Science teacher-educator intervention within an emerging Professional Learning Community

Henry Sykes

A Research & Development Project

Submitted for the MSc in Teacher Education 2020

DEPOSIT AND CONSULTATION OF THESIS

One copy of your dissertation will be deposited in the Department of Education Library via Oxford Research Archives where it is intended to be available for consultation by all Library users. In order to facilitate this, the following form should be inserted in the library copy of the dissertation.

Note that some graphs/tables may be removed in order to comply with copyright restrictions.

Surname	Sykes
First Name	Henry
Faculty Board	Education
Title of Dissertation	Science teacher-educator intervention within an emerging Professional Learning Community

Declaration by the candidate as author of the dissertation

1. I understand that I am the owner of this dissertation and that the copyright rests with me unless I specifically transfer it to another person.

2. I understand that the Department requires that I shall deposit a copy of my dissertation in the Department of Education Library via Oxford Research Archives where it shall be available for consultation, and that reproductions of it may be made for other Libraries so that it can be available to those who to consult it elsewhere. I understand that the Library, before allowing my dissertation to be consulted either in the original or in reproduced form, will require each person wishing to consult it to sign a declaration that he or she recognises that the copyright of this thesis belongs to me. I permit limited copying of my dissertation by individuals (no more than 5% or one chapter) for personal research use. No quotation from it and no information derived from it may be published without my prior written consent and I undertake to supply a current address to the Library so this consent can be sought.

3. I agree that my dissertation shall be available for consultation in accordance with paragraph 2 above.

Abstract

This study aims to observe a developing professional learning community amongst a mix of 8 beginning and experienced teachers who work in a science department in an inner-city secondary school. The study is framed around an intervention based on Japanese lesson study aimed at improving engagement in academic literature and reflective teaching practices.

Specifically, this action research answers the following questions:

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

   a) Based on a teacher-educator intervention, how does the PLC develop?
   b) What are the participants' perceptions of their knowledge development as a result of working within the PLC?

2. How is the PLC supporting the development of the teachers' knowledge?

This is done through reviewing literature related to; Teacher knowledge bases and how these bases can change, views on the nature of science, PLC's, lesson study, reflection, principles, identity, mentoring, peer relationships and social theory of learning. The literature is compared with data gathered from a reconnaissance survey, audio recordings of training sessions and post-intervention interviews. To answer the above research questions, the data gathered is systematically analysed using coding adapted from Wenger's (1998) work, 'Communities of Practice: Learning, Meaning and Identity'. Findings suggest, that within the research context, that the professional learning community emerges as a result of an alignment of individual principles with group principles. Hierarchical structures are necessary for collaboration within the group, however, as they emerge they may limit some knowledge development. Furthermore, the work suggests unstructured peer/group discussion and discourse is a way to develop teachers, however, time constraints limit the opportunity to do this. It is suggested for the future that the researched community of teachers could engage more critically with literature and Japanese lesson study and to develop the community, more attention should be given to exploring the relationship between the teachers.

Science teacher-educator intervention within an emerging Professional Learning Community.

Table of Contents

Contents	Page number
Introduction	5
Chapter 1: Research Rationale	7
Chapter 2: Literature Review	9
Chapter 3: Methodology, Research Methods and Ethics	34
Chapter 4: Analysis and Findings	55
Chapter 5: Discussion of the findings in relation to the literature and methodology	75
Chapter 6: Conclusion and implications for future research	87
References	90
Appendices	96

Introduction

The 2017 Migration Advisory Committee Partial review of the Shortage Occupation List for teachers, identified a shortage in teachers of general sciences, with this trend continuing in 2019 (Foster, 2019). Based on Initial Teacher Training (ITT) censuses nationally, targets for recruitment teachers in England have been missed every year since 2012 (Foster, 2019). Further to this, the 5-year retention rate within the profession for early career teachers dropped to 67% in 2017 (Worth, 2018). These points provide a backdrop for this piece of research.

Working as a secondary school head of science in an inner-city English school, I have, for the past 5 years, faced significant challenges in relation to the recruitment and retention of teachers. Out of financial necessity, as a school, we have looked to recruit teachers to the department from school-based teacher-education programmes, such as Teach First and Ark academies ITT. Taking this approach has placed a significant onus on myself and the experienced teachers in the department to provide training and support to these beginner teachers as they work towards QTS (qualified teacher status). Therefore, an understanding of how experienced teachers and beginners interact is significant to me professionally. Specifically, I am interested in how a mixed group of beginner and experienced teachers create opportunities to learn from and with each other. Therefore, this writing describes a piece of action research that I carried out to observe an emerging Professional Learning Community (PLC) in the described context. As Stoll et al. (2006, p.226) state,

> Developing professional learning communities (PLCs) appears to hold considerable promise for capacity building for sustainable improvement.

Through doing this research, it is my hope that I may, in some way, engender the community members to support one another and, potentially, create an environment where all learn and where all feel professionally supported to such an extent that they feel content to stay within the school and the profession. Furthermore, I hope that the emergence of a functioning PLC within the department will reverse the trend of the loss of expertise and ensure that the wealth of knowledge and perspectives within science teaching is retained and passed on to the next generation of teachers.

Chapter 1: Research Rationale

1.1- The nature of the research and the research questions

During the academic year 2019/20, the science department that I lead was given the opportunity to take control of a relatively sizable amount of time for continuing professional development (CPD). Historically, CPD was facilitated and managed at a whole school level. Therefore, as the researcher and as the departmental leader, I felt that to take this time to simultaneously carry out some research whilst fulfilling my professional obligations would make sense. Therefore, I designed the research around the work I had been tasked to do within the CPD sessions throughout the year.

In regards to my professional obligations, I had been briefed to carry out a minimum of 6 hours of group work with the science teachers in the school throughout the academic year, with the aim of the brief to develop the teachers' knowledge bases. Importantly this brief was fairly broad in scope and presented the opportunity to implement an intervention of my choosing. More details about the teachers (or research participants) are given in Chapter 3, however, they were a mix of experienced teachers and those new to the profession. From this, I considered how these teachers bring their beliefs, knowledge and experiences to bear working during CPD sessions. I, therefore, thought it would be worthwhile researching and consequentially developed the following research questions to underpin my work:

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

    a) Based on a teacher-educator intervention, how does the PLC develop?

b) What are the participants' perceptions of their knowledge development as a result of working within the PLC?

2. How is the PLC supporting the development of the teachers' knowledge?

In answering these questions, it is my hope that I will develop a better understanding of my professional work; something that has been summarised by others,

> "The notion of the teacher as a researcher is important. It is crucial to the growth of professional knowledge. It is a refinement of the intelligent engagement in an 'educational practice' .... it is a reassertion of the crucial place of professional judgement in an understanding of professional activity". (Pring, p.140)

It is my hope that this small-scale study might add something to the corpus of literature in relation to PLC's in teaching. However, the limitations of time and scale available to carry out this work were considered before commencing and based on these limitations I have made an effort to ensure that I do not make claims that are not justified by the data gathered.

1.2 Summary of Chapter

This is a small-scale piece of action research undertaken with the aim of investigating the emergence of a PLC amongst a group of experienced and early career teachers in a U.K. School. The scope of the research was dictated by the constraints and opportunities within the described context. Additionally, as the researcher I have dual roles within the research, i.e. head of department and researcher. To this end, the design of the research is dictated to some extent by my principles and professional obligations.

Chapter 2: Literature Review

This research is rooted in the work of a group of teachers, collaborating to develop their knowledge and practice. How they work together, how their identities and principles contribute to the progress of the group are arguably significant factors on how the group develops as a whole and how the individual participants develop their professional knowledge. The literature review attempts to explore what other writers have written in relation to these themes. In doing so, I hope to provide examples that can support my understanding of the nature of the PLC and how professional knowledge can develop and in turn address my research questions.

2.1- The nature of science and science learning

As part of the intervention for this research, teachers' understanding of the nature of science (NOS) and science teaching was a fundamental part of their educational history and current work and therefore their development within the PLC. In consideration of the aims of this work, discussing this topic also supports answering research question 1b. and is referred to in Chapter 5. Furthermore, knowledge of the nature of science is also foundational to science teaching, so it appears at the beginning of the review, as a reflection of this view point.

Brickhouse (1989, p.442), puts forward a view on science,

> Traditional philosophies of science have asserted that science is the search for truth and that as scientific theories progress, we come closer to knowing that truth. This view may be contrasted with more recent philosophies that believe that science consists of solving

problems and that scientific theories are tools to be used in solving problems and generating new research.

Kimball (1967) attributed the nature of science as:

- Curiosity
- Process orientated
- Dealing with knowledge
- Multiple scientific methods
- The methods of science are more in the realm of values than techniques
- Openness of mind
- Science as tentative

These two views about science and NOS illustrate the point that there is not universal agreement within the literature regarding the meaning of the term 'nature of science' (Lederman & Abell, 2014). With this in mind, to suggest that all teachers within this study have the same universal views on the nature of science is also questionable. Importantly, there is evidence that teachers' views on NOS heavily influences their behaviours in the classroom (Lederman, 1992). Therefore, to fully develop, it has been argued that teachers need to have a knowledge of NOS (Lederman, 1992). This can be problematic as teachers often confuse NOS with the practice of science (Lederman & Abell, 2014). In part, this may be a consequence of the lack of consensus generally in relation to the scientific method, the values of science and science as unique endeavours (Jenkins, 2007). Millar and Driver (1987) highlight how an interpretation of science based around unified rules for a scientific system would 'produce scientific knowledge at will' (p.41). To bring some congruence to the nature of science Donnelly (2005) suggests that the scientific body of knowledge is the disciplines unifier. In this Donnelly, neglects the social and cultural aspects of the nature of science (Millar and Osborne,

1998). However, arguably, to extricate human values from science could be problematic (Böhme et al. 1978). Abd-El-Khalick and Lederman (2000) from a scrutiny of literature with a focus on improving teachers' understanding of NOS suggests that it could be improved by exposing all science teachers to the cultural and historical contexts of NOS.

Some writers have observed that teachers often disregard NOS when making decisions in the classroom and that concerns in relation to personal accountability are overriding factors (Duschel and Wright, 1989). Additionally, with conflicting views on NOS, there is inevitably some disagreement as to how science is learnt. In a clear distinction, there is a view that learning science is active rather than passive and that new knowledge must be constructed by learners (Osborne and Gilbert, 1980). Added to this, that within school contexts, children's world views of science need to be taken into account when constructing this new knowledge (Driver and Easley, 1978); in this, identifying some themes of a Vygotskian constructivist approaches, defined as teachers helping students to construct knowledge (Tsai, 2002). Further perspectives on science teaching are discussed in section 2.10 rather than here, allowing for a more organised discussion on this topic that incorporates concepts from some of the subsequent sections of this Chapter.

2.2 Teacher Beliefs

Having discussed how the nature of science is significant to science teaching, I now discuss how teacher beliefs are also significant in teacher development. The themes from this section will support answering research question 1a. and 1b.

Research by Lederman and Zielder (1985) argues that teachers' philosophy of science does not impact on their practice and classroom behaviours. This 'philosophy' and other perceptions can be

broadly described as beliefs; 'tacit unconscious assumptions' (Kagan, 1992a) or judgments applied from accumulative understanding (Rokeach, 1968). There is a logical assumption that these beliefs will impact how a teacher behaves in the classroom (Richardson, 1996). However, it is suggested that teachers can be too constrained by circumstances to put their beliefs into practice (Levin and Ammon, 1991) and, importantly, for this work, there is a view that these beliefs are resistant to change (Koballa et al., 2000), with these beliefs often being formed prior to joining the profession (Anderson et al., 1995). Kagan (1992a) suggests that beliefs have been formed during the educational experiences of teachers as school pupils themselves. However, particularly significant to this research, as the science department has some beginning teachers, Hancock and Gallard (2004) noted that beliefs are often significantly impacted by teacher training programmes.

What then influences of teachers' beliefs? Nespor (1987), suggests that for beginning teachers their beliefs are distinguishable in six ways:

1. Assumptions that there exists matters that are beyond their control.
2. They are based on ideological stances rather than reality.
3. They are rooted in and rely upon teachers' ability to evaluate situations effectively.
4. They are influenced by teachers' memories of specific experiences.
5. They cannot be critically evaluated by others.
6. The specific context of where beliefs can be applied are not defined.

Conjecturally, based upon my professional knowledge, these are also beliefs that can potentially be held by experienced teachers. Further to this, for all science teachers their cultural contexts are a factor in determining teacher beliefs, with studies suggesting that when these cultural or indigenous perspectives are taken into account, beliefs can be changed (Ogunniyi, 2007), counteracting some of the views of Koballa et al. (2000). In relation to experienced teachers their belief system develops

alongside their knowledge through many years spent in the classroom, as pupils and as teachers (Pajares, 1992).

2.3- Teacher knowledge

As part of the action research I carried out an intervention to develop teachers' knowledge. In doing this I hoped to address research questions 1b. and 2. Therefore, reviewing the literature in relation to developing knowledge, gives some points of reference for understanding the change in teachers' knowledge.

To begin this section, I explore how different writers classify teacher knowledge. Ruzsnyak and Walton (2011) identify an issue with teaching that suggests there exists a problem within the profession, that teachers do not always have the language to discuss their knowledge. To counterbalance this, many writers have attempted to describe teacher knowledge bases, with many drawing on the work of Shulman (1986) who classified teacher knowledge within specific bases, (See *figure 2.3.a*).

Shulman's Knowledge bases	**Descriptor**
Subject matter knowledge (SMK)	Knowledge of the subject being taught
Pedagogical content knowledge (PCK)	Knowledge of practices and strategies to deliver and transform SMK. 'Understanding of what makes the learning of specific topics easy or difficult.' (Shulman, 1986, p.9)
Curricular knowledge (CK)	Knowledge of the curriculum

Figure 2.3.a

Shulman's concept of PCK conjecturally is an area of specific interest, as it is the knowledge a teacher acquires that allows them to transform the subject being taught into something that is pedagogically powerful and moves away from the generic or generalist knowledge of teaching strategies. Furthermore, PCK is useful to define as it describes how subject matter knowledge might be developed by beginner and experienced teachers alike (Grossman et al., 1989). Lee and Luft (2008) take the concept of Shulman's PCK and give it more description within seven bases: subject knowledge, strategies for teaching, resources, assessment, learners, purposes and curriculum organisation. Within this, the reintegrating of subject matter knowledge with some aspects of curricular knowledge, potentially creates ambiguity about the parameters of the meaning of PCK. Cochran et al. (1993) puts forward that PCK can be influenced by the context a teacher works in, and to an extent, the social and political landscape of this context. Other writers (McEwan and Bull, 1991) find congruence with Lee and Luft by suggesting that there is scope to remove the boundaries of knowledge bases entirely, arguably as Cochran et al. highlight.

Although Shulman's original idea of PCK is useful to explore teacher knowledge, the debate around the meaning of the term does in some ways limit it as a way to further discuss teacher knowledge. In contrast Rowland et al. (2005), working to develop a rationale for knowledge bases of primary mathematics teachers, in my professional view, constructed a more practical descriptor for teacher knowledge, known as the 'Knowledge Quartet'. Within this model Rowland et al. considers teacher knowledge within four broad bases. These bases can be summarised as follows:

Foundation: subject knowledge, purpose; identifying errors; underpinning of pedagogy; terminology; procedures.

Transformation: classroom demonstration; using instructions; representation of concepts; classroom examples.

Connection: making connections between procedures and concepts; sequencing; anticipation of complexity; recognizing appropriateness of concepts.

Contingency: responsive to students' needs; deviation from plans; insight.

The model of Rowland's et al. mirrors some of Shulman's original proposals in relation to PCK. For example, *Transformation* resonates with PCK, *Foundation* has elements of SMK and *Connection* has links to knowledge of curriculum and makes connections between concepts. Importantly Rowland et al.'s model introduces descriptors for the concept of *Contingency*, something that is missing from previous models of teacher knowledge. There is an argument that a knowledge of *Contingency*, requires a modicum of flexibility, something which can be problematic for beginner and novice teachers as they do not possess sufficient knowledge to adapt to meet the needs of their students (Calderhead and Robson, 1991).

2.4- Teacher-education

In situations where the beliefs of beginner science teachers are ignored, problems can arise as they attempt to build new knowledge over these existing beliefs (Anderson et al., 1992). Conjecturally, this will impact the work of all teachers as they become more experienced. Bruner (1996) describes this as new knowledge competing with the 'folk theories' that influence beginner teachers. Therefore, having discussed how to describe teacher knowledge, this section now discusses the literature with respect to how teacher knowledge and expertise can be developed. Through doing this, I hope to use the themes discussed to support answering research questions 1b. and 2.

Initial teacher-education can be broadly defined within concepts of professional growth, something that Kagan (1992b, p. 131) describes as,

> ...changes over time in the behaviour, knowledge, images, beliefs or perceptions of a novice teacher.

If teacher knowledge is manifested in practice, then the work of a teacher-education is to develop excellence in practice (MacIntyre, 1997). A model that can be applied for how teacher-education can happen within the context of my research is given by Clarke and Hollingsworth (2002). This 'interconnected model' named the 'Change Environment' shows the interplay between four domains of influence over teachers and their practice (see *figure 2.4.a.*) Within this model, the processes and cycle of enactment and reflection between domains provide a mechanism to describe how teacher knowledge can grow.

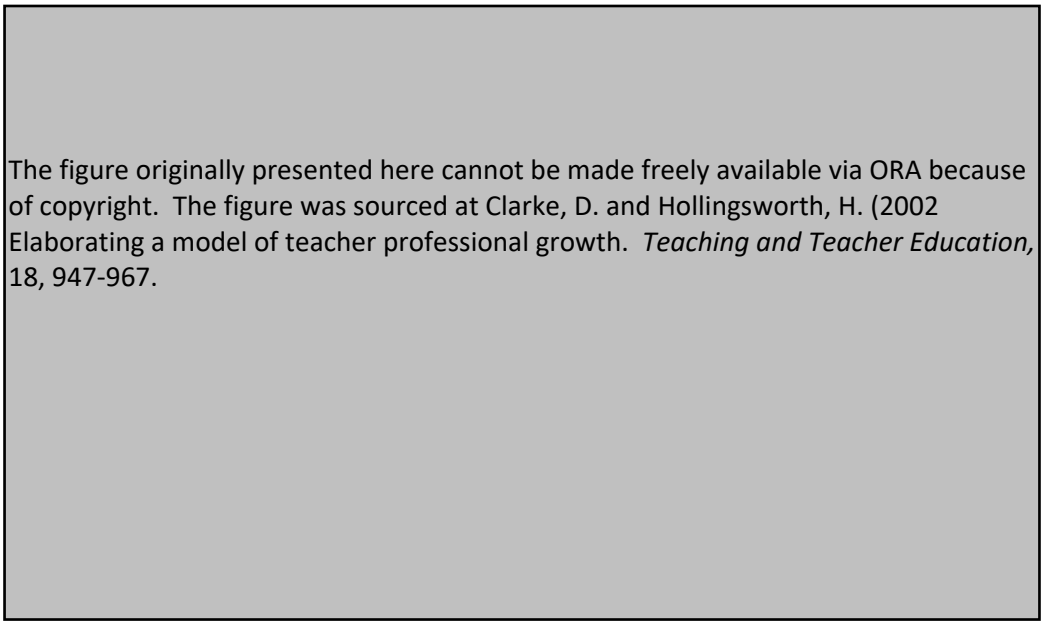


Figure 2.4.a. (Clarke and Hollingsworth, 2002, p.951)

Some writers have developed 'Stage Theories' to better understand teacher development and education. For example, Berliner (2004) describes the processes of building teacher knowledge and excellence within a period of 5 to 7 years, with Ericsson et al. (1993) putting it at 10 years. Berliner makes a clear distinction between experience and expertise, identifying that there is a dichotomy within this, suggesting that experienced teachers can have crystallised practice that doesn't necessarily transfer to expert knowledge.

Other writers have attempted to describe what teacher expertise is. Bransford (2001) rationalises this with identifiers of 'routinised expertise' and 'adaptive expertise'; suggesting that the latter is accustomed to, and expert in specific contexts of known parameters and routines. In contrast, the adaptive expert uses expertise within unfamiliar contexts, challenges their own thinking and has the ability to adapt to meet the needs of learners. In this, Branford's description of an adaptive expert, suggests that this categorisation of teachers would be heavily reliant on a contingent knowledge base, such as the one described by Rowland et al. (2005).

By contrast to the stage theories of Berliner and Ericsson et al., which arguably consider the progress and education of teachers over a long period of time, Fuller and Bown (1975) present a model of stages of development for beginner teachers. In this model they identify that beginner teachers develop through stages identifiable as concerns. This begins with a concern about 'survival' progressing to concerns about 'classroom tasks' and finally concerns for 'the learning of pupils'. Special consideration is also given to the development of beginner teachers by Furlong and Maynard (1993) in their study of primary beginning teachers. Like Fuller and Bown they categorise the concerns of this group, however, their model takes personalised views of beginner teachers and conjecturally considers their principles as follows: 'early idealism', 'personal survival', 'dealing with difficulties', 'hitting a plateau' [and] 'moving on'. (p.73). Importantly, these writers consider that each stage is not distinct and new teachers can move back and forth between these stages over a period of time. In contrast, Burn et al. (2003), suggests that beginning teachers only have concerns about learners much later in these stages whereas the researchers above argue they do consider learning much earlier.

To give some rationale of how to approach the design of teacher-education, Shulman (1987) gives a template for how teacher knowledge is constructed, naming it 'pedagogical reasoning'. With some similarities to Rowland's et al.'s (2005) knowledge quartet, in particular *transformation*, Shulman's model suggests that teacher knowledge grows through critical interpretation, representation and tailoring of thoughts and processes.

Carter and Doyle (1987) make a pervasive point when they identify that knowledge construction is dependent on experiences. With this in mind, care must be taken by teacher-educators when facilitating experiences for developing teacher knowledge and practice. Hagger and MacIntyre (2000) suggest a way of addressing this and highlight engagement in educational research literature as an experience that can inform practice; a significant point, as this was pursued within the

methodology of this research. Further to this, Korthagen and Kessels (1999) explore a framework for introducing a more informed approach to teacher-education called 'The realistic teacher approach'. In this they suggest a framework for how teachers develop theories and potentially counteract a common teacher belief that copying past teachers will bring about expertise (Calderhead, 1988). They propose that teachers form initial thoughts around events and experiences, naming these first impressions as *gestalt*. Importantly the writers identify that *gestalts* are unconnected, however through the mechanisms of reflection *gestalts* become connected to form *schema*, which in turn, can develop into personal theories, something the authors name *phonesis*. These personal theories are formed within the specific context of individual teacher's work, however, Korthagen and Kessels suggest that within this framework teachers can be presented with alternative theories, potentially rooted in educational research, naming these external influences as *episteme.* In this, the role of the teacher-educator is to support the teachers through the process of moving from *gestalt* to *schema* to *phronesis* and that the teacher-educator should only introduce theory (*episteme*) from empirical research.

2.5 Identity

There are arguments within the literature, explored below, that suggest that knowledge formation is dependent on identity, (see for example Elbaz, 1983). I therefore give a brief example of some pertinent literature in relation to professional teacher identity. As will be discussed in Chapter 3, my role within the research is threefold, and as a teacher-educator with responsibility for teacher development within the context, how my identity and knowledge, along with my principles influence the knowledge development of the participants is of interest. Therefore, in addition to discussing teacher identity, I also explore teacher-educator identities in more detail. In doing this I also support answering research questions 1a., 1b. and 2.

Within the literature, Gee (2001) recognises the shifting identities of professionals within differing contexts. To support in analysis of these identities, Gee simplifies professional identities into 4 categories, as follows:

- *Nature identity (NI)* - how our behaviours are influenced by our nature.
- *Institution identity (II)*- how our behaviours are influenced by the positions we occupy.
- *Discourse identity (DI)*- how our behaviours are influenced by our recognised accomplishments.
- *Affinity identity* (AI)- how our behaviours are influenced by certain affinity groups.

These identities have relevance for the behaviours of teachers and of teacher-educators and arguably provide more detail to Clarke and Hollingsworth's interconnected model. In particular, the significance of how identities influence the '*personal domain*'. For example, the *Affinity identity* will be important in the personal domain in how knowledge and beliefs develop in collaboration with others in PLC's. Wenger (1998) makes reference to this concept describing how identities 'translate into a form of individuality defined with respect to community' (p.152); something he labels *Mutuality of engagement*. He argues that individuals' identities manifest in actions in a community or enterprise and consequently these identities account for the ways of the community; something he names *Accountability to an Enterprise*.

To refer to teacher-educators, their identities can be classified as *school persons, scholars* and *researchers* (Ducharme, 1986); however, this writer gives little detail of the meanings of these terms and therefore adds little to the understanding of how the identities of teacher-educators influence their work. Ducharme (1986) further describes teacher-educator identities in essentially binary terms as 'school person/school-based practical teacher-educators' or as 'university-based research/ scholars'. This point does not reflect the changes in teacher-educator identity in the U.K, whereby

with the introduction of school-based teacher-education programmes, such as Teach First, that requires school-based practical teacher-educators to have knowledge bases and identities that have some parallels with their university-based researcher counterparts. Furthermore, it suggests that the knowledge base of a school-based teacher-educator would be lacking when implementing teacher-education strategies such as the Korthagen and Kessel's (1999) 'Realistic teacher-education Approach'. Within Ducharme's identification, there exists a point of conjecture that suggests the identity of a school-based teacher-educator is unclear. This may be because this type of teacher-educator has often transitioned from the identity of a teacher and therefore has to reinvent their new professional identity (Bullock and Christou, 2009); something which has personal resonance as I transition in my role within this project.

2.6- Principles

In section, after the exploration of identity above, I discuss teacher principles and teacher-educator principles. The principles that I, as a teacher-educator, bring to bear within interventions with participants influences, not only the outcomes of this study, but also the development of the participants. For example, I agree with Doyle and Ponder (1977), when they identified the fundamental principle that through practical action educational change can happen. With this in mind, this section supports answering research questions 1a. and 2.

There are many differing assertions within the literature of what teacher principles are. However, within England, the U.K government hold teachers professionally accountable within specific principles, summarised as,

> Teachers make the education of their pupils their first concern.... Teachers act with honesty and integrity; have strong subject knowledge, keep their knowledge and skills as teachers

> up-to-date and are self-critical; forge positive professional relationships; and work with parents in the best interests of their pupils. (Teachers' Standards, 2020).

Arguably, many teachers hold principles related to the importance of relationship building in successful teaching; a principle that is also perceived to be relevant to successful teacher-education (Korthagen et al., 2006). With specific reference to teacher-education, researchers have investigated the principles prevalent in education programmes (see Appendix A.). Common themes within this analysis suggests that within the design of teacher-education programmes the principle of building relationships along with scaffolding to support learning are significant (for example Grossman, 1990) and this will be key in my study of the development of a successful PLC. All identify the principle of the need for reflection or critical self-evaluation.

Finally, Loughran (2006, p.84) identifies the need for principles within teacher-education, but potentially also more widely in teaching with the statement,

> The principles that underpin our teaching must be clear and explicit not only to ourselves but also to our students if our beliefs and actions are to be more fully aligned in our teaching about teaching.

2.7- Social theory of learning and PLC's

As this research involves an intersection between, principles, identity and knowledge development; specifically, how these themes play out amongst a group of teachers working together. Consequently, this section explores how learning can happen within a social context. If relationships between teachers are central to teacher learning (Loughran, 2007), then it would appear that social learning is important. Therefore, this section supports answering research questions 1a.,1b. and 2.

Wenger (1998, p.5) places the social theory of learning as the 'interplay between community, practice, identity and meaning'. Central to the work of any learning community is the context in which the community is located and the relationship the community has to external influences; something Wenger describes as the *Local-global interplay.* For learning to happen, there needs to be shared experiences for teachers to understand teaching and learning (Berry and Loughran, 2002). Shulman (1999) puts more emphasis on this, placing this mechanism within the concept of scholarship. He identifies that for the scholarly work to happen, teachers must be a part of a professional community of learning. Further to this Nicol (1997) suggests that the work of teacher-educators is also dependent on relationships, where active listening happens. Much of the literature finds congruence with the views of Nicol and Shulman. For example, Korthagen et al. (2006) through a meta-analysis of three education programmes, showed that within each programme, participants viewed working with fellow professionals as a preferential way of learning. More importantly, they identified that teachers preferred working in horizontal peer to peer structures rather than traditional hierarchical structures, such as within the roles of mentor and mentee. To add further countenance to this point, it is seen that teachers, through shared reflection, can develop; in particular becoming more effective at analysing their own practice (Lyons and Pinell, 2001). However, Guskey (1999) comments that, although social learning is beneficial, it can result in shared ignorance, particularly within mentor/mentee relationships.

Key to my role of teacher-educator and a head of department, and my priority, is the need for teachers to change their behaviours and develop understanding of their practice. Rogmagnano (1994) highlighted the importance of collaboration to change behaviours. Therefore to create a community of practice or professional learning community is arguably key to building the infrastructure to sustaining improvements in teaching and subsequently pupil learning (Stoll et al., 2006). Therefore in continuing this section, having discussed some of the literature in relation to

social learning, I now explore what has been written in relation to PLC's; where social learning manifests itself.

As Stoll et al. (p.223) identify there are different interpretations of PLC's however, they claim them as,

> .....a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way.

The argument that teachers need supportive and engaging working environments in order to increase their abilities (Lewis, 1995), is a rationale for developing these communities. Much of the literature in relation to PLC's does not show quantitatively their impact on teaching and learning, with Mclaughlin and Talbert (2001) identifying that teaching communities can be strong and cohesive, however, not conducive to learning and change, with a preoccupation with sustaining 'traditions' amongst the community (Little, 1999). Wenger (1998) describes communities of practice as places where there is a shared narrative or history of learning, perhaps counterbalancing Little's identification of the lack of learning that can happen when sustaining traditions amongst a group. However, within this a tension can be created whereby members of the community must resolve their personal practices and beliefs that conflict with the agreed practices of the community (Jenlick and Jenlick, 2008). Wenger highlights a danger of not resolving this issue when suggesting that withdrawing from participation in community practices can result in individuals becoming marginalised.

To give more meaning to the term PLC, in a meta-analysis of other researchers into the work on the concept of community, Westheimer (1999) distils five attributes:

1. Shared beliefs and understanding
2. Interaction and participation
3. Interdependence
4. Concern for individual views
5. Meaningful relationships

With reference to teacher principles, de Lima (2001) sets out the imperative that forming a community of learning is dependent on the participants having a shared sense of duty to develop pupil learning and well-being. Hayward (1997) identifies that beginner teachers occupy vulnerable positions in schools; a point pertinent to the context of this work and underpinned by the necessity to develop Westheimer's attributes within a group. Within school contexts professional accountability exists, therefore, to support the development of a PLC, Fullan (2001) suggests care should be taken to shift focus away from cultures of accountability to cultures of developing shared norms and values.

Within this there are questions about how the effectiveness of a PLC is measured and within the context of this research, how I can remove a sense of accountability? Many writers have looked at the outcomes of pupils (for example Wiley (2001)) and judged the presence of PLC amongst teachers as beneficial, but arguably producing meaningful data to support this correlation could potentially be problematic.

In parallel to Westheimer's attributes of a community other writers (Hord,2004; Louis et al., 1995; King and Newman, 2001) have suggested that there are ways to develop a community:

1. Shared values and vision
2. Collective responsibility
3. Collaboration

4. Reflective professional inquiry
5. Group and individual learning is promoted

In this, these five concepts neglect the need for members to have,

> .... a solid basis of expert knowledge and skills, strongly emphasising the professionalisation of teachers' work through increasing expert knowledge. (Stoll et al. p.232)

In addition, these writers do not include openness and seeking resources outside of the school context (Stoll et al. 2006), in a way neglecting to consider the *external domain* as suggested by Clarke and Hollingsworth (2002). Wenger (1998) addresses this when highlighting the importance of 'joint enterprise' and the recognition that tensions could exist between engaging with external stakeholders or resources, whilst attempting to retain a sense of 'indigenous enterprise'.

Literature exists that comments on the development and sustainability of a PLC. Wenger (1998) describes the emergence of structures within PLC's and references *Generational Encounters*. A term that is pertinent to this work, it describes the relationships individuals hold with one another based on their identities and status within the community.

2.8 Reflection

A key element of a professional learning community is collaborative reflective practice (Wenger, 1998). As Loughran (2007, p.93) states,

> There is little doubt that being metacognitive (questioning one's own learning, or thinking about one's own thinking); becoming more aware of the thoughts and actions that influence the development (or not) of one's own understanding, offers insights into teaching and learning dramatically different to being told what to know and how to think.

Therefore, during the implementation of the intervention aspect of the research, in order to observe the developing community of learning and address research question 1b. and 2., I endeavoured to include time for the participants to reflect on classroom teaching practices. Consequently, in this section, I briefly discuss some pertinent literature.

Dewey's 1933 work, gives a framework for reflection and reflective cycles, suggesting that the reflection progresses through the following 5 stages:

- **Suggesting**- acknowledging new ideas within situations.
- **Problem seeing**- Considering problems within contexts or situations.
- **Hypothesis formation**- Developing new ideas in relation to problems under consideration.
- **Reasoning**- Making links with previous experiences to the problem under consideration.
- **Hypothesis testing**- Creating and testing solutions to the problem under consideration.

For the successful implementation of this cycle, Dewey suggests that participants must have three attributes; *open-mindedness*, *whole-heartedness* and *responsibility.* Grumet (1990) draws parallels with reflective cycles with teaching mechanisms and therefore suggests that, in this, reflective cycles within teaching can equate to research. To support Dewey's concept, Schön (1983) suggests that reframing situations and considering them from different perspectives helps understanding. Furthermore, it is a way to discuss and make professional knowledge explicit (Korthagen et al. (2001) and from this allows teachers to make changes to their pedagogical practice (Dinkleman, 2003). A

concern that can be applied to a model, such as Dewey's is that teachers can become more descriptive than reflective, particularly, during teacher observation analysis (Murray et al.,2009).

The challenge as a teacher-educator is how to successfully implement the different ways to reflect as discussed above. Lesson study does seem to offer these opportunities and this will be outlined in the next section.

2.9 Lesson Study

As John (2002) suggests, teachers need to have shared experiences to discuss and reflect upon teaching and learning. However, in relation to experienced teachers, activities such as shared lesson planning have been seen as a way to placate administrative obligations (Calderhead,1996); exemplifying a misunderstanding that teacher-education constitutes 'showing and telling' (Myers, 2002). Further to this, modelling teaching practice as a teacher-educator rarely goes beyond instructional expertise (Greene, 2004). With this in mind, lesson study is propositionally a way to enact John's view. Therefore, within this study an intervention was carried out with a group of teachers which is described in detail in Chapter 3. At the core of this was a Japanese lesson study, and the vehicle through which to develop the PLC and individuals' knowledge around a shared experience. This therefore appears in this section of the review primarily to develop the concept of lesson study in the context of this research, but also to support addressing all the research questions.

Japanese lesson study or *jugyou kenkyuu* is centred around cycles of group teacher planning, observation of classroom practice, followed by a group analysis and reflections on data gathered from observations (Lewis, 2002). Importantly the observed or 'research lesson' are,

regarded not as an end in themselves but as a window to the larger vision of education *(Lewis et al., 2006, p. 3).*

Details of the mechanism of lesson study are given below in *figure 2.9.a*. as proposed by the Teacher Development Trust Network (2020).

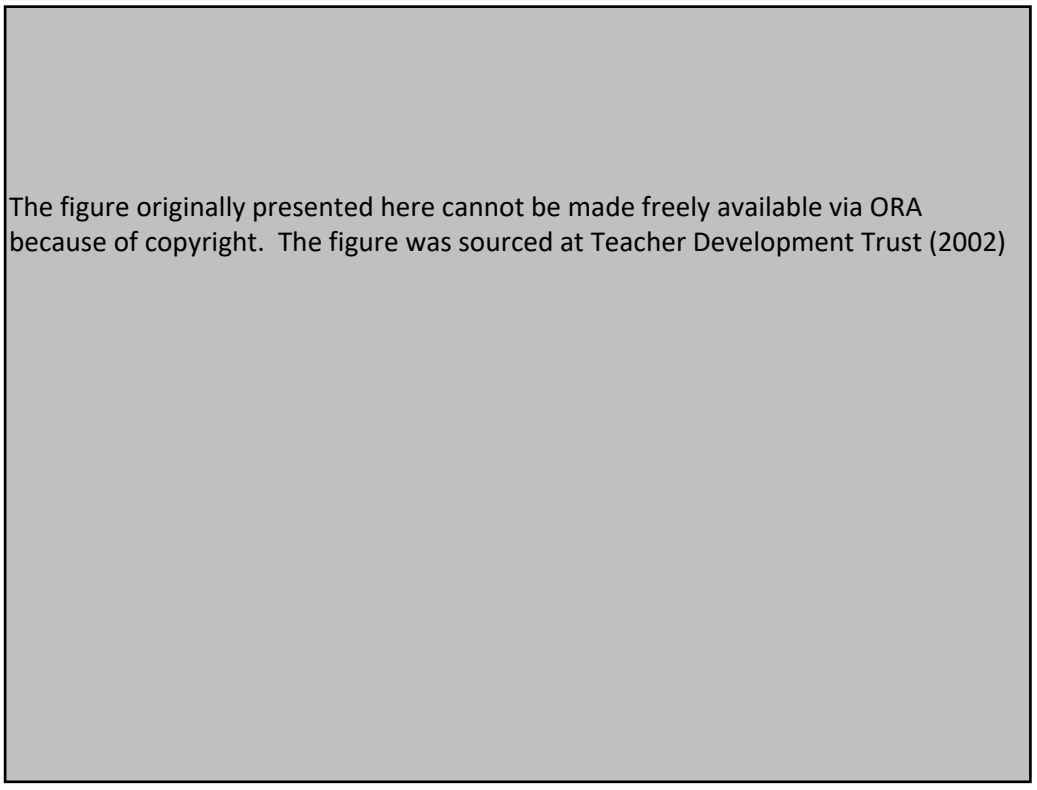


Figure 2.9.a. (Taken from the Teacher development trust, https://tdtrust.org/what-is-lesson-study/, 2020)

These mechanisms fit within the consensus of scientific enquiry (Feuer et al., 2002), however the collection of data within a classroom is from a small sample, therefore the mechanism when described as scientific has some shortcomings (Lewis et al.,2006). Nevertheless, lesson study has been seen as a way to improve teacher knowledge (Lewis et al., 2013) and to foster collegiality amongst groups of teachers (Taylor et al., 2005). Significant for this research, it has also been seen that through the use of lesson study, professional learning communities can be sustained beyond the original parameters of the community goals (Doig and Groves, 2011). In their action research study with small groups of American science and maths teachers Groth et al., (2020), suggested that lesson study helped to facilitate reflection amongst teachers. In addition, they identified that through lesson study there was a reduced sense of professional isolation; something that is a potential cause for teachers leaving the profession. Within this study the writers also noted the challenge, as facilitators, of stimulating conversations amongst the teachers without taking over. Amongst the groups they also noted that beginner teachers focussed more on general pedagogical concerns rather than focusing on content specific pedagogy. This showed some parallels with some of the concepts presented in Berliner's (2004) stage theory.

2.10 Approaches to science teaching

A central constituent of Japanese lesson study is observation of teaching practice. Therefore, in this final section, some of the literature in relation to approaches to science teaching are briefly explored as they were examples of approaches implemented, discussed and reflected upon in lesson study. Conjecturally, this section has some parallels with teacher beliefs, however, the models for science teaching discussed here were also used as resources, explicitly as part of the lesson study. Therefore, the literature reviewed here supports answering research questions 1b. and 2.

Tsai (2002), whilst looking at the intersection of teacher belief and practice amongst Taiwanese science teachers, categorised teaching into three broad groups, defining them as:

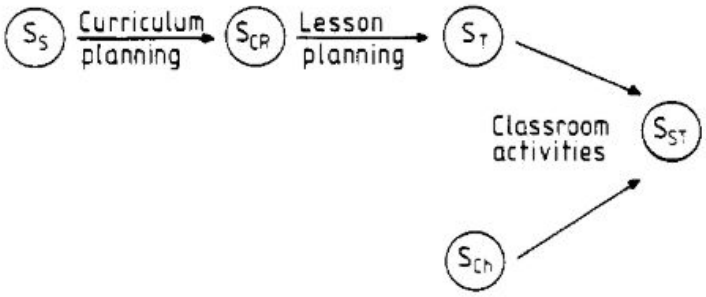
- *Traditional*- Teachers transfer knowledge to their students.
- *Process*- Through problem-solving and doing the process of science teachers facilitate the transfer of knowledge.
- *Constructivist*- Teachers support their students to construct new knowledge.

Of these three, constructivism is an approach that has been commonly used and interpreted for school contexts (Driver and Bell, 1985); specifically taking the view of Vygotsky (1978) that through conversation and involvement in shared activities children can have profound changes in their understanding. Importantly Richardson (1997), highlights that constructivism is a theory of the way people learn rather than how they should learn. Nevertheless, others have taken the constructivist view and given further pertinence to science teaching. For example, Neidderer (1987) put forward that the conversations, such as the ones highlighted by Vygotsky, ought to include an acknowledgement of the differences between scientific and everyday perspectives. In the work presented by Gilbert et al. (1982) take this further when they propose a series of assumptions that teachers make within conversations with pupils in the classroom, classified as follows:

- **Blank minded assumption**- Teachers assume pupils come to classrooms with no prior knowledge of science.
- **Teacher dominance assumption**- Teachers assume that pupil knowledge is insufficient and prevailing teacher knowledge is of greater significance.
- **Student dominance assumption**- Teachers assume that pupil knowledge is sufficient to use this knowledge to develop further understanding.

In this, the writers arguably make some links with the principles that teachers hold, to the basic descriptions given by Tsai and give some meaning to how these principles can be enacted. Within

the paper they show a preference for classrooms where student dominance is used to co-construct new understanding. A rationale for this is given in *figure 2.10.a.*



S_s- Scientist's science

S_{cr}-Curricular science

S_T- Teacher science

S_{ST}- Student science

S_{Ch}- Children's science

Figure 2.10.a (Adapted from Gilbert et al., 1982, p.63)

In this model they propose that knowledge bases of scientist's science (S_s) and science curriculum (S_{cr}) understanding converge through curriculum and lesson planning to create the overall knowledge base of a science teacher (S_T). This knowledge can be used either through the concept of blank minded or teacher dominance assumptions to create new scientific knowledge within students (S_{ST}). They argue that children's views of science (S_{Ch}), i.e. their misconceptions and preconceptions, ought to be incorporated into classroom activities in order for more meaningful construction of

student scientific knowledge (S_{ST}). With this approach they show some parallels with the work of Posner et al., (1982) and support arguments that it is desirable that teachers have a 'concept of teaching as a conceptual change' (Hewson and Hewson, 1987, p.439). Furthermore, there are links between this approach to teaching, something that Cooper and MacIntyre (1995) describe as 'reactive teaching' whereby teachers need to respond to the interest and responses of pupils. Arguably, this can create issues for teachers as they attempt to utilise contingent knowledge as described by Rowland et al. (2005). It is these more constructivist views of science teaching we will be exploring through lesson study and, in doing so, aim to develop as a PLC.

A point of note, is that the work of Gilbert et al. (1982) described above, was also used by the participants during the intervention of this research, as will be described in Chapter 3.

2.11 Summary of Chapter

This Chapter aims to outline the literature pertinent to the scope of this research. In particular, there is a focus on how teacher knowledge, beliefs, principles and identity intersect. From this, there is a review of how teacher-education can develop teacher knowledge. The second half of the review focuses on the literature that is pertinent to the intervention aspect of the research. In particular, there is consideration of how teachers learn socially and construct professional learning communities. Finally; reflection, lesson study, and approaches to science teaching are explored as specific examples of mechanisms that were enacted as part of the research.

Chapter 3: Methodology, Research Methods and Ethics

In this Chapter, I aim to describe how I employed a methodological approach in research to answer the research questions; along with an account of the intervention I employed to investigate a professional learning community within my secondary school science department. Additionally, I comment on why specific approaches to the research were taken; paying particular attention to the ethical considerations for the research, along with some comments on the choice of specific methodological instruments. The Chapter is organised in the following way:

- 3.1 The context of the research
- 3.2 The researcher and the research participants
- 3.3 Methodology rationale
- 3.4 Data collection rationale
- 3.5 Data analysis rationale
- 3.6 Ethical considerations
- 3.7 Summary of the Chapter

3.1- The context of the research

The school is a small inner-city all-girls' faith English secondary school with a cohort of approximately 750 on roll. The number of pupils receiving Pupil Premium funding - a poverty indicator for pupils in England - sits relatively high, at 51%. Pupils are generally keen to learn, however behaviours of some can be challenging.

Between 2010 and 2019, and largely in line with national trends (Britton et al., 2019), the school has seen an 8% real terms reduction in funding. Within the last 3 years, teaching redundancies and structural changes have been made to reduce the expenditure of the school. Furthermore, a reluctance of school leaders to invest in external providers for teacher-education, has increased the reliance on middle and senior leaders within the school to provide teacher-education opportunities. In turn, this has impacted on the sense of 'good-will' amongst the teaching staff and has arguably made the challenge of engaging staff in school-led teacher development more challenging.

For the preceding five years, and in line with national trends, (see Foster, 2019) the science department has faced challenges in relation to recruitment and retention of teaching staff. This, in conjunction with the school's drive to reduce staffing costs, has resulted in the department transitioning to a policy whereby recruitment is almost exclusively from school-based Initial Teacher Training (ITT) providers. This route of training expects trainees, contracted by the school, to take on significantly larger teaching responsibilities than through traditional teacher training programmes. This has placed some pressure on some of the more experienced department members. To facilitate this, the school has provided some training opportunities to develop individual mentoring capacity.

3.2- The research participants and the researcher

3.2.1- The research participants

All the participants are currently members of the science department in the described context. The science department consists of a mix of experienced and new teachers, all of whom consented to participate in the research. Most are teachers born in the U.K. after 1982, experiencing a U.K. style primary and secondary education that would have, from 1988, generally followed the National Curriculum. All continued their education in U.K. universities, with *Figure 3.2.a* containing further

information about the participants' educational backgrounds. These details have been included as they may give some insight into individuals' behaviours and responses throughout the investigation. The length of service of each individual has been included to demonstrate the nature of the development of the department as a group. Pseudonyms have been used to ensure their anonymity.

Teacher	**Basic information**
Sonia	Female, school education outside the U.K, born before 1982. Completed undergraduate study and Postgraduate Certificate in Education in the U.K. 15 years of teaching experience. Has been working in the school for 10 years. Holds a remunerated position of responsibility within the department. Biology specialist.
Alison	Female, British, state-educated (comprehensive) in the U.K., born after 1982, gained a Postgraduate Certificate in Education in the U.K. and has 6 years of teaching experience. Has been working in the school for 3 years. Holds a remunerated position of responsibility within the department. Biology specialist.
Camille	Female, British, state-educated (comprehensive) in the U.K., born after 1982. A Newly Qualified Teacher (NQT) trained in the school through the 'Teach First' programme. Has been working in the school for 18 months. Biology specialist.
Kate	Female, British, state-educated (comprehensive) in the U.K., born prior to 1982, gained a Postgraduate Certificate in Education in the U.K. and has 17 years of teaching experience. Has been working part-time in the school for 1 year. Biology specialist.

Aisha	Female, British, state-educated (comprehensive) in the U.K., born after 1982. Completing initial teacher training in the school through the 'Teach First' programme. Has been working in the school for 6 months. Biology specialist.
Raj	Male, British, state-educated (comprehensive) in the U.K., born after 1982. Completing initial teacher training in the school through the 'Ark-ITT' programme. Has been working in the school for 6 months. Chemistry specialist.

Figure 3.2.a

3.2.2 The researcher/ teacher-educator

In this section, I include some basic details about my educational and professional background; details which I feel are relevant when considering the choices, I made during the intervention section of the research. I also include some detail of my principles in relation to teacher-education. In doing this, I hope to give the reader further rationale for the purposes of this work.

I received a private/state secondary education in the U.K., studied as an undergraduate and gained a PGCE in the U.K. I have been a science teacher for 13 years and have been working as head of the department for science in the described context for 5 years. Some basic principles of my work that are pertinent include; collaboration is an effective way to learn, knowledge should be constructed, teachers need to feel empowered and this can be achieved through democratic processes.

3.3 Methodology rationale

As described in Chapter 1, the research questions were devised in response to the demands and obligations of my role as head of the department. The research was guided by my principles and values, something that Pring (2004, p.121) comments more generally upon,

> Educational practice consists of a range of transactions between teachers and learners. Such transactions are educational because they are guided by certain aims and values.... Educational research, therefore, must be centrally, though by no means exclusively focussed on these transactions.

I felt I had the choice to characterise the overall methodology as a case study, or action research. Therefore, some of the issues related to this choice are given below:

- Ferrance (2000), justifies that action research makes teachers more effective when they identify problems for themselves, examine and assess their own work, work collaboratively and help each other.
- There is an argument to say that the work done with this research is more applicable to a case study model as it is a study of an instance of a single bounded system i.e. a community (Creswell, 1994).
- Piggot-Irvine et al. (2015 p. 548) suggest, action research is 'a collaborative transformative approach with a joint focus on rigorous data collection'.

- With this emphasis on collaboration, pursuing action research is a way in which participants can 'reassert professional judgements' (Pring, 2004).
- The limitations of time for data gathering may not explicitly allow for using feedback cyclically to inform the direction of work; a characteristic that Kemmis et al. (2014) suggest is needed for action research.

Reflecting on these points, I felt that, despite some limitations, taking an approach based on action research would be justified.

There are differing interpretations of action research processes e.g Lewin (1946), Mckernan (1991), Bassey (1998). However, for simplicity, the plan for work was guided by five steps for action research suggested by Moroni (2011) (see *Figure 3.3.a*).

Step	***Description***
Diagnosis	Diagnosis of a problem; which involves what is to be investigated and the purposes of the action research, for example: to answer a research question, to test a hypothesis, to improve practice.
Planning	Planning an intervention to address the problem; which involves considering what the intervention will comprise, what data are required and how to gather them and what data-collection instruments are required.
Action	Putting the intervention into practice; which involves, consideration of timing and duration, participants, contents of the intervention.

Assessment	How far the intervention has met its objectives of solving the problem; which involves consideration of how to analyse and interpret data.
Critical reflection and communication of learning	Reflection on the experience and what has been learned and sharing this; which involves consideration of how to disseminate the findings.

Figure. 3.3.a - Adapted from Cohen, Manion and Morrison (2018) p.449

As described previously, the department had initially been allocated 6 hours of time in which I was to carry out some training and development with the group of participants. In my role as head of department, I considered the diverse needs of the participants, the economies of scale, my principles of constructivism and collaboration and my desire to give teachers agency. I therefore devised a strategy that pursued collaboration as a way of managing teacher development.

Using Morini's model helps to organise and describe the processes involved in each step of the research and intervention, therefore this section is subdivided into:

- 3.3.1- Diagnosis
- 3.3.2- Planning
- 3.3.3- Action
- 3.3.4- Assessment
- 3.3.5 -Critical reflection and communication of learning

3.3.1- Diagnosis

To begin the research, I sent out a survey for the department to complete within a seven-day period. The aim of this was to understand more about the participants' professional needs. I asked a series of questions about science teacher training and development (see Appendix B.). Using this method of reconnaissance, I hoped to gather some initial data that might be used for comparative purposes. Additionally, from this data collection, I was able to formulate a general point of view of the group as a whole, which would inform the direction of the next phase of the research. The data was analysed inductively, using some approaches similar to LeCompte and Preissle (1993) i.e. initial review to find phenomena, looking for relationships within these phenomena and creating working typologies to take forward.

3.3.2.- Planning

The themes from the survey analysis were presented to the group in an initial one hour planning meeting (see Appendix C. for presentation materials used). It was explained to the group that the outcomes from this meeting would form an intervention that would support their practice. The purpose of this intervention, from the research perspective, was to ensure that the group had, as a professional learning community, a shared experience and the opportunity to construct new knowledge, thus addressing the research questions. Within the meeting, the participants were presented with a choice about what themes they would like to discuss and how they would like to progress through future sessions. With some support from myself, at the end of this initial meeting the group decided upon a basic proposal:

1. Engage, as a group, with some academic literature related to science teaching.

2. Carry out one cycle of Japanese lesson study focussed on the themes presented in the literature; in this developing praxis or action through reflection (Kemmis,2009).

In this way, the participants' involvement in the planning of the intervention was a way to develop the PLC through a shared learning experience.

3.3.3- Action

The subsequent training sessions happened over a period of 3 weeks, details of which are presented in *Figure 3.3.3.a.*

Session	**Approximate Timing**	**General description**
Survey feedback (Meeting 1)	1 hour 30 mins	Feedback on the survey was presented to the group and the future direction of the intervention was collectively decided.
Engaging with literature (Meeting 2)	1 hour	With my support, the group decided to engage with some educational literature and spent time reading an article by Gilbert et al. (1982) (as reviewed in Chapter 2). Primarily the group focussed on one of the key themes of the article, which they reduced to a key question: *How do you plan and implement strategies in teaching that ensures that you bring forward pupils' preconceptions and misconceptions of science?*

Planning a lesson (Meeting 3)	1 hour 30 mins	To test their interpretations of the Gilbert et al. article, collectively the group decided upon a Japanese lesson study, using a model set out by the Teacher Development Trust Network (2020). The group planned part of a lesson to be taught, that reflected their interpretations of the article. The group agreed upon the format for the observation of the planned lesson and nominated a teacher to teach the lesson.
Observing a lesson	30 mins	The group observed 30 minutes of the lesson they planned.
Reviewing the observed lesson (Meeting 4)	1 hour 30 mins	The group shared reflections on the observed lesson.

Figure 3.3.3.a.

At the end of this cycle of sessions, data gathered was analysed (more detail of this is contained in section 3.4). The themes of this analysis formed the basis of semi-structured post intervention interviews conducted with four individuals within the group.

3.3.4- Assessment

Raw data was collected in the following ways:

- Survey sent out to staff electronically.

- All meetings and interviews conducted were audio recorded.

3.3.5- Critical reflection and communication of learning

Patterns emerging from meeting audio recordings were coded and were compared with individuals corresponding statements from the initial surveys and interviews. From this process findings were generated (see Chapter 4) and these findings were compared against literature (Chapter 5).

3.4- Data collection rationale

Having discussed the stages in the intervention for the action research in this section, a rationale is given for the data collection methods; specifically, how the data collected attempts to address the research questions (summarised in *Figure 3.4.a*). Below, each research question is presented within its own subsection. Each subsection contains some discussion as to how the data collection method addresses the research question and also makes reference to the limitations of the method of data collection.

Research question	**Data collection methods**
1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,	Reconnaissance Survey Audio recordings of CPD sessions Post intervention interviews

a) Based on a teacher-educator intervention, how does the PLC develop?	
1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically, b) How is the PLC supporting the development of the teachers' knowledge?	Audio recordings of the CPD sessions Post intervention interviews
2. How is the PLC supporting the development of the teachers' knowledge?	Audio recordings of CPD sessions Post intervention interview

Figure 3.4.a.

3.4.1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

a) Based on a teacher-educator intervention, how does the PLC develop?

(i) Reconnaissance Survey

I chose to use a survey to elicit teachers' perceptions of their professional needs (see Appendix B. for questions) in order to shape the direction of an intervention. The survey was relatively short and administered by email, designed to be easy and quick to complete. All participants responded, and the responses give a limited insight into the professional needs and knowledge of the participants. Without a follow up discussion to clarify individual teacher's responses, arguably some nuances and meaning were lost. However, the survey and subsequent analysis generated adequate information for the research to progress and therefore was considered sufficient.

(ii) Audio recordings of CPD sessions

The dialogue recorded between the participants demonstrated mechanisms by which teacher learning was happening; fundamental to the development of the PLC. In this, using this data in analysis should answer the above research question.

An advantage of gathering data in this way was that a large amount of information was generated. The recordings are limited to observing the initial teacher response and doesn't allow for interrogation of all the participants' views. To address this the participants were given the option to keep a journal as a record of their reflections. As a group, they opted not to do this, considering it to be too time consuming.

(iii) Post intervention interviews

The post intervention interviews were carried out individually within 2 weeks of the end of the final session. Audio recording ensured that thorough analysis could be carried out as it captured a relatively large amount of data. The interviews were conducted with four participants and generally lasted between 30 and 45 minutes. Unstructured interviews were chosen because it allowed me to use 'follow up' questions with the participants if I felt their comments were of interest or needed clarification. However, each interview began with me asking about how the participants felt about working collaboratively (see Appendix D. for further questions used). Due to their unstructured nature, some interesting angles of thought were discussed, with the participants commenting upon, for example, their views on collaboration or their own learning. Comments and views expressed in these interviews can be referenced against the literature to consider how the PLC is developing.

Due to time constraints, not all participants were interviewed. This limits the strength of the claims made in relation to answering the first research question.

.

3.4.2. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

b) What are the participants' perceptions of their knowledge development as a result of working within the PLC?

(i) Audio recordings of CPD sessions

The dialogue recorded between the participants is a manifestation of teacher knowledge. Analysing the utterances of individuals can provide a limited amount of information about their perceptions of what knowledge they develop.

(ii) Post intervention interviews

The views of the participants given in the interviews are directly linked to addressing this research question, i.e. what they say as their perceptions give an insight into their beliefs about how the PLC is supporting their knowledge development and what knowledge they have developed.

3.4.3. How is the PLC supporting the development of the teachers' knowledge?

I have justified the use of interviews and audio recordings above and these data sources were used to answer this research question.

(i) In the final interview some teachers talked about their developing knowledge bases in the unstructured interviews; through doing this it could show how individual participants' knowledge bases were changing over time.

(ii) Within the recordings of meetings, changing teachers' knowledge bases can be observed by comparing statements made within meetings.

There is a limitation to answering this question, with respect to some of the participants as either; they did not attend all meetings or they were not interviewed. This limits which claims can be made about changing knowledge bases of some of the participants; something that is reflected when evaluating the findings.

3.5 Data analysis rationale

The data gathered informed my thinking between each stage of the intervention and analysis. By coding and comparing to generate some findings I used some of the elements of a grounded theory as espoused by Glaser and Strauss (1967). I believed presenting and analysing the data using the same chronological order as the data collection would bring some coherence and demonstrate my thinking as the researcher through each stage. Cross-referencing the themes emerging from the coding processes with the literature was a way to further provide evidence to support answering the research questions.

Within the subsections below, I aim to describe in more detail how I approached the analysis.

3.5.1 Analysis of the survey

The purpose of the initial survey was to elucidate the participants' professional needs and therefore had to be inductive. Using a process of cross-referencing similar responses between participants was seen as a simple way to find general themes for the group discussion. Having a threshold of 3 congruent or similar statements between participants was considered to be significant enough to take forward to the planning phase. To be able to present a coherent summary of the survey to the participants, congruent views that tallied 2 or less were omitted.

3.5.2 Analysis of the audio recordings

Audio recordings were collected to address all the research questions. They were listened to inductively to consider emerging themes in the discourse. Due to my personal relationships to the

participants and therefore introducing my bias, I felt there were basic themes emerging as a result of individuals' identities. In light of this, I chose to revisit some of the work of Wenger (1998), who writes at length on the issues of identities within learning communities (reviewed in Chapter 2). In my attempt to make sense of this PLC I formulated a code based on an interpretation of some of Wenger's writing, as described in *Figure 3.5.a*. .By focussing on systematically coding the discourse within specific themes, I may have misinterpreted some of the statements made by participants. This is something which also must be considered when reviewing the findings of the research.

Category of discourse	**Code**	**Descriptor**
Accountability to an enterprise.	A	Demonstrates a teacher knowledge base to develop ideas and perspectives to progress group thinking.
Generational encounters	G	Participants demonstrate an identity typical of their professional status or role. e.g. departmental leaders creating dialogue.
Mutuality of engagement	M	Initiatives or participates in discourse.
Local-Global interplay	L	Refers to external factors or influences

Figure 3.5.a.

Each participants' utterances were placed within a code for each meeting. Importantly, it was considered that some utterances could be dual coded. A tally of codes per participant was made per meeting and presented graphically. This, with vignettes of typical responses, is incorporated into data analysis to give flavour and illustrative points which can be presented as evidence to address the research questions.

3.5.3 Analysis of unstructured interviews

Firstly, audio recordings of interviews were listened to for each participant and summaries of the individuals' responses are presented. These views were then compared with some of the participants' behaviours captured in the audio recordings of meetings. By doing this, I hoped to provide some evidence for addressing the research questions, in particular research question 1b. and 2.

3.6 Ethical considerations

An area of considerable ethical discussion were my roles within the research. As discussed earlier, within this work I had two roles; that of the head of the department and as the researcher. As the facilitator of much of the intervention, I was also a teacher-educator participant in the research. With this in mind, I subdivide the next section as follows:

- 3.6.1- Researcher
- 3.6.2- Head of department
- 3.6.3- Participant

In this, I hope to explain my stance in relation to each of my roles and how this has created some ethical conflicts which influence some of the design of the research.

3.6.1- Researcher

During the design of this piece of research BERA (2011) guidelines were consulted. The teachers that participated consented to data being collected about them. At each stage of the research, participants were giving the option to withdraw, should they feel the need to. The nature of the research was made explicit to each participant; specifically, how data was collected and how it was stored. To ensure the anonymity of the participants, they were given pseudonyms. The audio recordings from the research were securely stored and then deleted after analysis.

A point of note is that, throughout the research, the participants did not object to participating in the approaches chosen for the research.

3.6.2- Head of department

In my role I am responsible for the performance management of all teachers who participated in the research. In addition to this, I work as a teacher-educator mentoring the participants who are working towards gaining their QTS (Qualified Teacher Status) with the school. This created some real challenges regarding the design of the research and the authenticity of the data collected; specifically, the power dynamics and the relationships between myself and the participants. Within the design of the research, I aimed to reduce this issue as much as possible. A fundamental strategy I employed was to allow the teachers' views originating from the survey to dictate the initial direction of the research. Furthermore, I was explicit during the intervention to ensure that the

participants understood that the work they were doing was not related to the performance management or any school initiatives that they could be held accountable for. To ensure that teachers felt secure, I made a decision that they should not have to produce any work that needed to be done outside of the meetings. In doing this, I negated a potential concern of the participants that I was data gathering for performance management purposes. I also made it clear at each stage of the cycle that they had the choice to withdraw from the research; through doing this I hoped to give the teachers agency and a sense that they were empowered to make decisions. Even with these steps, it is unlikely that the process completely addressed the issue of power dynamics between myself and the participants. As a consequence, this needed to be taken into account during data analysis and when reviewing the findings.

3.6.3 Participant

I could be classified as a participant for the work I undertook within the group of teachers; I had a specific responsibility as a teacher-educator for developing the sessions, I also undertook the role of teacher in the observation section of the Japanese lesson study. Throughout the audio recordings, my utterances and therefore my principles, shape some of the dialogue. During meetings and interviews, I was careful not to express my opinions during some discussions; my reasoning for this being that I felt that the initial design was a sufficient expression of my principles and identity. To express my opinions too often in meetings, may detract from the research or result in the data gathered providing support for self-study, rather than for action research. To ensure that my voice wasn't dominating within the work, I decided not to analyse my interactions within the group.

3.7 Summary of Chapter:

This Chapter describes the methodology for the action research. The research is described using Moroni's model, whereby some reconnaissance was done in the form of a survey to identify the participants' professional needs. The planning aspect of the model involved the group of participants agreeing the direction for an intervention; settling on engaging with an academic article related to science teaching pedagogy, followed by a Japanese lesson study. The Chapter then continues to describe the rationale behind data collection and analysis. Specifically, it highlights how the data for the research is collected in the form of an electronic survey, audio recordings of collaborative planning/ reflection sessions and post intervention interviews. The Chapter then describes how the data gathered provides evidence for answering the research questions. Finally, the ethical considerations for the research are considered. In particular, the author's dilemmas in relation to occupying multiple roles within the research.

Chapter 4: Analysis and Findings

As highlighted at the beginning of this research report, the purpose of the work is to answer the following:

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

   a) Based on a teacher-educator intervention, how does the PLC develop?

   b) What are the participants' perceptions of their knowledge development as a result of working within the PLC?

2. How is the PLC supporting the development of the teachers' knowledge?

In this Chapter I present the data gathered from the research. In this, I aim to provide evidence of how the research allows me to develop answers to the research questions. To aid with the narrative of this Chapter, the data is organised and presented in the same chronological order as it was gathered. At the end of the Chapter, overall findings are presented against each research question. Therefore, the Chapter is subdivided as:

- 4.1 Reconnaissance survey
- 4.2 Meetings
- 4.3 Interviews
- 4.4 Summary of Overall Findings

At the beginning of sections 4.1 to 4.3, a short description of the events related to the data gathering are given. From this, the analysed data is presented. Some vignettes are given as typical examples of emerging themes and to give an overall perspective of teacher responses (Corden and Sainsbury, 2005).

4.1- Reconnaissance survey

The survey was undertaken to understand the participants' professional needs and to an extent, beliefs about science teaching; however, as this was distributed electronically, there was little opportunity to explore participants' beliefs in depth. The responses given by teachers were used to inform the next stage of the intervention cycle.

In order to systematically present participants' answers they are presented thematically in *figure 4.1.a*.

Participant	**General positivity to science teacher education.**	**Considers science teaching development as a professional obligation.**	**Prefer to develop science teaching practice over other areas of professional practice**	**Proposes that collaboration is a way to improve teaching practice**	**Proposes that observation/ reflection cycles are a way to improve teaching practice**
Sonia	✓	✓	x	✓	✓
Alison	✓	✓	x	✓	✓
Camille	✓	✓	✓	✓	✓
Kate	✓	✓	✓	✓	✓
Aisha	✓	✓	✓	✓	✓
Raj	✓	✓	✓	x	✓
Tally	**6**	**6**	**4**	**5**	**6**

Figure 4.1.a.

It can be noted that the teachers' responses show a considerable alignment, demonstrating a positivity to continuing science teacher-education. A typical response was put forward by Kate in relation to her feelings about her general positivity towards science teacher-education,

> More intense at the start of my teaching career, more about how to teach, classroom management and some science specific. I feel as though it is good, it would be good if it was more structured and regular. The Royal Society of Chemistry training has been very useful.

Camille summarises the general view on the importance of science specific teacher development,

> ....Yes, this is important because science-specific practice is unique from other subject areas. Therefore, the development of science teaching practice plays a significant role in improving the teaching and delivery of science. Ultimately, this can help to increase student engagement and outcomes.

All respondents also indicated that they consider science teaching development as a professional obligation. For example, Sonia said,

> We don't get a chance just to talk about science teaching in school very much. I think it's something I've often done on my own, but when I think about it, it's probably the most important part of my development.

With respect to collaborative processes in science teacher development the majority of participants made comments that showed a preference for collaborative processes and observation. With those who did not, they omitted language linked to collaborative processes rather than making statements that rejected them. A typical response given by Alison,

> Working together is useful, pooling of resources, open door observations, team teaching, open discussions of success and failure.

The table also shows that they do see observation/ reflection cycles as way to improve teaching practice. For example, a typical response from Raj,

> My training at the moment makes us do lots of reflection and evaluation after lessons. When I talk to people in feedback it helps to think about where I went wrong or right and what to do next time.

In summary, the data gathered from this section of the research suggested that the group showed aligned responses and potentially, from this, in relation to the development of the PLC, aligned principles and beliefs. Importantly they showed a belief that they have an obligation to take responsibility for their science teaching development. The teachers used language to describe their development that was linked to collaborative learning. This suggested that potentially a mechanism such as lesson study would be a successful way to develop the participants' knowledge within the PLC.

4.2- Meetings

As discussed in Chapter 3, the themes that emerged from the survey were used to inform the direction of the intervention cycles. Four meetings happened, therefore the data and some findings from each meeting is presented in turn. The analysis of the meetings provides evidence to answer all the research questions. As described in Chapter 3, these meetings were audio recorded. The discourse within the audio recordings is systematically presented using coding based on an adaptive interpretation of the work of Wenger (1998), as shown in *figure 4.2.a.*

Category of discourse	Code	Descriptor	Examples from the data
Accountability to an enterprise.	A	Initiates a new idea. Demonstrates a teacher knowledge base to develop ideas and perspectives to progress group thinking. E.g. knowledge of classroom practices, curricular knowledge, knowledge of collaborative strategies	Camille brings forward in meeting 4, discusses her knowledge of classroom management, to support discussions.
Generational encounters	G	Participants demonstrate an identity typical of their professional status or role. E.g. departmental leaders or experienced teachers dominate direction of dialogue, new and beginner teachers are diminished, new teachers present novel or unconventional perspectives.	Sonia, in meeting 1, as an experienced teacher, organises and asks questions of the group.
Mutuality of engagement	M	Initiatives or participates in any discourse.	Any participant speaks.
Local-Global interplay	L	Refers to external factors or influences. E.g. discusses resources, time issues or expectations set outside the PLC.	Kate in meeting 1, refers to the pressures of delivering good exam results for pupils.

Figure 4.2.a.

4.2.1 – Meeting 1

I gave a presentation to the participants (see Appendix C.), highlighting the findings from the reconnaissance survey, with some materials designed to generate discussion. After the presentation, a discussion took place amongst the group focussing on how they would like to progress for the next few meetings/ training sessions, concluding that they would like, with support, to read an article based on 'science teacher educational research'. The coded participant utterances were tallied and are presented in *Figure 4.2.1a*.

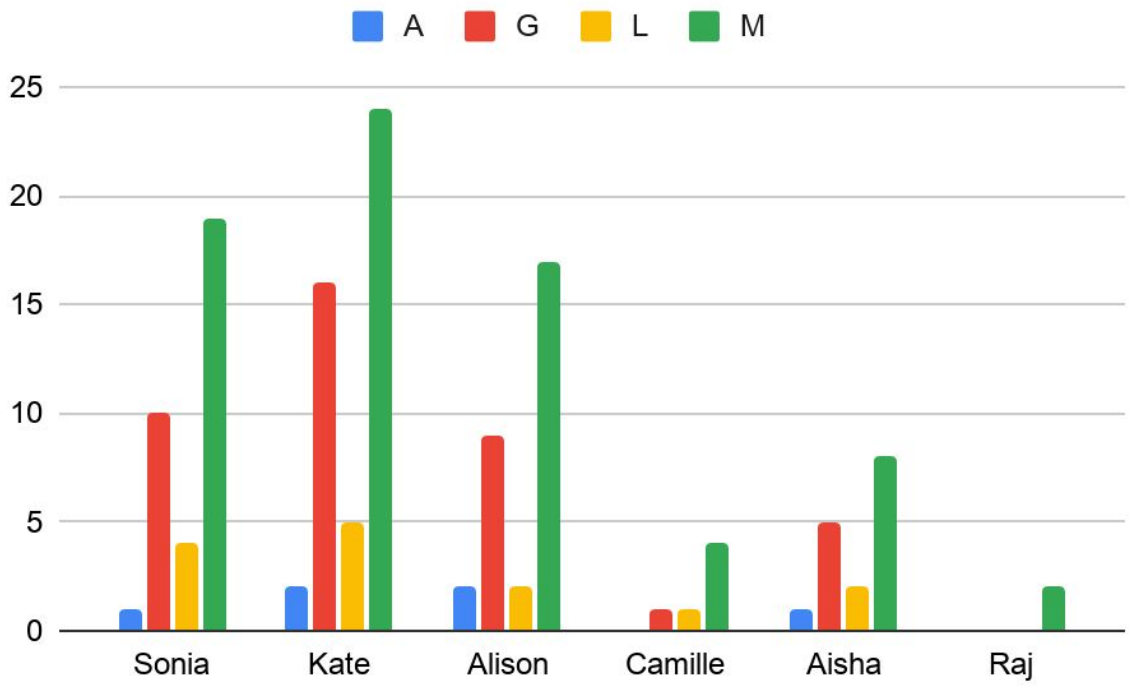


Figure 4.2.1a.

From an analysis of *Figure 4.2.1a*., it can be seen that there are emerging patterns within the group. As described in *Figure 3.2.a.* in Chapter 3, there are differences in the amount of teaching experience between the participants. This is reflected within the levels of participation, with the more experienced teachers' participation (Sonia, Kate and Alison) considerably higher than new or beginner teachers (Camille, Aisha and Raj). There is also an incidence of the experienced teachers with responsibilities within the department working as leaders within the group. A typical example of this is Sonia, who speaks often and brings forward external influences for discussion. For example,

> The problem we face is we need to try and do this in a way that means that what we do has an effect on the [exam] results.

There are few points within the meeting where participants bring forward their knowledge to develop ideas and alternative perspectives. This is potentially surprising, however, it can be rationalised, as the ideas discussed in the meeting were predetermined by the teachers' responses to the survey and by the presentation given prior to the discussion.

As an example, within a discussion about their physics knowledge, Alison asked Aisha and Raj to discuss their knowledge with the group. In these instances, the discourse is coded in a number of ways. Firstly, in asking a question to the beginner teachers Alison demonstrates a generational encounter (G), whereby she is aligning her identity with her professional status, (this has some echoes of Gee's (2001) work and will be discussed in Chapter 5). Secondly, in these questions, she also shows a mutuality of discourse (M) by initiating a topic to discuss. From this Aisha is able to engage in the discussion (M), furthermore in her response she is able to talk about her training to date with external providers, demonstrating her knowledge and understanding, something that creates further discussion amongst the group (A & L).

This vignette highlights some of the typical patterns of discourse within the meeting. Firstly, the more experienced staff talk more, behave in a way that would align with an identity typical of how others see them. In addition, beginner teachers talk less during this collaborative session. However, when new teachers speak, they can bring novel perspectives and ideas to discussions. Arguably, the lack of utterances from new teachers, in particular Raj, is an example of a generational encounter; however, to code this as such is problematic. It could be argued that there are issues of marginalization or an existence of peripheral members of the community, exemplified by Raj's lack of participation; something which may impact the learning of individuals or the group as a whole. To address research question 1a., I suggest that this meeting shows that collaboration is how the PLC develops; however, the participants do not have equal status in this collaboration.

4.2.2- Meeting 2

This was a short discussion of only 15 minutes - compared with meeting 1 lasting nearly 90 minutes - the beginning being dominated by my instruction giving, with the bulk of the time allotted to teachers to read the literature provided. However, the teacher discourse follows a similar pattern to the vignette described in meeting 1. *(see figure 4.2.2.a*).

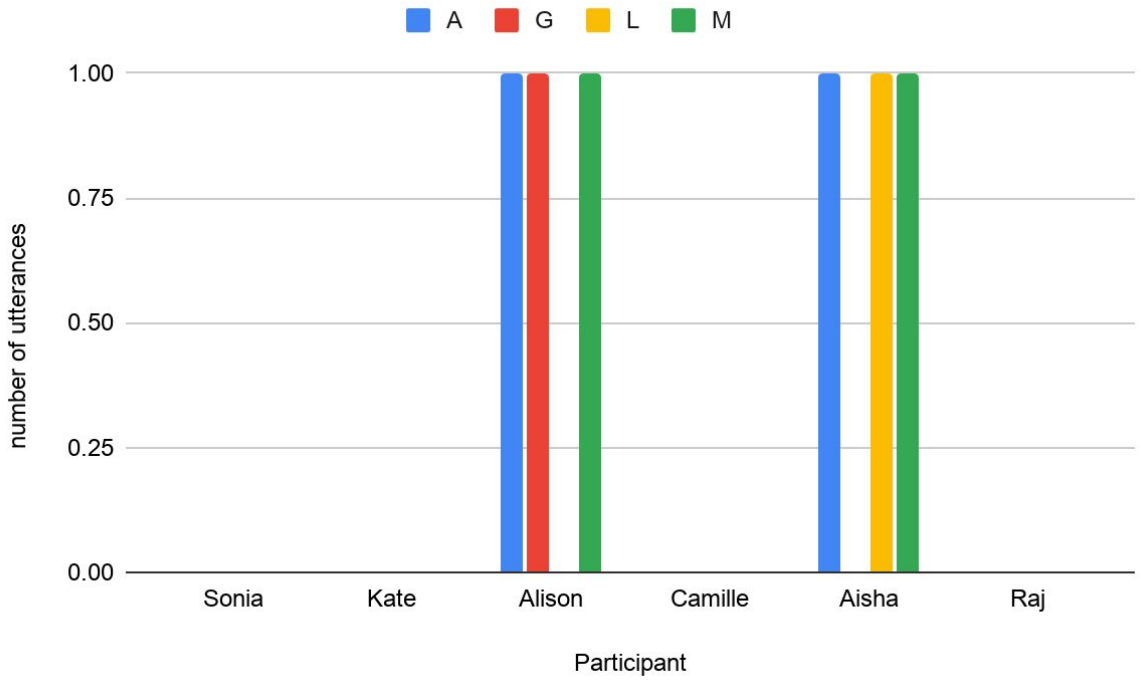


Figure 4.2.2.a.

4.2.3- Meeting 3

Meeting 3 lasted approximately 90 minutes, focussing on a planning session within the Japanese lesson study framework. During the meeting, I had less interaction with the group, I suggested lesson study as a potential tool for future work, then interjected only to stimulate or clarify points within the discussion. There was a silent period of 40 minutes as the group worked on individual sections of the plan. At the end I was unanimously nominated to deliver the planned lesson later in the week; in this, the group demonstrated some collective agency and arguably some shared principles and beliefs.

The results from the coded analysis are presented in *figure 4.2.3.a*.

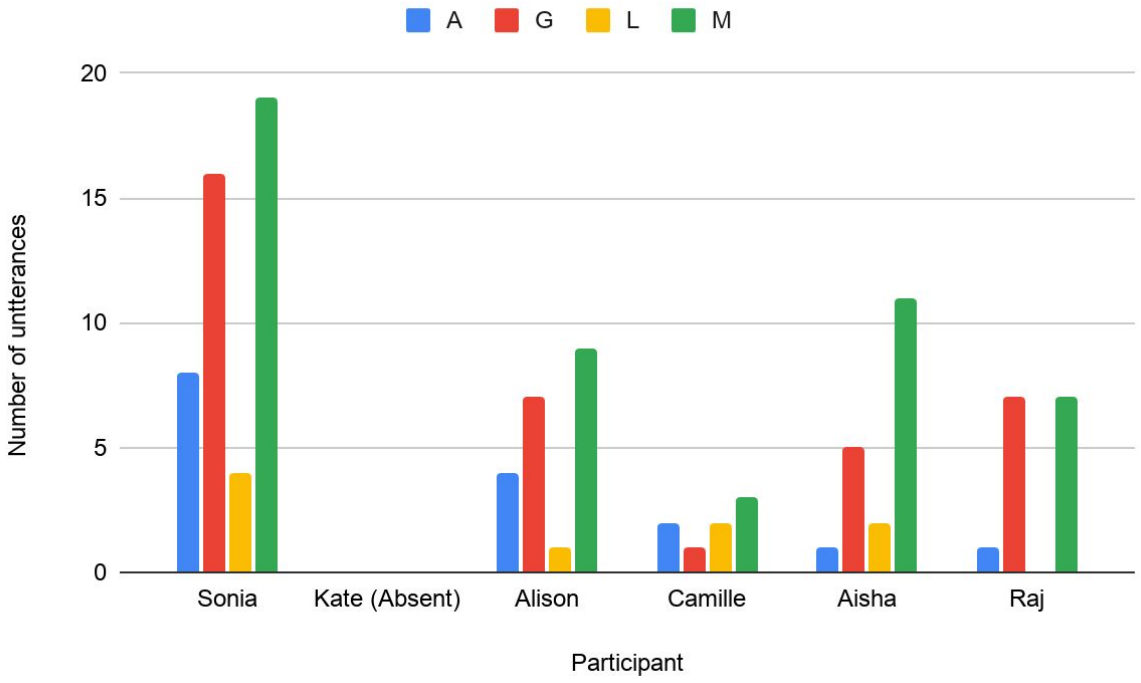


Figure 4.2.3.a.

Using the Gilbert et al. (1982) article as a stimulus, the group planned a lesson around constructivist themes in science teaching; something that they unanimously supported. In this, there is a suggestion that their personal beliefs aligned within the group. An instance that expands upon *Figure 4.2.3.a* was instigated by Sonia, at the meeting mid-point when she asserted,

> The perspective of children's science is inadequately considered, by us as teachers, because we are constrained by frameworks and it's probably useful for us as a department to work on this.

In this statement she was unchallenged, something that was typical when she spoke in the meeting. This arguably shows she has a dominant identity within the group (G). The vignette also shows some insight into her thinking and demonstrates her desire to develop perspectives amongst the other teachers. This presents some generational typicality (G), whereby the beginner teachers often make

statements that are in agreement with the more experienced teachers rather than challenging them. Again, Raj and Camille do not interact significantly within the meeting, with Raj not bringing any alternative perspectives from external sources; something that I felt was unusual, based on my belief that he, as a trainee teacher, was currently attending other training opportunities where he was exposed to new ideas.

Some of the data presented here helps address research questions 1a. and 2.. In respect to research question 1a., the PLC is developing because experienced teachers like Sonia have a desire to develop knowledge and understanding in others. However, this can create instances where experienced teachers dominate and arguably make it more difficult for beginner teachers to challenge the thinking of the group. With reference to research question 2., arguably the nature of the meeting would suggest that the group is developing knowledge in line with the themes of the meeting, i.e. lesson study, constructivist approaches to teaching and to an extent, strategies for science teaching. I would argue that based on Sonia's vignette as an example, the assertiveness of experienced teachers may support new thinking within the group, leading to new knowledge formation. However, in contrast - and as something I believe to be more likely – examples such as these may demonstrate that dominance of individuals going unchallenged within the meeting show that the attributes of PLC's, e.g. collaboration (Hord, 2004) or concern for others views (Westheimer, 1999) are not being met in every instance. Therefore, in this example it is not clear if the PLC exists in line with interpretations in literature, and if it does not exist then how does it support developing knowledge?

4.2.4- Meeting 4

This focussed around a post observation discussion on the lesson section of the lesson study cycle. The meeting lasted just over 80 minutes, mostly consisting of unstructured discussion led by the group, rather than by myself. The audio recording was analysed and is presented in *Figure 4.2.4.a*

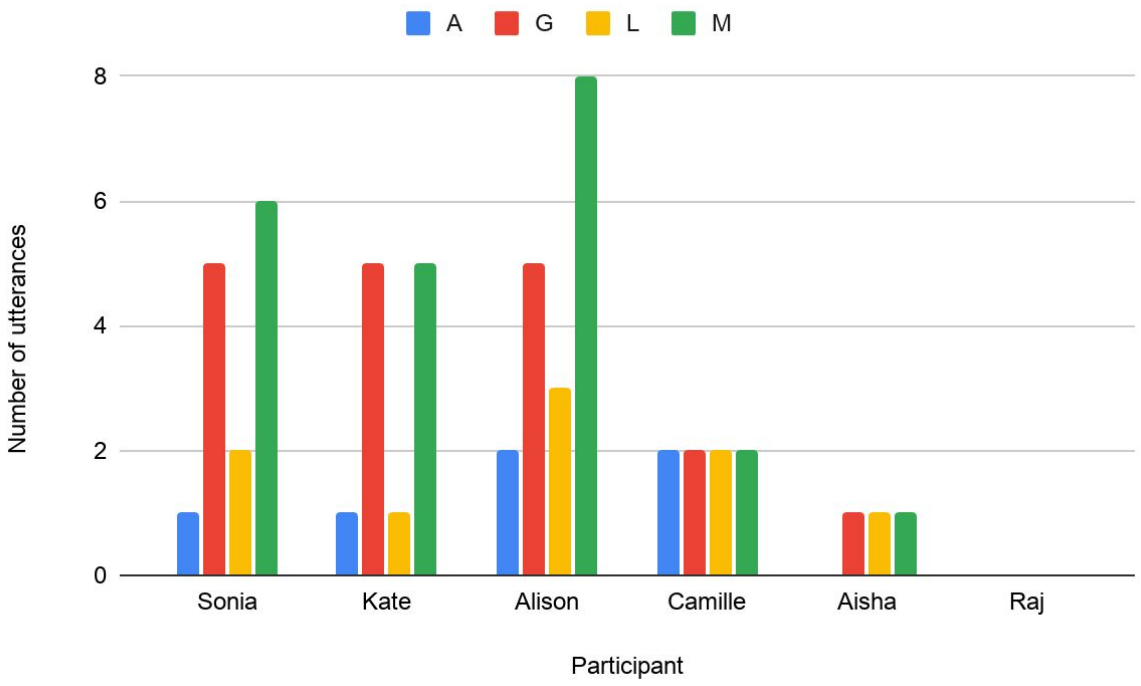


Figure 4.2.4.a.

Comparing *Figure 4.2.4.a.* with previous meetings, a theme continues, showing experienced teachers speaking more than new or beginner teachers. The newer teachers, in this case Camille, bring forward knowledge gained in other settings. On the topic of asking good questions that draw out the pupils' 'worldviews of science' Camille, bringing in her knowledge from other settings says,

> Perhaps the type of activities we plan aren't necessarily the best way to bring out pupils' ideas. Maybe we need to look at this with another resource... I've used misconception worksheets before.

With Kate agreeing, stating:

> ...the topic that was taught, it was difficult to show that pupils have their own world view. Maybe we should look at what Camille said.

Camille responded, suggesting the reasoning behind not being able to draw out pupils' world views on science rested on the,

> ....ability of a teacher to create the correct culture that allows for pupils to talk about their ideas openly.

The example of Camille's interaction helps to address research questions 2. She shows that she is prepared to challenge the thinking of the more experienced staff. In response, her views are listened to and generate further discussion. She shows that she has insight into alternative ways of teaching which may be developing knowledge of teaching strategies in others. With regards to research question 1a. the analysis of this section of the meeting contradicts some of the patterns that appear in previous meetings, such as the dominance of experienced teachers. However, it is an instance of collaboration with reflective professional inquiry (Hord, 2004), that may show a PLC functioning within recognised parameters and a way in which the PLC is supportive of developing new knowledge.

4.3-Interviews

The purpose of the interviews were to identify the thinking of the participants, to provide evidence of their developing knowledge within the PLC and therefore address all research questions.

As a note to the methodological approach, only 4 of the 6 participants were interviewed, Camille declined to be interviewed and Sonia was unable to attend the interview session before the end of the data collection period.

In order to systematically present the findings of the interviews, this section is subdivided for each participant. Within each subdivision, a summary of the themes of the answers to the interview questions (see Appendix D.) are given. The interview responses are then analysed by contrasting answers given with the data presented in *Figures 4.2.1a. to 4.2.4.a* and with some answers given in the reconnaissance surveys (*Figure 4.1.a.*).

4.3.1- Interview with Kate

As discussed in Chapter 3, Kate is an experienced teacher with more than 16 years teaching experience. In interview answers, she highlighted that in terms of developing her knowledge she believes that she had developed some subject knowledge as a non-specialist teaching Physics. She perceived that engaging more in academic literature related to education is key to her personal development. In terms of how she wants to learn she expressed that she wants a choice about what to develop professionally, and has felt that in the past, some of the training and development opportunities she has experienced have been 'forced upon her'. Although she said she prefers to focus on personal development, she does want to work with others when good relationships exist and her interview showed some evidence that she values working collaboratively - a key feature of a PLC (Westheimer,1999). She stated she perceives collaboration is a powerful way to develop practice and, connected to this, she prefers to discuss and share best practice through working with others in small groups of professionals in specific subject areas. In addition, she expressed a preference to work within peer to peer relationships, rather than working within hierarchical

structures and in a non-judgmental environment, and therefore does not think hierarchies work whilst collaborating.

In these answers, Kate is consistent in her view that collaboration is important to her personal development and the development of others. This is corroborated by her behaviours within survey answers and meetings, where it can be seen that she consistently engages with others and puts forward ideas to develop their thinking (A). In data from meetings, it is interesting to note that her utterances rarely bring in external sources of information (L) as in the interview, she highlighted that she would prefer to have more opportunities to engage with academic educational literature.

Another point of note is Kate's belief that peer to peer relationships are important when developing teacher knowledge. In analysis of comments during meetings, Kate behaves in a way that is consistent with her position as an experienced teacher, whereby she speaks often and in ways that demonstrate something akin to a hierarchy; whereby she often instigates conversation or probes the thinking of others. This suggests there is a divergence in Kate's belief in flat, non-hierarchical structures for collaboration and her behaviour within a PLC. In the interview, she did not make reference to a preference for reflection as a mechanism to improve practice.

Significantly, within Kate's answers she references more of 'how' she learned rather than 'what' she learnt, which in some ways limits the evidence for addressing research question 1b.

4.3.2- Interview with Alison

Alison is an experienced teacher with remunerated responsibility within the science department. In the interview, she put forward the belief that dialogue and collaboration are important for personal development; environments where all can speak in meetings helps facilitate learning. She believes

informal peer to peer relationships are preferential to formal hierarchical mentor/mentee relationships. In respect to observing classroom practice, she stated that observing with other people provides insight into how to personally develop, however lesson study could be overbearing for participants. She suggested being non-judgmental about teacher development was important. With reference to knowledge development she linked scientific phenomena and applications of science as important in the intervention, answering research question 1b..

In the initial survey and in the interview, Alison showed that she was positive in her responses to science teacher education, collaboration and to observation. This was born out in her behaviours in meetings. For example, in meeting 4, she participated in discourse most (M), and in all other meetings made frequent contributions. Conjecturally, this may suggest that there is an alignment between her principles and development of the PLC, i.e. she feels professionally obliged to make this endeavour work, and this may support addressing research question 1a..

4.3.3- Interview with Aisha

As described in the methodology, Aisha is a beginner teacher who has been trained within the 'Teach First' programme and therefore, to an extent, was accountable to me as she progressed towards gaining Qualified Teacher Status (QTS). With this in mind, her answers to the questions in the interview may have been skewed by power dynamics. However, in the interview it was evident that she felt it was important to be open-minded, listen and support collaboration. She felt that science PCK was more important than general pedagogy, and observing classroom practice of others supported personal development in this regard. However, in relation to observation she stated there needed to be a clear purpose to make it effective. She thought engaging in academic literature is useful and this, along with lesson study, had 'made her think' and also brought the department together. In this statement, it could be argued that she felt she had developed a knowledge of

reflective practice. In collaboration, she preferred the non-hierarchical relationships, but recognised that structured mentor/mentee relationships can also be useful.

4.3.4- Interview with Raj

At the time of the data collection, Raj was part way through his training with Ark Academy ITT. In this Raj was also working towards QTS and therefore, similarly to Aisha, his relationship to me may have impacted on the responses he gave. Comparative to Aisha, Raj had less classroom experiences, due to the timing and nature of his training programme. His view was that lesson observation is a powerful way to develop practice, however, would find being the subject of a lesson study overwhelming. He felt that collaborative processes have to have a specific focus and that discussion during collaborative meetings is useful, however, discussing practical aspects of teaching was more useful than discussing theoretical perspectives during the intervention. In this, suggesting he may have developed some knowledge of teaching strategies.

As can be seen from the evidence Raj spoke infrequently in meetings, therefore, making comparisons between his interview with his comments in meetings difficult. That said, his lack of response and interaction within meetings, in itself suggests that Raj enacts the principle he gives within the survey, i.e. that collaboration is not necessarily the best way to learn. He does also, contradict himself, suggesting that he does learn from others. Within the interview, he makes suggestions that collaboration needs to have a practical focus. In this, arguably, his principles do not align with the purposes of the intervention and the PLC more generally. Perhaps his reticence

around his involvement in the intervention may be because of his training to date, whereby his training provider placed an emphasis on routinised teaching practice (Bransford, 2001). Further to this, his view of lesson study 'being overwhelming' if he were the teacher being observed may give some insight to his thinking, suggesting that he has anxieties in relation to accountability and being judged. In turn, this might give some meaning behind his lack of interaction within the intervention.

4.4- Summary of Overall Findings

In this section, I present each of the research questions in turn, and attempt to answer them using a summary of the findings and analysis. These findings will then be more thoroughly explored against the literature in Chapter 5.

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

    a) Based on a teacher-educator intervention, how does the PLC develop?

The teacher intervention provided a mechanism for the PLC to develop with collaboration being a most notable attribute of this PLC. Generally, I believe this came about because of the open mindedness of the participants, however, conjecturally, there may have been individual issues with collaborating when principles did not align. Collaborative processes were often - but not always - dominated by experienced teachers, which in turn imposes a hierarchy. In some instances, this calls into question whether or not collectively the participants were showing the attributes of a PLC. The lesson study provided opportunities for group reflection with examples of the beginner teachers

showing alternative ways of thinking; however, this was rare. More often, there was evidence of new or beginner teachers being marginalized within the PLC and throughout the intervention.

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

   b) What are the participants' perceptions of their knowledge development as a result of working within the PLC?

The participants interviewed spoke about developing knowledge of subject matter, application of science and strategies for teaching. Interestingly, the participants did not all explicitly reference developing knowledge of reflective practices, with none describing knowledge of constructivist approaches to teaching. The participants articulated beliefs that they developed knowledge within collaborative processes and they prefer non-hierarchical structures for this. Arguably, not all teachers agreed with the focus of the collaboration. When this happens, these individuals may learn less; this brings into question issues around how relationships and the democratic processes of the PLC impact on knowledge development.

2. How is the PLC supporting the development of the teachers' knowledge?

The participants give examples of where they feel they have developed knowledge and this is reviewed when answering research question 1b. Further to this, from interpreting participants' responses in interviews and behaviours in meetings I believe they developed a knowledge of collaborative practices and professional inquiry. I also believe the group developed a knowledge of mechanisms of reflection and a knowledge of constructivist approaches to teaching, however, this is

less explicit in the data. In this, the PLC contributed to knowledge development, however, as stated above, this is not necessarily recognised by all participants.

Finally, within the PLC, some participants' dominance is sometimes supportive of teacher knowledge development, but could arguably be limiting.

Chapter 5: Discussion of findings in relation to the literature and methodology

In this Chapter I aim to consider the analysis and findings within Chapter 4 alongside the reviewed literature. In this, I consider whether the findings are supported by, or conflict with the literature. From making these comparisons, I discuss how well the methodology supports answering the research questions. To help facilitate a coherent narrative, the Chapter is organised in subsections as follows:

- 5.1 Addressing research question 1a.
- 5.2 Addressing research question 1b.
- 5.3 Addressing research question 2.
- 5.4 Evaluation of methodology and considering improvements
- 5.5 Summary of Chapter.

5.1- Addressing research question 1a.

The first question this research attempts to answer is,

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

a) Based on a teacher-educator intervention, how does the PLC develop?

To facilitate the contrasting of the literature, this section is subdivided into sections that mirror the findings related to this research question, and is therefore organised as follows:

- 5.1.1 -Collaboration
- 5.1.2- Hierarchy
- 5.1.3- Marginalised participants

5.1.1 - Collaboration

As shown throughout the participants' answers within the reconnaissance survey, their willingness to participate within the intervention and within the answers given during post intervention analysis; there was the pervasive principle that collaboration was a way to learn. With this view the group showed that they agreed with the stance taken by Rogmagnano (1994) and also with Korthagen's (2006) meta-analysis, that collaboration is needed to change behaviours. This point also shows that a condition necessary for a community of learning, as suggested by some writers (Hord,2004; Louis et al., 1995; King and Newman, 2001) was present. The behaviours and comments made by the participants throughout the intervention also align with attributes of Westheimer's (1999) interpretation of a PLC, specifically; interaction, participation and interdependence. Westheimer's attribute of interdependence was demonstrated to an extent with all participants communicating

through active listening and responding to each other; however, with some participants, notably Raj, airing views less.

5.1.2- Hierarchy

As highlighted in the data, the participants generally suggested that they preferred working within non-hierarchical structures; for example, three participants who were interviewed stated a preference for working within peer to peer relationships rather than for example, mentor/ mentee relationships. However, the data analysed as part of the intervention suggested that the experienced teachers tended to dominate, with beginner teachers, though talking less, bringing forward proportionally more ideas from external sources. This inconsistency between experienced teachers' principles and behaviours can potentially be rationalised using Gee's (2001) categorisation of professional identities. As per Gee (2001), the experienced teachers have an *Affinity identity* within the group, whereby they want to be seen as collegiate. However, to refer back to Gee, other identities, particularly *Institution identity* and *Discourse identity* perhaps dominated. To rationalise this, within this research, my role as the facilitator of the research and head of department may have influenced the behaviour of the participants. As the teacher-educator within the intervention, it was difficult for me to present an alternative *Affinity identity*, i.e. I still had to behave as the head of department and lead the sessions, to an extent hold colleagues to account, and ultimately project a particular *Institution identity*. Potentially, the more experienced teachers observed this and reacted in a way that mirrored my behaviours. Therefore, a tension may have been created between enacting their principles or beliefs and their need to present a specific identity to me. This may be an

example of where they are constrained and cannot put their beliefs into practice (Levin and Ammon, 1991). In this, I felt that Wenger's (1998) view that development of practice is found at the intersection between community and identity has some truth.

5.1.3- Marginalised participants

Within the interview, the survey and also discourse during interventions, the participants showed that they preferred using collaboration to learn from one another. These behaviours and principles show some parallels in the literature as they demonstrated shared values and vision (Hord,2004). However, there were examples of members of the community becoming marginalised through non-participation (Wenger, 1998). Therefore, it could suggest that within this PLC, the group did not always have concern for all individuals' views as they did not work together and consider everyone's perspectives. This brings forward Westheimer's (1999) fifth attribute of a PLC: meaningful relationships. In the development of this PLC, to an extent, meaningful relationships were being enacted through a combined effort of the participants to learn and be open to one and other (Stoll et al., 2006) within the community. However, some relationships were neglected; exemplified by the relationship of Raj to the rest of the participants. As discussed in Chapter 4, Raj was noticeably withdrawn from the group. This perspective echo's Hayward's (1997) view that beginner teachers occupy vulnerable positions in schools. In this, Raj's (and to an extent all the beginner teachers) lack of participation, there is a suggestion that he may have had concerns of personal survival as discussed within the stage theories Fuller and Bown (1975) and Furlong and Maynard (1993). With Raj's reduced participation within the group, it could decrease his opportunities to learn,

consequentially increasing his vulnerability as a professional. In this, there are echoes of Jenlick and Jenlick's (2008) view that individuals must resolve their personal beliefs with the beliefs of the PLC.

5.2- Addressing research question 1b.

The next research question I wish to address is,

1. Within the described context, what are the characteristics of the emerging professional learning community (PLC)? Specifically,

b) What are the participants' perceptions of their knowledge development as a result of working within the PLC?

From the analysis within the group of participants, more can be interpreted by how they developed knowledge rather than explicitly what knowledge they thought they developed. Therefore, to an extent, the findings for this question are more limited. However, the participants made reference to developing knowledge of subject matter (Shulman, 1986), application of science and strategies for teaching which could be categorised as PCK (Shulman, 1986). There was some inference that they understood they may also have developed knowledge of reflective practice as outlined by Dewey (1933) through being critical (Shulman, 1987), but were not explicit in describing the mechanism of this.

In response to the research question, I expected there to be more reference to science teaching, constructivist approaches and NOS during the participants' interviews. Conjecturally this issue may align with Rusznyak and Walton (2011), that the participants lacked the vocabulary to discuss their knowledge. In reality, the participants referred very little to their personal views of NOS, maybe because they unanimously chose a focus for the lesson study that was underpinned by a specific view of NOS with a specific constructivist approach to science teaching contained within Gilbert et al. (1982). Initially I interpreted this as the participants having a shared understanding of NOS and science teaching and therefore beliefs aligned in accordance with Westheimer's characteristic of a PLC. However, upon reflection, with the introduction of an external stimulus in the form of the Gilbert et al. article, the groups' confidence in expressing their own beliefs may have become impeded. Arguably, this could be a mechanism for how PLC's become preoccupied with sustaining traditions (Little, 1999) and create a narrow set of preferred beliefs. With NOS as an example, the arguments made by writers (see for example, Duschel and Wright, 1989: Lederman, 1992; Lederman and Zielder, 1985: Richardson, 1996) on the impact of beliefs on teacher classroom practice are arguably moot points if beliefs are imposed, even through democratic processes. In future, perhaps tacit personal beliefs Kagan (1992a) need to be explored further rather than inferred from collective understanding before researching or working with this PLC. Explicitly focusing on NOS as Add-El-Khalick and Lederman (2000) suggest, could be useful; in doing this PLC members may be more confident in expressing their beliefs and conjecturally, more likely to refer to knowledge they developed rather than how they developed it.

With reference to the data, I felt that there was a disconnect between how individuals perceived themselves and how they behaved. In particular the experienced teachers interviewed preferred non-hierarchical structures for learning, however, they dominated meetings, cementing their status within established hierarchies, as discussed in section 5.1.2. The commonly shared perception that

collaboration was important demonstrates another example of Westheimer's characteristic of a PLC; shared belief and understanding. The group's belief in this also echoes some of the views on social learning espoused by Korthagen et al. (2006), Nicol (1997) and Shulman (1999). However, not all their professional beliefs were fully aligned. In agreement with the literature it would be expected that they may have differing professional beliefs depending on the stage of their career (Nespor, 1987).

5.3- Addressing research question 2.

In this section I address the final research question,

2. How is the PLC supporting the development of the teachers' knowledge?

In order to create a logical sequence to answering this question the section is subdivided as follows:

- 5.3.1- Developing knowledge bases.
- 5.3.2- Professional inquiry
- 5.3.3- Dominance

5.3.1-Developing Knowledge bases.

The teacher's appeared to take on board the views of Driver and Easley (1978) that children's world view of science needs to be taken into account in order to progress their learning. Arguably, this was

the simplest specific example of knowledge that the participants, as a group, developed. Simultaneously, they also acquired a knowledge of lesson study and its mechanisms as a tool for developing personal understanding of classroom practice and reflective processes. I believe that the group's enthusiasm for engaging in this part of the intervention as suggestive that teachers' beliefs are resistant to change (Koballa et al., 2000), is potentially a false assumption.

There was good evidence to show that the teachers were developing knowledge of reflective processes, despite not specifically identifying it as a knowledge base. However, using this knowledge would arguably be a *foundational* development within Rowland et al.'s (2005) model. The evidence is suggestive that participants generally developed knowledge of constructivist approaches to teaching (Gilbert et al., 1982), an example of *transformation* and *connection* knowledge (Rowland et al.,2005) and within Shulman's (1986) PCK model.

5.3.2- Professional inquiry

There are a number of ways the evidence from the findings suggest how the PLC supported the development of the teachers' knowledge, for example,

(i) provides external sources of theory on which to discuss and develop their knowledge and practice.

(ii) gives them the opportunity to discuss and collaborate.

(iii) gives them an opportunity to experiment through lesson study.

As the nature of the intervention required the group to carry out the lesson study, I thought the problem that Guskey (1999) highlights of 'shared ignorance' was negated. I also felt that the learning was happening as the group engaged with the scholarly nature of educational practices (Shulman,

1999), something the group worked on in joint enterprise (Wenger, 1998). Generally, the group also commented that they preferred working within a group structure to develop their practice, something that aligned with Korthagen et al.'s (2006) meta-analysis. On this point, I believe the participants bridged a gap between teacher and teacher-educator, whereby they supported each other in learning.

To use Bruner's (1996) idea of teacher 'folk theories', I held a view that the participants would be reticent about engaging with educational research, however I noted that the group showed an interest and willingness to engage in literature. Within the intervention the teachers showed a willingness to develop their knowledge in a way that seems to align with 'The Change Environment' model (Clarke and Hollingsworth,2002). The group were generally receptive to the *external domain* particularly, in the form of their engagement with the educational literature. Their principles and attitudes were suggestive that they wanted to develop from within the *personal domain*, through *professional experimentation,* and this manifested in their engagement in the lesson study. In this interplay, it could be argued that there were *salient outcomes*, such as new knowledge of teaching strategies.

The group showed a desire to move away from the prescribed routinised (Bransford, 2001) view of teacher expertise. However, within the intervention, there was little opportunity for the participants to enact Bransford's concept of adaptive expertise. On this theme, the group were unable to show that they were developing *contingent* knowledge (Rowland et al., 2005) within classroom settings. However, there is a connection to this knowledge base within the group meetings, where all the participants were required to behave in accordance with contingent thinking, whereby they had to bring forward their thinking in a way that was responsive to the utterances of others.

5.3.3- Dominance

As discussed in section 5.1.1. some participants were dominant. However, to refer back to myself, although silent within the data gathered, I feel I also had a significant role in how the participants developed knowledge within the PLC; in particular the principles I brought to bear as a teacher-educator, for example my desire to build relationships (corroborated by Grossman, 1990) and my identity as a researcher (Ducharme, 1986). To an extent, the teacher-educator principles I enacted followed the process of Korthagen and Kessel's 'Realistic Teacher approach' (1999). Through discussions in meetings the group brought forward their 'folk theories' of teaching (Bruner, 1992), which then changed as they engaged with the external theories within Gilbert et al. (1982). I created opportunities for teacher agency and this therefore may explain another way in which the PLC supports participants knowledge development

5.4- Evaluation of methodology and considering improvements

The methodological instruments of the survey and audio recordings provided a large volume of data which supported my ability to address the research questions. However, with hindsight, each one of these could have potentially been improved.

In relation to the survey, I felt that I could have asked more questions to elucidate more thoroughly, the principles and beliefs of each participant and how they view themselves as professionally within the group.

Analysing the audio recordings using a designed framework to codify the conversations amongst the group allowed me to extrapolate and distil key themes in relation to development of the PLC and supported answering questions 1a. and 2. in particular. However, with this approach, I reduced my focus of the analysis down to a small number of themes and may have missed some of the richness of the conversation or misinterpreted some of the meaning and intention of the participants'

comments. To negate this, if done again, I would perhaps take the themes and interpretations back to the participants in a process akin to respondent validation (Cohen, Manion and Morrison,2018).

In relation to the post intervention interviews, I felt that the questioning was guided by the emergent themes from the meeting analysis. I made a decision to conduct these interviews in a semi-structured way, and in this, the comments I made during the interview may have influenced the responses of the participants. Furthermore, my approach to analysis of these interviews could have been more systematic. Potentially formulating a coding system as I did for the meetings may have given greater insight into the meaning of the participants responses. Potentially, using a structured interview or a survey may have been a way to negate this. Furthermore, taking one of these approaches may have made comparisons between the participants and charting the group's development within the PLC, potentially more straightforward.

At the core of the research is the ethical consideration that I occupy a number of roles, in particular my role as the teacher-educator and head of the department, responsible for holding the participants to account within the institution. The issue of my professional identity and to an extent, personal identity may have made it difficult for the participants to be totally honest in all their interactions with me throughout the research. Therefore, the principles that I brought to bear within the research and my need to maintain accountability to the institution undoubtedly impacted on how the participants responded. For example, I cannot be sure that they believed collaboration was a way in which they learn, particularly as some participants did not always collaborate effectively. Therefore, when considering future implications from this work, this point will need to be taken into account.

5.5- Summary of Chapter.

In order to address the research questions, this Chapter reviews the analysis and findings in Chapter 4 against some of the literature reviewed in Chapter 1. Key to this synthesis is the congruence of the behaviours of the group with literature linked to PLC's, for example Westheimer's (1999) propositional attributes of a PLC. A link between the behaviour of the participants and Gee's (2001) identity codification is made and this gives some rationale for the relationship dynamics amongst the group.

Some of the data gathered shows that the emerging PLC supports the development of teacher knowledge, for example, knowledge of teaching strategies, reflection and subject matter. The developing knowledge bases of the teachers is compared against Rowland et al. 's *Knowledge quartet* and Clarke and Hollingsworth's *Interconnected mode*l. I briefly refer to my role within the PLC and how this may have influenced how the PLC develops knowledge in the participants.

The final section of the Chapter evaluates the methodology, significantly suggesting that a deductive approach could have been employed in parts of the research and may have delivered more clarity of meaning. Furthermore, there is some discussion of how my role as head of department and teacher-educator would have impacted the findings.

Chapter 6: Implications for the future

To conclude and to consider the implications of this work for the future, I believe I must discuss the PLC from two perspectives; as head of the science department (section 6.1) and as the researcher/ teacher-educator (section 6.2).

6.1- My considerations as a head of department

As described, the group of teachers involved in the research are at different points in their careers, facing various challenges and influences. Although this research only takes a snapshot of the emergence of a PLC amongst the group, I feel that on the whole, regardless of the status of the teachers within the department, they all engaged in a positive manner with the research. Furthermore, it appeared that they enjoyed spending time with each other during meetings. Within the audio recordings, deadtime was filled with jovial conversation where hierarchical structures appeared to dissolve. I feel that, in addition to the professional conversations that were analysed within this piece of work, these instances of relationship-building play a significant part in developing the PLC. In addition, there is perhaps an argument to suggest that this is a mechanism by which teachers learn from one another, something, explored by McNicholl, Childs and Burn (2013).

Potentially, this may be something I could attempt to facilitate within the department; however, this may be difficult as it runs a risk of contrived collegiality (Hargreaves, 1994). However, to create a genuinely collaborative democratic model where teachers' voices are brought to the fore is certainly a challenge to address.

Throughout the work, I was conscious of my roles of observer, participant and leader of the PLC. With the end of the research, my roles within the PLC become simplified. I will continue to participate and to lead without fear of over influencing research outcomes. Nevertheless, I will attempt to retain some of the evaluative principles of the research as I progress within the PLC. In particular, I will be considerate of how the issues of my identities and principles impact upon the hierarchical structures of the group and how power dynamics impact behaviours of the teachers. In this, I will attempt to overcome some of the issues presented by Groth et al. (2020).

Historically within the department, there has been a relatively high turnover of staff, with, over the past five years, an average of two members of staff leaving the department every 9 months. This presents a specific difficulty for building and sustaining a PLC amongst a group of teachers - the sharing of common principles and goals - and is potentially the biggest challenge I face in relation to supporting teacher development within the department. Again, with this, I perhaps need to be more explicit with the current group of teachers about our shared beliefs and principles, so that when new members join the PLC, there is an established framework for new participants to 'buy into'. However, as discussed, at the core of a PLC are positive relationships, and with new members of staff joining an established group of teachers, there is an inevitable chance that there are disconnects between personalities, resulting in poor professional and personal relationships, leading to a lack of learning opportunities. That said, I feel the positivity of the relationships in the current group, is fertile ground for making the PLC sustainable.

In relation to some staff participating more than others within the group, I will be mindful to attempt to intervene and encourage them to bring forward their views within meetings; something that I felt I could not do within the research project for fear of over influencing the outcomes.

6.2 -My considerations as a researcher and teacher-educator

Considering the PLC from the perspective of an educational researcher has been insightful and potentially shown me new perspectives of the teachers I work with. For example, I held a belief that teachers generally had a rejectionist view of educational research and of the research into practice paradigm (Korthagen and Kessels, 1999). I had this belief challenged when the group showed that they were interested in reviewing educational literature and were also willing to attempt to use it within Japanese lesson study. As a consequence, in future, I must be mindful of the danger of my own beliefs overriding the views of others and introduce more educational literature into the sessions that I run, as Hagger and MacIntyre suggest (2000).

Within my current context, the bulk of the work I do in relation to teacher-education is within one to one settings, therefore this project has ensured I pursue a different trajectory by attempting to work with a group and consequently, increased my knowledge base of teacher-educator practices. For example, the lesson study that the teachers undertook, was in itself a small piece of action research; something which the group responded positively to. The knowledge I have developed in approaching this action research should be useful to support me with facilitating more small-scale research activities with groups of teachers.

The extent to which the work I've attempted could be recreated in other settings is open to conjecture. The school was supportive of the research concept and ring-fenced time for the activities of the PLC to be done. In addition, the school leaders did not stipulate any specific outcomes they

wished to see from the group of teachers; a point of note, as it allowed for the teachers to bring forward and pursue their own professional development unimpeded. Arguably, this is often something that is not afforded to other teacher-educators or other teachers in other settings. In this, it allowed for teacher agency and, as Wenger (1998) alludes to, an exploration of principles and professional identities; themes to reflect on that would allow for the development of practice.

References

- Abd-El-Khalick, F. and Lederman, N. (2000) Improving science teachers' conceptions of nature of science: a critical review of the literature, International Journal of Science Education, (22)7, 665-701.
- Anderson, L. M., Blumenfeld, P., Pintrich, P. R., Clark, C. M., Marx, R. W., & Peterson, P. (1995). Educational psychology for teachers: Reforming our courses, rethinking our roles. Educational Psychologist, 30, 143-157.
- Bassey, M. (1998) Action Research for Improving Educational Practice. In R. Halsall (ed.) Teacher Research and School Improvement. Buckingham, U.K. Open University Press, 167-178.
- BERA, (2011). Ethical Guidelines for Educational Research.BERA.
- Berliner, D. C. (2004). Describing the behavior and documenting the accomplishments of expert teachers. Bulletin of Science, Technology and Society, 24(3), 200–212.
- Berry, A., & Loughran, J. J. (2002). Developing an understanding of learning to teach in teacher education. In J. Loughran, & T. Russell (Eds.), Improving teacher education practices through self-study (13–29). London. Routledge Falmer
- Böhme, G., Van Den Daele, W. and Krohn, W. (1978). The 'scientification' of technology. In W. Krohn, E. T. Layton, Jr. and P. Weingart (eds), Dynamics of Science and Technology: Social Values, Technical Norms, and Scientific Criteria in the Development of Knowledge Sociology of the Sciences, 2 , 219–250.
- Bransford, J. D. (2001). Thoughts on adaptive expertise. Retrieved from http://www .vanth.org/docs/AdaptiveExpertise.pdf. in: Schneider, R. M., and Plasman, K. (2011). Science teacher learning progressions: A review of science teachers' pedagogical content knowledge development. Review of Educational Research, 81(4), 530–565.
- Brickhouse, N. W. (1989). The teaching of the philosophy of science in secondary classrooms: Case studies of teachers' personal theories. International Journal of Science Education.
- Britton, J., Farquharson, C. and Sibieta, L. (2019). 2019 annual report on education spending in England.Institute for Fiscal Studies. Retrieved from https://www.ifs.org.uk/
- Bruner, J. (1996). The culture of education. Cambridge MA.Harvard University Press.
- Bullock, S. M., and T. Christou. 2009. "Exploring the Radical Middle Between Theory and Practice: A Collaborative Self-Study of Beginning Teacher Educators." Studying Teacher Education 5 (1): 75–88.
- Bullough R. V. J. (1997) Practising theory and theorizing in teacher education. In Loughran, J. (2007). Enacting a pedagogy of teacher education. Enacting A Pedagogy of Teacher Education: Values, Relationships and Practices, 1–15. London. Routledge.
- Burn, K., Hagger, H., Mutton, T., & Everton T. (2000) Beyond Concerns with Self: the sophisticated thinking of beginning teachers, Journal of Education for Teaching, 26 (3), 259 – 278.

- Calderhead, J., & Robson, M. (1991). Images of teaching: Student teachers' early conceptions of classroom practice. Teaching and Teacher Education, 7, 1-8.
- Calderhead, J. (1988). Knowledge structures in learning to teach. In Calderhead, J. (Ed.) Teachers' professional learning (51-64). London: Falmer Press.
- Calderhead, J. (1996). Teachers' beliefs and knowledge. In D. Berliner & R.C. Calfee (Eds.), Handbook of educational psychology, (709–725). New York. Simon and Schuster, Macmillan.
- Carter, K., and Doyle, W. (1987). Teachers' knowledge structures and comprehension processes. In J. Calderhead (1987). Exploring teachers' thinking. London: Cassell.
- Clarke, D., and Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. Teaching and Teacher Education, 18, 947–967.
- Cochran, K.F., Deruiter, J.A., & King, R.A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. Journal of Teacher Education, 44(4), 263–272.
- Communities: A Review of the Literature, Journal of Educational Change, 7, 221-258
- Cooper, P., & McIntyre, D. (1995). The crafts of the classroom: Teachers' and students' accounts of the knowledge underpinning effective teaching and learning in classrooms. Research Papers in Education, 10 (2), 181–216.
- Corden, A. and Sainsbury R. (2005). The Impact of Verbatim Quotations on Research Users: Qualitative Exploration, York: Social Policy Research Unit, University of York.
- Creswell, J.W. (1994) Research Design: Qualitative and Quantitative Approaches. Thousand Oakes, CA. Sage.
- de Lima, J.A. (2001). Forgetting about friendship: Using conflict in teacher communities as a catalyst for change. Journal ofEducational Change 2(2), 97–122.
- Dewey, J. (1933). How We Think. New York. Heath and Co.
- Dinkelman, T. (2003). Self-study in teacher education: A means and ends tool for promoting reflective teaching. Journal of Teacher Education, 54(1), 6–18.
- Doig, B., and Groves, S. (2011). Japanese lesson study:Teacher professional development through communities of inquiry. Mathematics Teacher Education and Development 13 (1), 77–93.
- Donnelly, J. (2005). Reforming science in the school curriculum: a critical analysis. Oxford Review of Education, 31(2), 293-209.
- Driver, R., & Easley, J. (1978). Pupils and Paradigms: a Review of Literature Related to Concept Development in Adolescent Science Students, (5)1, 61-84.
- Driver, R. and Bell, B. (1986) 'Students' thinking and the learning of science: a constructivist view', School Science Review, March, 443-56.
- Ducharme, E. R. (1986). Teacher educators: What do we know? ERIC Digest 15. ERIC Clearinghouse on Teacher Education Washington, DC. ERIC Document Reproduction Service No. ED 279 642.
- Duschl, R. A., & Wright, E. (1989). A case study of high school teachers' decision making models for planning and teaching science. Journal of Research in Science Teaching, 26(6), 467–501.
- Elbaz, F. (1983). Teacher thinking: A study of practical knowledge. New York: Nichols.
- Ericsson, K. A., Krampe, R. T., and Tesch Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100, 363–406.
- Ferrance, E. (2000) Action Research. Providence, RI: North-east and Islands Regional Educational Laboratory at Brown University.
- Feuer, M. J., Towne, L., & Shavelson, R. J. (2002). Scientific culture and educational research. Educational Researcher, 31(8), 4-14.
- Foster, D. (2019). Teacher recruitment and retention in England. House of Commons Library. (7222). Retrieved from: https://commonslibrary.parliament.uk/research-briefings/cbp-7222/
- Fullan, M. (2001). The new meaning of educational change (3rd ed.). New York and London. Teachers College Press and Routledge Falmer.

- Fuller, F.F. and Bown, O.H. (1975). Becoming a teacher, in: K. RYAN (Ed.) Teacher Education: the Seventy-fourth Yearbook of the National Society for the Study of Education.Chicago, IL. University of Chicago Press.
- Furlong, J. and Maynard, T. (1995). The Growth of Professional Knowledge. Mentoring student teachers. London. Routledge.
- Gee, J. P. (2001). Identity as an analytic lens for research in education. In Secada, W. G. (Ed.), Review of research in education, Vol. 25 (99–125). Washington, DC: American Educational Research Association.
- Gilbert, J. K., Michael Watts, D., & Osborne, R. J. (1982). Students' conceptions of ideas in mechanics. Physics Education, 17, 62-66.
- Greene, T. (2004). Literature review for school-based staff developers and coaches. Oxford, OH. National Staff Development Council.
- Grossman, P. (1990). The making of a teacher: Teacher knowledge and teacher education. NewYork: Teachers College Press. in John, P. D. (2002). The teacher educator's experience: case studies of practical professional knowledge. Teaching and Teacher Education,18.
- Grossman, P. L., S. M. Wilson, and L. E. Shulman. 1989. "Teachers of Substance, Subject Matter Knowledge for Teaching." In Knowledge Base for the Beginning Teacher, edited by M. C. Reynolds. New York: Pergamon
- Groth, R.E., Bergner, J.A., Weaver, S.D. and Welsh, G.S. (2020). Using Japanese Lesson Study to Merge Inservice Professional Development and Preservice Clinical Experiences, The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 93(2), 93-99,
- Grumet, M. R. (1990). Generations: Reconceptualising curriculum theory and teacher education. Journal of Teacher Education, 40(1), 13-17.
- Guskey, T. (1999). Apply time with wisdom. Journal of Staff Development, 20(2), 10-15.
- Hagger, H., and McIntyre, D. (2000). What can research tell us about teacher education? Oxford Review of Education, 26, 483–494.
- Hancock, E., & Gallard, A. (2004). Preservice science teachers' beliefs about teaching and learning: The influence of K-12 field experiences. Journal of Science Teacher Education, 15(4), 281–291.
- Hargreaves, A. (1994). Changing teachers, changing times: Teachers' work and culture in the postmodern age. London: Cassell.
- Hayward, G. (1997). Principles for school focused initial teacher education: Some lessons from the Oxford Internship Scheme. In Allsop, R. and Benson, A., (1997). Mentoring For Science Teachers,11-26. Buckingham: Open University Press.
- Hewson, P. W. and Hewson, M. G. A'B. (1987) Science teachers' conceptions of teaching: Implications for teacher education, International Journal of Science Education, 9 (4), 425-440.
- Hord, S. (2004). Professional learning communities: An overview. In S. Hord (ed), Learning together, leading together: Changing schools through professional learning communities. New York: Teachers College Press.
- Jenkins, E. (2007). School science: a questionable construct? Journal of Curriculum Studies, 39(3), 265–282.
- Jenlick, P. M. and Jenlick, K.E.(2008). Creating Democratic Learning Communities: Transformative Work as Spatial Practice. Theory Into Practice. 47(4), 311-317.
- Kagan, D. M. (1992a). Implications of research on teacher belief. Educational Psychologist, 27, 65-90
- Kagan, D. M. (1992b). Professional Growth Among Preservice and Beginning Teachers. Review of Educational Research. 62(2), 129-169.
- Kemmis, S., McTaggart, R., and Nixon, R. (2014) The Action Research Planner: Doing Critical Participatory Action Research. Dordrecht. Springer.

- Kemmis, S. (2009) Action Research as a practice-based practice. Educational Action Research, 17 (3), 463-474.
- Kimball, M. E. (1967). Understanding the nature of science: A comparison of scientists and science teachers. Journal of Research in Science Teaching, 5, 110-120.
- King, M.B. & Newmann, F.M. (2001). Building school capacity through profes- sional development: Conceptual and empirical considerations. International Journal of Educational Management 15(2), 86–93.
- Koballa, T. R., Gräber, W., Coleman, D. C., & Kemp, A. C. (2000). Prospective gymnasium teachers' conceptions of chemistry learning and teaching. International Journal of Science Education, 22, 209–224.
- Korthagen, F., Loughran, J., & Russell, T. (2006). Developing fundamental principles for teacher education programs and practices. Teaching and Teacher Education, 22, 1020–1041.
- Korthagen, F.A.J, Kessels, J., Koster, B., Lagerwerf, B. and Wubbels, T. (2001). Linking practice and theory: The pedagogy of realistic teacher education. Hillsdale, NJ. Laurence Earlbaum.
- Korthagen, F. A. J., and Kessels, J. P. A. M. (1999). Linking theory and practice: Changing the pedagogy of teacher education. Educational Researcher, 28(4), 4–17.
- LeCompte,M. And Preissle, J. (1993) Ethnography and Qualitative Design in Educational Research (second edition), London. Academic Press Ltd.
- Lederman, N. and Abell, S. (2014). *Handbook Of Research On Science Education*: Volume II. Oxford. Routledge, 600-620.
- Lederman, N. G., & Zeidler, D. L. (1987). Science teachers' conceptions of the nature of science: Do they really influence teaching behavior? Science Education, 71(5), 721–734.
- Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. Journal of Research in Science Teaching, 29(4), 331-359
- Lee, E., & Luft, J. A. (2008). Experienced Secondary Science Teachers' Representation of Pedagogical Content Knowledge. International Journal of Science Education, 30 (10), 1343–1363.
- Levin, B. B., & Ammon, P. (1991, April). Toward an understanding of teacher development: A longitudinal case study of four teachers. Paper presented at the Annual Meeting of the American Educational Research Association. Chicago.
- Lewin, K. (1946) Action research and minority problems. Journal of Social issues. 2(4), 34-46.
- Lewis, C., Perry, R., and Murata, A. (2006). Features I How Should Research Contribute to Instructional Improvement? The Case of Lesson Study. Educational Researcher, 35 (3), 3-14.
- Lewis, C. (1995). Educating hearts and minds: Reflections on Japanese preschool and elementary education. New York. Cambridge University Press.
- Lewis, C. (2002). Does lesson study have a future in the United States? Nagoya Journal of Education and Human Development, 1(1), 1-23.
- Lewis, J. M., Fischman,, D.,Riggs, I. and. Wasserman, K. (2013). Teachers Learning in lesson study. The Mathematics Enthusiast, 10 (3), 583–619.
- Little, J.W. (1999). Teachers professional development in the context of high school reform: Findings from a three-year study of restructuring schools. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, April.
- Loughran, J. (2007). Enacting A Pedagogy of Teacher Education: Values, Relationships and Practices, 1–15. Abingdon. Routledge.
- Louis, K.S., Kruse, S.D. & Associates. (1995). Professionalism and community: Perspectives on reforming urban schools. Thousand Oaks, CA. Corwin Press Inc.
- Lyons, C. A., & Pinnell, G. S. (2001). Systems for change in literacy education. Portsmouth, NH. Heineman.
- MacIntyre, A. (1997). After Virtue*,* 2nd ed. Notre Dame, IN. University of Notre Dame Press.
- McEwan, H., & Bull, B. (1991). The pedagogic nature of subject matter knowledge. American Educational Research Journal, 28(2), 316–334.

- McKernan, J. (1991) Curriculum Action Research. London. Kogan Page.
- McLaughlin, M.W. & Talbert, J.E. (2001). Professional communities and the work of high school teaching. Chicago: University of Chicago Press.
- Mcnicholl, J., Childs, A., & Burn, K. (2013). School subject departments as sites for science teachers learning pedagogical content knowledge. , Teacher Development: An international journal of teachers' professional development, 17(2), 155-175.
- Migration Advisory Committee (2017). Partial Review of the Shortage Occupation List Review of teachers. Home Office. London
- Millar, R., & Driver, R. (1987). Beyond processes. Studies in Science Education. (14)1, 33-62.
- Millar, R. & Osborne, J. (Eds) (1998). Beyond 2000: science education for the future. London. King's College.
- Murray, S., Ma, X., & Mazur, J. (2009). Effects of peer coaching on teachers' collaborative interactions and students' mathematics achievement. Journal of Educational Research, 102(3), 203–212.
- Myers, C. B. (2002). Can self-study challenge the belief that telling, showing, and guided practice constitute adequate teacher education? In J. Loughran, & T. Russell (Eds.), Improving teacher education practices through self-study, (130–142). London. RoutledgeFalmer.
- Nespor, J. (1987). The role of beliefs in the practice of teaching. Journal of Curriculum Studies, 19, 317-328.
- Nicol, C. (1997). Learning to teach prospective teachers to teach mathematics: the struggles of a beginning teacher educator. In J. Loughran, & T. Russell (Eds.), Teaching about teaching: purpose, passion and pedagogy in teacher education (95–117). London. Falmer.
- Niedderer, H. (1987.) A teaching strategy based on students' alternative frameworks - theoretical conceptions and examples', Proceedings of the Second International Seminar. Misconceptions and educational strategies in science and mathematics 2, 360-7, Cornell University.
- Ogunniyi, M. B. (2007). Teachers' stances and practical arguments regarding a science-indigenous knowledge curriculum: Part 2. International Journal of Science Education. 29 (10), 1189-1207.
- Osborne, R. J. and Gilbert, J. K. (1980), A technique for exploring students' views of the world. Physics Education, 15, 376-379.
- Pajares, M.F. (1992) Teachers' beliefs and educational research: Cleaning up a messy construct. Review of Educational Research 62, 307–332.
- Piggot-Irvine, E. , Rowe, W., and Ferkins, L. (2015) Conceptualizing indicator-domains for evaluating action research. Educational Action Research, 23 (4), 545-566.
- Posner, G. J., Strike, K. A., Hewson, P. W. and Gertzog, W. A. (1982). Accommodation of a scientific conception: Towards a theory of conceptual change. Science Education, 66, 211-227.
- Pring, R., (2004). Philosophy Of Education. London. Continuum.
- Richardson, V. (1997), Constructivist Teacher Education: Building New Understandings . London. The Falmer Press.
- Richardson V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula, T. Buttery & E. Guyton (Eds.), Handbook of research on teacher education,2nd ed, 102–119. New York, NY. Simon & Schuster Macmillan.
- Rokeach, M. (1968). Beliefs, attitudes, and values: A theory of organization and change. San Francisco. Jossey-Bass
- Romagnano, L. (1994). Wrestling with Change: The Dilemmas of Teaching Real Mathematics. Portsmouth, NH. Heinemann.

- Rowland, T., Huckstep, P., & Thwaites, A. (2005). Elementary Teachers' Mathematics Subject Knowledge: The Knowledge Quartet and the case of Naomi.Journal of Mathematics Teacher Education, 1(8), 255–281.
- Rusznyak, L., & Walton, E. (2011). Lesson planning guidelines for student teachers: A scaffold for the development of pedagogical content knowledge. Education as Change, 15(2), 271-285.
- Schön, D. A. (1983). The reflective practitioner: How professionals think in action. New York. Basic Books.
- Shulman, L. S. (1986). Knowledge Growth in Teaching. Educational Researcher, 15, 2.
- Shulman, L.S. (1987). Knowledge and teaching: foundations of the new reform, Harvard Educational Review, 57(1), 1 – 22.
- Shulman, L. S. (1999). Taking learning seriously. Change, 31(4), 10-17.
- Stoll, L., Bolam, R., McMahon, A., Wallace, M. and Thomas, S. (2006). Professional Learning
- Taylor, A. R., Anderson S., Meyer K., Wagner M. K., and West, C.(2005). Lesson study: A professional development model for mathematics reform. The Rural Educator, 2 (2),17–23.
- Teacher Development Trust (2020). Image retrieved from https://tdtrust.org/what-is-lesson-study/
- Teacher Standards (2020). Department for Education. England. Retrieved from https://www.gov.uk/government/publications/teachers-standards
- Tsai, C. C. (2002). Nested epistemologies: Science teachers' beliefs of teaching, learning and science. International Journal of Science Education, 24(8), 771-783.
- Vygotsky, L.S. (1978). Mind in Society: the development of higher psychological processes, London. Harvard University Press.
- Wenger, E. (1998). Communities of practice: Learning, meaning, and identity.New York NY. Cambridge University Press.
- Westheimer, J. (1999). Communities and consequences: An inquiry into ideology and practice in teachers' professional work. Educational Administration Quarterly 35(1), 71–105.
- Wiley, S. (2001). Contextual effects of student achievement: School leadership and professional community. Journal of Educational Change. 2(1), 1–33.
- Worth, J. (2018).'The UK's teacher supply is leaking... and fast'. June (28).
- Times Educational Supplement. Retrieved from https://www.tes.com/

Appendices

Appendix A.

Grossman (1990) (In John P.D. (2002) (pp.323-324))	**Bullough (1997) (In Loughran, J. (2007) (pp.84-85))**	**Korthagen, Loughran and Russell (2006) (pp.1025-1036)**	**Berry and Loughran (2002) (pp.17-22)**
A coherent vision of teaching organized around the subject matter to be taught.	Teacher identity is important and teacher education must begin by exploring the teaching self.	Principle 1: Learning about teaching involves continuously conflicting and competing demands.	Assertion 1: Start as if you're halfway through the subject.
A collaborative relationship among the tutor mentors and students.	The exploration of teacher identity necessitates a study of schooling and wider social context	Principle 2: Learning about teaching requires a view of knowledge as a subject to be created rather than as a created subject.	Assertion 2: Be confident to be responsive to possibilities in learning experiences.
A shared sense of ownership.	An understanding of social philosophy and the aims of education in a democracy are important.	Principle 3: Learning about teaching requires a shift in focus from the curriculum to the learner.	Assertion 3: An uncomfortable learning experience can be a constructive learning experience.
The existence of the appropriate scaffolding for learning.	Teacher education must challenge beliefs whilst still being supportive and respectful.	Principle 4: Learning about teaching is enhanced through (student) teacher research.	Assertion 4: A shared experience with a valued other provides greater opportunity to reframe situations and confront one's assumptions about practice.
A reflective stance taken by the teacher educator towards both his/her own practice and towards the learning of student teachers.	Articulation of program decisions is important in building a trusting environment.	Principle 5: Learning about teaching requires an emphasis on those learning to teach working closely with their peers.	
	Learners choose whether or not to accept responsibility for learning.	Principle 6: Learning about teaching requires meaningful relationships between schools, universities and student teachers.	
	There is no one best teaching style or approach to teaching	Principle 7: Learning about teaching is enhanced when the teaching and learning approaches	

	but quality judgments must still be made in developing practice.	advocated in the program are modelled by the teacher educators in their own practice.	
	Individuals make their own meaning of teacher education.		
	Program continuity involves more than just sensible sequencing of content. Opportunities for students to create their own sense of continuity is also crucial.		
	A language of learning and applying it with others is part of being a professional.		
	Teaching requires exploring new methods and techniques and purposefully engaging in ongoing data-driven self-evaluation.		

Appendix B.

Reconaissance survey questions
1. What do you feel about the science teacher training you have received throughout your career?
2. What do you feel about the science teacher training you have received at this school?
3. Do you feel that understanding and developing science teaching practice is important?
4. Do you feel that you want to develop other aspects of your role as a teacher(E.g your role as a form tutor, or leadership & management)?
5. How do you think science teacher training could be improved in this school?
6. What role do you think observation has in the development of science teachers?
7. What do you think is an effective way to share science teaching practice?
8. Is there someone who you think you work effectively with in relation to the development of your practice?

Appendix C.- Slides used in Meeting 1.

Departmental CPD: 11.02.2020- *Obligatory session*

Life can only be understood backwards; but it must be lived forwards.

Søren Kierkegaard (1813-1855)



Questionnaire response summary:

The purpose of the the form was to establish your views on science teacher development in the school.

Themes in your answers:

- Science specific teacher training is important, there should be more of it and should it should be undertaken in a structured and 'semi-regular'way.
- Science teaching practice can be supported through observation of practice and that observation is purposeful.
- Science teacher training can be supported through collaboration.
- You are interested in building your leadership capacity.
- Practical work is potentially an area of interest for some.
- Some are happy to be recorded teaching. Some are happy to use an 'open-door' policy for observation.

My interpretation:

- There is a blend of development interests i.e. leadership and pedagogical content knowledge. Developing subject knowledge seems less important.
- You want shared experiences that you can discuss and **reflect on**. This could be a way to; develop our team, develop individual practice and leadership capacity.

Fundamental ideas.

"A problem is unlikely to be acted on if It is not viewed as a problem…….. Experience alone does not lead to learning, reflection on experience is essential." Loughran (2002, p.35)

Teachers who see their classrooms conceptually and apply personal theories can develop professional knowledge. This will, in turn, lessen the complexity of their work in the classroom (Copeland, 1981).

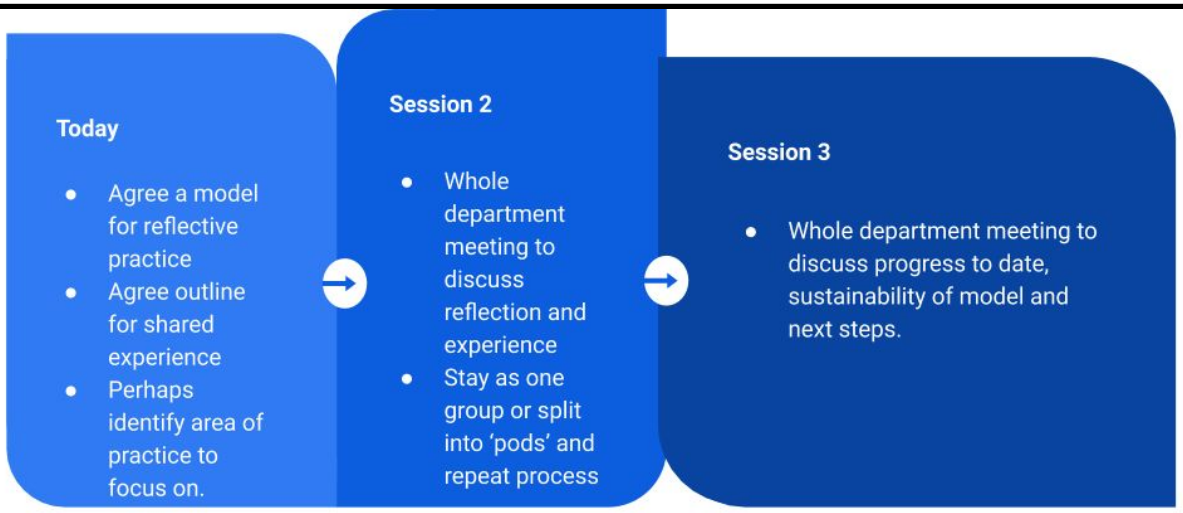
- Copeland, W. D. (1981). Clinical experiences in the education of teachers. British Journal of Teacher Education, 7(1), 3–16.
- Loughran, J. J. (2002). Effective reflective practice in search of meaning in learning about teaching. Journal of Teacher Education, 53(1), 33-43.

A suggested aim for our CPD…

Look at an area of science teaching practice conceptually and reflect on it together.

Which can be categorised within two threads:

- *Developing an area of practice*
- *Developing reflective practice*

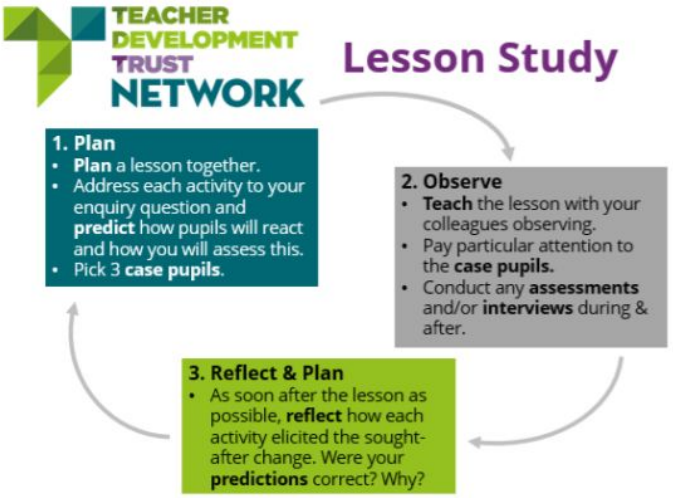


Proposal:

Suggestions for reflective practitioners. Points to discuss

- *Journals or work diaries*
- *Japanese lesson study*
- *Peer to peer interviews*
- *The listening project*

Japanese lesson study



Bigger stimuli questions

The following are questions I have studied, considered and have some knowledge of. Pick one or more of them and consider what they mean. Do you have any answers to them now? What could you do to answer them more deeply?

1. *What makes a good science question in a lesson?*
2. *Why do we put an emphasis on practicals in science lessons? Are we right to do so?*
3. *What does an expert science teacher look like?*
4. *Where do we gain knowledge as science teachers, through educational theories or through our professional experience?*
5. *What does learning look like in a science lesson?*
6. *What role does 'educational research' have in your classroom?*

If you have other questions we can discuss them too.

Appendix D.

Semi-structured interview questions
How do feel about the observation?
How do you feel about working within the group?
Is there anything that you would like to do again? Would you do it differently?
What was the most important part of the Japanese lesson study and why?
Do you think you learnt anything? If so, what?
How does what we did compare with other CPD sessions you have been involved with?
Is there anything you might use from the meetings or observation in the future?