work with pre-service teachers. There is a need to consider how pre-service teachers can be best *prepared* for adaptation to placement and developing their skills of knowing needs to be an essential component of teacher education. Given the not

insignificant effect that the placement experience has on pre-service teachers, both cognitively and emotionally, it will be important in the future to prepare them for the environment in which they will be working. Time spent considering their role and how they will cope with working with a variety of individuals will be a valuable part of their induction to courses.

One of the more challenging issues to have emerged from the study is that of preparing pre-service teachers to learn new knowledge. Given that it seems likely that many of those on future courses will be asked to acquire new skills and knowledge it seems logical to consider how they can be helped. Creating opportunities for those on future courses to experience learning the new would seem to be an appropriate way of responding to what has been found out through this study.

The third implication for future practice drawn from the study is in relation to working with teachers in placement areas. The study highlights the importance of relationships with teachers and how this can affect knowledge developed. It is important therefore that placement mentors recognise the *significance of their role* in directing pre-service teachers' knowledge. Both the departmental philosophy about the subject and the interaction with individual mentor have been identified as making a noticeable difference in terms of what knowledge was developed and how it was acquired. Given the current nature of partnership models of teacher education that are school-focused the role of mentors in school to develop the knowledge of individuals will remain a high priority. From the findings and discussion there is clearly much that can be passed on to mentors in terms of the ways in which per-service teachers have experienced placement and the important role that they play in supporting and developing subject knowledge.

Schools need to recognise their responsibility for the development of pre-service teachers' subject knowledge given how their experience defines what they learn. In order to do this it could be possible for schools to be responsible for a *Subject Knowledge Development Plan* that considered the experiences that could be offered to the pre-service teacher with whom they are

working. This would be discussed at the beginning of the placement and explore the needs of the individual pre-service teacher in a way that they were given equal consideration with the needs of the school to provide learning opportunities for their pupils.

7.7 Summary

This chapter has provided a description of the main knowledge claims, or summaries resulting from the study. In doing so it has thrown new light on a much under-researched area of teacher education. The experiences of the pre-service teachers involved in the study demonstrate the extent to which fixed set of competences are wholly inappropriate in defining what subject knowledge in subjects such as Design and Technology. Indeed, the study has brought into question the very nature of subject knowledge as previously understood within teacher education and suggested that new ways of looking at how pre-service knowledge development is conceived need to be developed.

The study also highlights the need to prepare pre-service teachers for their time whilst on placement in schools and the issues that they are likely to face. In addition, the study draws attention to the role that teachers play in shaping the knowledge that pre-service teachers have access to and the ways in which their role as gatekeepers to subject knowledge can benefit and hinder those looking to teach future generations. The use of a phenomenological approach in exploring the lived experience of pre-service teachers has proven highly effective and suggests that this methodological strategy may be effective for future research into this area.

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Appendix A. Ethics paperwork

Participant information sheet

Subject knowledge development of beginning teachers in secondary design and technology in England.

Researcher: Mike Martin, ECL

You are being invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information and ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not.

What is the purpose of the study?

The purpose of the research is to develop insights into the process of subject knowledge development of beginning teachers of design and technology in secondary schools.

Do I have to take part?

No. It is up to you to decide whether or not to take part. If you do you will be given this information sheet and asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. A decision to withdraw will not affect your rights as a student of LJMU.

What will happen to me if I take part?

You will take part in three interviews and three group discussions which are aimed to explore how your subject knowledge has developed through your course of training. They will take place in December, February and May/June of this academic year and will take place at the IM Marsh Campus at a time

convenient to you. The interview will last no more than 20 minutes. It will be audio recorded so the interviewer can accurately record your responses.

How will the data be used?

The responses from interviews and results of the group discussion will be used to identify factors that have influenced the development of subject knowledge along with areas of commonality and differences between the experience of individuals. Verbatim quotes may be used by the researcher to illustrate responses but these will be anonymised.

Are there any risks / benefits involved?

There are no risks to you and taking part in this research project will not affect your assessment or progress on your course in any way. You might, however, find some benefit from the opportunity to reflect on how you subject knowledge has developed and may do so in the future.

Will my taking part in the study be kept confidential?

Yes. All the information that we collect from you during the study will be coded to ensure confidentiality and stored securely in password-protected files. Responses will be reported anonymously and all data will be destroyed within two years of the completion of the study.

Contact Details of Researcher

Mike Martin, ECL, Liverpool John Moores University, Barkhill Road, Liverpool L17 6BD.

Tel: 0151 231 5287

Email: m.c.martin@ljmu.ac.uk.

If you have concerns about any aspect of how the research has been undertaken please contact the researcher's supervisor Sandra Hiett at S.Hiett@ljmu.ac.uk.

Gatekeeper information sheet

Subject knowledge development of beginning teachers in secondary design and technology in England.

Researcher: Mike Martin, ECL

Your students are being invited to take part in a research study. Before you consent to their involvement is important that you understand why the research is being done and what it involves. Please take time to read the following information and ask us if there is anything that is not clear or if you would like more information.

What is the purpose of the study?

The purpose of the research is to develop insights into the process of subject knowledge development of beginning teachers of design and technology in secondary schools.

Do the students have to take part?

No. It is up to them to decide whether or not to take part. If they do you will be given a similar information sheet and asked to sign a consent form. They are still free to withdraw at any time and without giving a reason. A decision to withdraw will not affect their rights/any future treatment/service you receive.

What will happen to them if they take part?

Students will take part in three individual interviews lasting no more than 20 minutes. These will take place during the 2012/2013 academic year. The interviews and discussions will take place at the IM March Campus and will be arranged at a time convenient to them. They will be audio recorded so the researcher can accurately record responses.

Are there any risks / benefits involved?

There are no risks to students but they might benefit from the opportunity to reflect on how their subject knowledge has developed and may do so in the future.

Will their taking part in the study be kept confidential?

Yes. All the information that we collect from them during the study will be coded to ensure confidentiality and stored securely in password-protected files. All data will be destroyed within two years of the completion of the study.

Contact Details of Researcher

Mike Martin, ECL, Liverpool John Moores University, Barkhill Road, Liverpool L17 6BD. Tel: 0151 231 5287. Email: m.c.martin@ljmu.ac.uk.

If you have concerns about any aspect of how the research has been undertaken please contact the researcher's supervisor Sandra Hiett at S.Hiett@ljmu.ac.uk.

Faculty of Education, Community and Leisure
IM Marsh Campus, Barkhill Road
Liverpool John Moores University
Liverpool L17 6BD
0151 231 5287.
m.c.martin@ljmu.ac.uk

Research Project: Subject knowledge development of beginning teachers in secondary design and technology in England.

Dear Kate Johnston,

As part of my doctoral study at LJMU I am undertaking a research project looking at the subject knowledge development of beginning teachers of secondary design and technology. The purpose of the research is to develop insights into the process of subject knowledge development of beginning teachers of design and technology in secondary schools.

In order to get an in-depth view of the experience of beginning teachers developing subject knowledge it is planned to interview participants to develop personal narratives and to have discussions with them as a group. In addition, the perspective of the researcher will be recognised with a personal blog recording the changing perspectives of the researcher over the course of the project.

I would like to invite students to take part in this project and have included a Gatekeepers Information Sheet. I would be grateful if you could sign the Permission Form enclosed and return it to me.

Should you require any further information about the project please contact myself or my supervisor Sandra Hiett at s.hiett@ljmu.ac.uk.

Participant Consent Form

Subject knowledge development of beginning teachers in secondary design and technology in England.

I confirm that I have read and understand the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights.	
I understand that any personal information collected during the study will be anonymised and remain confidential.	
I agree to undertaking interviews and participating in group discussions that will be audio recorded	
I am aware that verbatim quotes might be used but that they will be anonymised.	
I agree to take part in the above study	

Name of Participant	Date	Signature
Name of Researcher	Date	Signature

Gatekeeper Consent Form

Subject knowledge development of beginning teachers in secondary design and technology in England.

I confirm that I have read and understand the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily	
I understand that participants participation is voluntary and that they am free to withdraw at any time, without giving a reason and that this will not affect their legal rights.	
I understand that any personal information collected during the study will be anonymised and remain confidential.	
I agree to students undertaking interviews and participating in group discussions that will be audio recorded	
I am aware that verbatim quotes might be used but that they will be anonymised.	
I agree that students can take part in the above study	

Name of Gatekeeper	Date	Signature
Name of Researcher	Date	Signature

Note: When completed 1 copy for gatekeeper and 1 copy for researcher

Appendix B. Interview questions

Since ... in what ways has your subject knowledge developed?

In what ways have teachers helped / influenced your subject knowledge?

Any differences between personal knowledge and what you have had to teach?

How do you feel about teaching new things?

How do you go about learning new things?

How has the school arena affected what you have learned?

Have you been able to learn anything beyond what you have taught?

Any knowledge transferred between specialist areas?

What comparisons between placements can you make?

Appendix C. Transcript extract

This extract provides an example of the informal dialogical style that was used for the interviews as a whole.

Allison: She did say, you know, maybe after Christmas I'm going to be maybe RM and Food so more of a balance where at the minute I was only RM at the start, mainly observing and sort of assisting and then I solely took on all Food and so now I am all Food and then after Christmas I am going to be Resistant Materials and Food cos I said, you know, that I would like that balance and my subject mentor said she would like that as well.

MM: Do you know what you are going to be doing then after Christmas?

Allison: No. She says this week that she is going to give me like the new projects that they are working on.

MM: Right but it will probably be something different than what you have done already?

Allison: Yeah or it will be something different, the project has finished for the last, the ones that they were working on and we are going to start on something new immediately after Christmas and I have the joy of starting that.

MM: Should be fun! Erm, yeah I mean a question that I am asking everybody is outside of what you have been teaching, have you had any opportunities to learn other bits of knowledge about food or about RM or is it all focused on exactly what you are teaching?

Allison: No, I've feel that for me, I get a lot of books and just try and read them or even what I also think is very useful is you know even like You Tube videos, like I think that is very useful too just to show you different ways that they are being taught in the classroom but I think, for knowledge, for me anyway, I think the best thing for me is looking up and reading books and then applying it in schools and seeing it if worked and if it didn't, then sort of evaluating that and

trying to just go back over the knowledge. I just think books are like, for me, for getting something into my head I think I have to sort of read up on it and then try and apply it cos it's the practical skills and things.

MM: Even with practical stuff, you find that?

Allison: Yeah.

MM: Do you try stuff out at home at all?

Allison: Oh yeah, yeah, like definitely I would try out a lot of the stuff that I am going to do or even things that I would adapt. I like to adapt the recipes and I practice at home first before putting it in place in the classroom and it worked very well in letting them see like if we don't put in so many eggs or reduce the amount of flour, just to show the different functions of ingredients and that was why I showed them that. So to increase your knowledge you sort of have to read around it as well and apply it practically. I think it is very important to read up on it because there are so many things that I have read that have just sort of helped like research is the only way that I seem to be able to, you know, get it in there and apply it.

MM: Has there been any, I know we have talked about it, have there been any situations where the teacher has said 'you really ought to do this this way' but you want to do it another way? Or has that not happened because you ….?

Allison: No she seems to just, erm, the only thing she has ever really said to me is, erm, I would like you to spend more time on like, spend more time management on maybe getting them to clean up because I think they are being very rushed for their washing up.

MM: You kind of have to go with the flow of the lesson but not 'oh don't do your pastry this way, do it this way'?

Allison: No she is very quite good that way, she would be very much, everything I do she would really be saying to me ‘oh that worked well, can I have this’ or, you know, so that is what, no I’ve never been criticised that way.

MM: Because for one or two other people it is like that ‘I have been teaching this for 20 years and I have got my way of doing it you know, I know you have got your way but I want you to teach the children this way’.

Allison: I’m sure she probably is like that but she doesn’t want to actually say it to me. She might be like, well, I’ve never felt you know, she has interfered in that way to say to me, you know, even to say to me ‘I think you would be better doing this’ which I think sometimes I would benefit from.

MM: Oh right.

Allison: Yeah I think I would benefit from that like if she felt, cos she has taught it more than I have so maybe, yes I have my way of doing it but, you know, maybe if she thought there was a way of doing it that was better, like she has taught it to pupils for longer than me and you know, if she said to me ‘this is how I feel that, you know…’

MM: So do you think sometimes she is too much hands off and not enough, in just letting you get on with it?

Allison: Yeah last year when I was in Resistant Materials the teacher there would be ‘I think do this, you know, instead, I have found this works better’, she’d be more that way but I think it is just my teacher afterwards would comment more on things like time management and on, you know, questioning, things like that would be more what she focuses on and not so much my knowledge.

Appendix D. Marked up transcript extract

The researcher comments are highlighted in blue italics.

Allison: She did say, you know, maybe after Christmas I'm going to be maybe RM and Food so more of a balance where at the minute I was only RM at the start, mainly observing and sort of assisting and then I solely took on all Food and so now I am all Food and then after Christmas I am going to be Resistant Materials and Food cos I said, you know, that I would like that balance and my subject mentor said she would like that as well.

Negotiation with teacher about taking on different material area.

MM: Do you know what you are going to be doing then after Christmas?

Allison: No. She says this week that she is going to give me like the new projects that they are working on.

MM: Right but it will probably be something different than what you have done already?

Allison: Yeah or it will be something different, the project has finished for the last, the ones that they were working on and we are going to start on something new immediately after Christmas and I have the joy of starting that.

Wary of teaching new things outside of experience.

MM: Should be fun! Erm, yeah I mean a question that I am asking everybody is outside of what you have been teaching, have you had any opportunities to learn other bits of knowledge about food or about RM or is it all focussed on exactly what you are teaching?

Allison: No, I've feel that for me, I get a lot of books and just try and read them or even what I also think is very useful is you know even like You Tube videos, like I think that is very useful too just to show you different ways that they are

being taught in the classroom but I think, for knowledge, for me anyway, I think the best thing for me is looking up and reading books and then applying it in schools and seeing it if worked and if it didn't, then sort of evaluating that and trying to just go back over the knowledge. I just think books are like, for me, for getting something into my head I think I have to sort of read up on it and then try and apply it cos it's the practical skills and things.

Learning most from books.
Evaluation of teaching seen as important in refining knowledge.

MM: Even with practical stuff, you find that?

Allison: Yeah.

MM: Do you try stuff out at home at all?

Allison: Oh yeah, yeah, like definitely I would try out a lot of the stuff that I am going to do or even things that I would adapt. I like to adapt the recipes and I practice at home first before putting it in place in the classroom and it worked very well in letting them see like if we don't put in so many eggs or reduce the amount of flour, just to show the different functions of ingredients and that was why I showed them that. So to increase your knowledge you sort of have to read around it as well and apply it practically. I think it is very important to read up on it because there are so many things that I have read that have just sort of helped like research is the only way that I seem to be able to, you know, get it in there and apply it.

Structure knolwedge for teaching at home prior to application in school.
Reading around the subject helping to apply knolwedge when teaching.

MM: Has there been any, I know we have talked about it, have there been any situations where the teacher has said 'you really ought to do this this way' but you want to do it another way? Or has that not happened because you ….?

Allison: No she seems to just, erm, the only thing she has ever really said to me is, erm, I would like you to spend more time on like, spend more time management on maybe getting them to clean up because I think they are being very rushed for their washing up.

MM: You kind of have to go with the flow of the lesson but not 'oh don't do your pastry this way, do it this way'?

Allison: No she is very quite good that way, she would be very much, everything I do she would really be saying to me 'oh that worked well, can I have this' or, you know, so that is what, no I've never been criticised that way.

Receiving praise for subject knowledge delivery.

MM: Because for one or two other people it is like that 'I have been teaching this for 20 years and I have got my way of doing it you know, I know you have got your way but I want you to teach the children this way'.

Allison: I'm sure she probably is like that but she doesn't want to actually say it to me. She might be like, well, I've never felt you know, she has interfered in that way to say to me, you know, even to say to me 'I think you would be better doing this' which I think sometimes I would benefit from.

Desire to receive feedback on how knowledge is structured for learning.

MM: Oh right.

Allison: Yeah I think I would benefit from that like if she felt, cos she has taught it more than I have so maybe, yes I have my way of doing it but, you know, maybe if she thought there was a way of doing it that was better, like she has taught it to pupils for longer than me and you know, if she said to me 'this is how I feel that, you know…'

MM: So do you think sometimes she is too much hands off and not enough, in just letting you get on with it?

Allison: Yeah last year when I was in Resistant Materials the teacher there would be ‘I think do this, you know, instead, I have found this works better’, she’d be more that way but I think it is just my teacher afterwards would comment more on things like time management and on, you know, questioning, things like that would be more what she focuses on and not so much my knowledge.

Appendix – Researcher comments

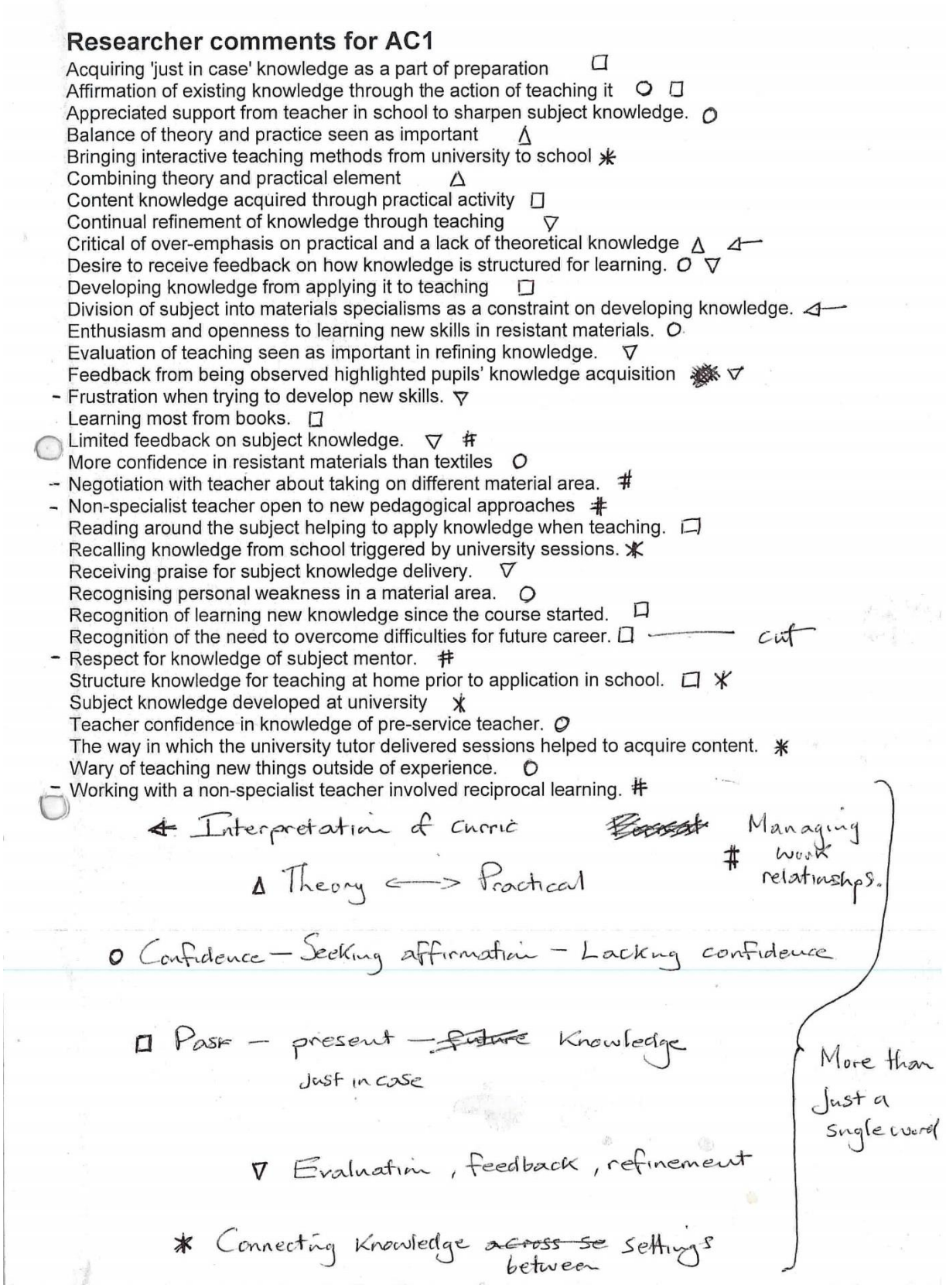
Below is an example of the researcher comments resulting from the first interview with Allison.

Researcher comments for Allison 1

Acquiring 'just in case' knowledge as a part of preparation
Affirmation of existing knowledge through the action of teaching it
Appreciated support from teacher in school to sharpen subject knowledge.
Balance of theory and practice seen as important
Bringing interactive teaching methods from university to school
Combining theory and practical element
Content knowledge acquired through practical activity
Continual refinement of knowledge through teaching
Critical of over-emphasis on practical and a lack of theoretical knowledge
Desire to receive feedback on how knowledge is structured for learning.
Developing knowledge from applying it to teaching
Division of subject into materials specialisms as a constraint on developing knowledge.
Enthusiasm and openness to learning new skills in resistant materials.
Evaluation of teaching seen as important in refining knowledge.
Feedback from being observed highlighted pupils’ knowledge acquisition
Frustration when trying to develop new skills.
Learning most from books.
Limited feedback on subject knowledge.
More confidence in resistant materials than textiles

Negotiation with teacher about taking on different material area.
Non-specialist teacher open to new pedagogical approaches
Reading around the subject helping to apply knowledge when teaching.
Recalling knowledge from school triggered by university sessions.
Receiving praise for subject knowledge delivery.
Recognising personal weakness in a material area.
Recognition of learning new knowledge since the course started.
Recognition of the need to overcome difficulties for future career.
Respect for knowledge of subject mentor.
Structure knowledge for teaching at home prior to application in school.
Subject knowledge developed at university
Teacher confidence in knowledge of pre-service teacher.
The way in which the university tutor delivered sessions helped to acquire content.
Wary of teaching new things outside of experience.
Working with a non-specialist teacher involved reciprocal learning.

Appendix E. Marked up researcher comments



Researcher comments for AC1

Acquiring 'just in case' knowledge as a part of preparation □
Affirmation of existing knowledge through the action of teaching it ○ □
Appreciated support from teacher in school to sharpen subject knowledge. ○
Balance of theory and practice seen as important △
Bringing interactive teaching methods from university to school ✳
Combining theory and practical element △
Content knowledge acquired through practical activity □
Continual refinement of knowledge through teaching ▽
Critical of over-emphasis on practical and a lack of theoretical knowledge △ ◁—
Desire to receive feedback on how knowledge is structured for learning. ○ ▽
Developing knowledge from applying it to teaching □
Division of subject into materials specialisms as a constraint on developing knowledge. ◁—
Enthusiasm and openness to learning new skills in resistant materials. ○
Evaluation of teaching seen as important in refining knowledge. ▽
Feedback from being observed highlighted pupils' knowledge acquisition ▽
- Frustration when trying to develop new skills. ▽
Learning most from books. □
Limited feedback on subject knowledge. ▽ #
More confidence in resistant materials than textiles ○
- Negotiation with teacher about taking on different material area. #
- Non-specialist teacher open to new pedagogical approaches #
Reading around the subject helping to apply knowledge when teaching. □
Recalling knowledge from school triggered by university sessions. ✳
Receiving praise for subject knowledge delivery. ▽
Recognising personal weakness in a material area. ○
Recognition of learning new knowledge since the course started. □
Recognition of the need to overcome difficulties for future career. □ —— cut
- Respect for knowledge of subject mentor. #
Structure knowledge for teaching at home prior to application in school. □ ✳
Subject knowledge developed at university ✳
Teacher confidence in knowledge of pre-service teacher. ○
The way in which the university tutor delivered sessions helped to acquire content. ✳
Wary of teaching new things outside of experience. ○
- Working with a non-specialist teacher involved reciprocal learning. #

◁ Interpretation of curric ~~Concept~~ Managing # work relationships.

△ Theory ⟷ Practical

○ Confidence — Seeking affirmation — Lacking confidence

□ Past — present — ~~future~~ Knowledge
just in case

▽ Evaluation, feedback, refinement

✳ Connecting Knowledge ~~across se~~ between settings

More than just a single word

Appendix F. Explicated meanings

The following is a list of explicated meanings from researcher comments for the December set of interviews.

Meanings for Andrea 1

Significant peer support.

Provoking an emotional response.

Perspectives on the act(ion) of teaching.

Fitting in - establishing roles / changing roles

Knowledge across arenas and situations.

Considering pedagogy.

Meanings for Allison 1

Interpretation of curriculum.

Managing work relationships.

Reflections on theoretical and practical knowledge.

Confidence - seeking affirmation, lacking confidence.

Past and present (just in time) knowledge.

Evaluation, feedback, refinement.

Connecting knowledge between settings.

Meanings for Bev 1

Experience affects emotional state / provokes an emotional reaction.

Linking the practical and theoretical.

Knowledge across situations and materials.

Preparing and managing content knowledge - plus perspectives.

Experiencing and managing challenge / complexity.

Meanings for Clare 1

Perspectives on and linking between material areas.

Necessity of preparation and validation.

Complexity of working relationship with teacher.

Placement shaping experience.
Developing the skill of moving between contexts.
Recognising difference between knowledge for making and knowledge for teaching.

Meanings for Dawn 1

Drawing comparison with own experience.
Effect of setting and pupils' experience.
Positive relationship with the teacher.
Reflections on pedagogy.
Perspective on (curriculum) content.

Meanings for Gordon 1

Significance of preparation.
Teacher micro- managing the experience.
Specific pedagogical approaches and embedded culture.
Comparing and working in different arenas.

Meanings for Ian 1

Learning to adapt quickly and make the experience manageable.
Experiencing support from the teacher.
Developing knowledge through action.

Meanings for Louise 1

Use of talk to support pupils learning.
Reconciling differences with the teacher.
Linking knowledge between arenas.
Challenge of work in new material areas.
Varying levels of confidence.

Meanings for Molly 1

Establishing an identity.
Breaking down knowledge into parts.

Balancing theory and practice.

Experiences in other settings informing school experience.

Intersubjectivity with teacher(s).

Perspectives on working with materials.

Meanings from Richard 1

Feeling exposed.

Revealing existing knowledge and experience.

Arena affect on personal learning.

Significance of preparation.

Activity supports learning.

Meanings for Zara 1

Collaborative learning.

Adjusting to teacher role.

Breaking down knowledge into parts.

Observations on the nature of practice.

Connecting university and school arenas.

Appendix G. Matrix

The matrix below contains all of the explicated meanings from the researchers comments and are colour coded according to aspects of the phenomenon.

Participant	December	March	June
Andrea	Significant peer support. Provoking an emotional response. Perspectives on the act(ion) of teaching. Fitting in - establishing roles / changing roles Knowledge across arenas and situations. Considering pedagogy.	Increasing confidence in teaching. *Focusing on self-development needs. More intervention than support from the teacher. Experiencing discomfort. Significance of planning.	Confidence with experience. Learning from (making) activity. Significance of relationships. Embedding practice / pedagogy. University to school 'transfer'
Allison	*Interpretation of curriculum. Managing work relationships. Reflections on theoretical and practical knowledge. Confidence - seeking affirmation, lacking confidence. Past and present (just in time) knowledge. *Evaluation, feedback, refinement. Connecting knowledge between settings.	Varied and changing relationships. Focus of theory. Activity supports personal learning. Making use of own school experience. Increasing autonomy / confidence. Materials – taking on the new.	*Dealing with assessment. Variance between arenas / placements. Drawing on own school experience. Teachers' expectations. Balancing theory and practice. Significant relationships (dialogue).
Bev	Experience affects emotional state / provokes an emotional reaction. Linking the practical and theoretical. Knowledge across situations and materials.	Linking materials. *Reflecting on personal agenda. Focus on resources. Teaching affected by staffing.	

	Preparing and managing content knowledge - plus perspectives. Experiencing and managing challenge / complexity.	*Increasing critique of arena.	
Clare	Perspectives on and linking between material areas. Necessity of preparation and validation. Complexity of working relationship with teacher. Placement shaping experience. Developing the skill of moving between contexts. Recognising difference between knowledge for making and knowledge for teaching.	Working outside of comfort zone. Constraints restricting experience. Significance of preparation / planning. Working with others. Staffing affected experience.	Making changes through practice. Value of making. Insider / outsider identity and team membership. Teacher feedback on content and delivery. Arena limiting knowledge development.
Dawn	Drawing comparison with own experience. Effect of setting and pupils' experience. Positive relationship with the teacher. Reflections on pedagogy. Perspective on (curriculum) content.	*Significance of language. Recalling / managing prior knowledge. University – school links. Refining pedagogy / activity. Significance of material areas.	
Gordon	Significance of preparation. Teacher micro- managing the experience. Specific pedagogical approaches and embedded culture.	Working with new (materials). Perception of self by pupils. Variable / various relationships.	Contrast between arenas. Learning from teachers' support. Working with the less familiar.

	Comparing and working in different arenas.	Factors affecting pedagogy and preparation.	
Ian	Learning to adapt quickly and make the experience manageable. Experiencing support from the teacher. Developing knowledge through action.	Emotional response to teaching. Experienced support from teacher. Learning through action. Managing confidence issues. Moving across materials. Significance of planning.	
Louise	Use of talk to support pupils learning. Reconciling differences with the teacher. Linking knowledge between arenas. Challenge of work in new material areas. Varying levels of confidence.	Constraints affecting experience. Working with unfamiliar knowledge. Confidence – experiencing variation. Significance of engaging pupils.	Arena affects content and pedagogy. Coping with the less familiar. University to school 'transfer'
Molly	Establishing an identity. Breaking down knowledge into parts. Balancing theory and practice. Experiences in other settings informing school experience. Intersubjectivity with teacher(s). Perspectives on working with materials.	Balancing theory and practical. Changing preferences of materials. *Awareness of limitations. Affected by arena / context. Significance of relationships.	University to school 'transfer' Variability of teacher support / control. Comparing teacher(s) and self – critique. Teachers' expectations. Link with own experience. Preparing resources.

Richard	Feeling exposed. Revealing existing knowledge and experience. Arena affect on personal learning. Significance of preparation. Activity supports learning.	Technical – simple balance / accessibility. Theory / practical balance. Working with the unfamiliar. Matching content / pedagogy to pupils. Using prior knowledge.	University to school 'transfer' Using resources and making things. Teaching the new. *Benefitting from variety.
Zara	Collaborative learning. Adjusting to teacher role. Breaking down knowledge into parts. Observations on the nature of practice. Connecting university and school arenas.	Teacher managing experience. Independent working. Arena affecting experience. Developing pedagogy./ preparation	

Relationships	Emotions	Comparison / connecting	Adaptation	Placement
Theory / practice	Confidence	New	Action	Pedagogy